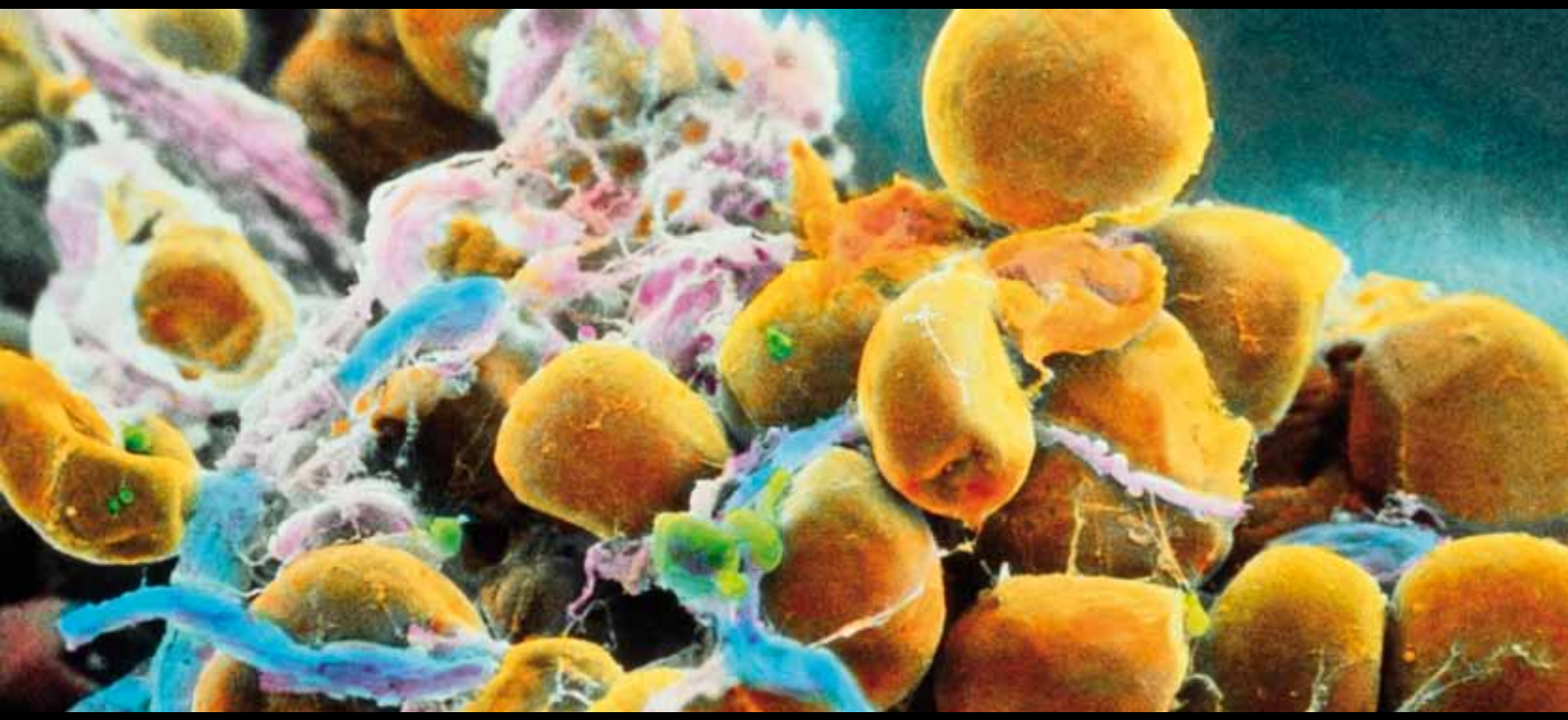
Journal of Obesity

Self-Regulation, Motivation, and Psychosocial Factors in Weight Management

Guest Editors: Pedro J. Teixeira, Jutta Mata, Geoffrey C. Williams, Amy A. Gorin, and Simone Lemieux



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Editorial Board

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 582348, 4 pages
doi:10.1155/2012/582348

Editorial

Self-Regulation, Motivation, and Psychosocial Factors in Weight Management

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Received 15 October 2012; Accepted 15 October 2012

Any attempt to self-regulate one's body weight takes place at the intersection of the external environment and innate biological predispositions that, especially when combined, can be highly conducive to energy surpluses and excessive fat mass accretion. Prominent examples of such factors are high availability of calorie dense, palatable foods, economical constraints that negatively influence lifestyle choices, and the human predisposition for liking sweet and fatty foods. As a consequence, it is no surprise that the majority of individuals have become overweight or obese, apparently "losing control" and "succumbing" to these external and internal obesogenic pressures. At the same time, it is known that behaviors related to body weight regulation, namely, physical activity and diet, are generally within the reach of voluntary control and regulation, as evidenced by studies of successful weight loss maintainers who report dramatic changes in their lifestyles despite being surrounded by seemingly obesogenic environments [1]. These improvements have frequently been linked to individuals finding new ways of relating to one's weight and lifestyle, new self-perceptions, motives, goals, emotional responses, habits, and so forth (e.g., [2–4]). This apparent paradox is reinforced by a frequent tension between population-level ("environmental," "political") versus individual-level ("motivational," "self-regulatory") approaches to addressing the problem of obesity, which may be misguided; both will likely be necessary and one can inform the other.

Various perspectives can be taken to address obesity prevention and treatment. One is that obesity, at a population level, is largely "caused" by environmental factors and consequently it should primarily be tackled with public health measures [5]. Other views, informed by advances in molecular biology, tend to favor approaches rooted in the genetics of obesity (e.g., prevention by early risk diagnosis) [6] and/or pharmacological solutions to treat the most prevalent forms of obesity [7]. Lately, interventions derived from applying principles of behavioral economics have come forth with solutions based on "nudges" and small changes in contextual "default conditions," as they bypass individuals' volition, biases, and errors in judgment [8]. While other perspectives exist (e.g., [9, 10]), this special issue is a statement that exploring psychological determinants of health behavior such as reasons, goals, expectations, values, beliefs, or self-perceptions - and getting individuals more (and better) motivated in self-managing their health, remain important aspects to address in fighting obesity. While, in concept, no one disputes that motivational factors or, more generally, psychosocial processes are relevant to understanding why people behave the way they do, in regards to their health, this topic has sometimes been presented as "old news" in

obesity research, which is premature. We believe that a more productive stance is one that recognizes that a multitude of perspectives and solutions must be effectively integrated in order to more successfully fight obesity [11].

Environmental change may be slow to implement, can be very expensive, is often stalled by industries with competing interests, and can have unpredictable and even paradoxical outcomes, all of which makes research in this area a formidable challenge [12]. Furthermore, social and economical conditions will evolve, and many people will move across different physical and cultural environments through the course of their lives (sometimes for long periods), which could limit the efficacy of some environmental interventions. Therefore, it is crucial to also improve existing strategies and develop new strategies that help people better navigate obesogenic environments, wherever and whenever they exist, by maximizing their own self-regulatory resources. Again, a critical point is that population-based initiatives to fight obesity can and should be informed by "individual-level" research (e.g., mass, internet-based campaigns to promote fruits and vegetables which apply sound theory-based motivational principles); similarly, "individual-level" interventions (e.g., primary care consultations) should be mindful of research findings in areas such as the impact of the built environment of physical activity or how contextual "nudges" impact health-related decisions and behavior. Regardless, all these initiatives must be supported by focused, high-quality research that seeks to understand why, how, and under which conditions children, adolescents, and adults are more likely to remain at, or achieve healthful levels of body weight. This special issue aims to make a contribution to this research.

The 14 articles published in this special issue underline the importance of psychological factors in the context of body weight self-regulation. For instance, L. Karhunen and colleagues [13] show that psychobehavioral factors are more important for weight regulation than individual satiety levels or diet characteristics, whereas E. A. Dennis and colleagues [14] point out the difficulty of maintaining weight during freshman year at college, even with explicit training in self-regulation skills. C. Bégin and colleagues [15] demonstrate that self-regulation during weight loss attempts systematically differs between women with lower and higher depressive symptoms, underlining the importance of psychological health and wellbeing as a prerequisite in self-regulation of health behaviors.

Three articles investigate the role of self-perceived weight in adolescents. R. C. Krauss and colleagues [16] show that accuracy differences in weight perceptions explain some of the weight disparities between adolescents of different ethnic groups in the US. K. Ojala and colleagues [17] report that overweight boys and girls in Finland accurately perceived their weight as higher and had a lower body image than normal-weight children. Importantly, adolescents who perceived themselves as being overweight despite being in a healthy weight range were more likely to actually be overweight 11 years later [18].

Three articles examine physical activity, a health behavior central in weight management. E. Guérin and M. S. Fortier [19] showed how situational motivation and perceived exercise intensity predict changes in positive affect following physical activity. D. S. Buchan and colleagues [20] reviewed current psychological models for increasing physical activity levels and describe the need for more ecological models. M. L. Segar and colleagues [21] show that framing physical activity as a way to positively influence daily well-being enhanced body image and perceptions about the physical activity experience in overweight women.

Three articles investigate the role of the social environment for self-regulation of bodyweight, particularly, the role of parents in children's and adolescents' weight management. K. P. Jakubowski and colleagues [22] showed that parental readiness to change weight control behaviors was predictive of adolescents' body mass index at treatment end. In their review, L. A. Frankel and S. O. Hughes [23] made interesting connections, applying the literature on parental influence on their children's emotion regulation to parental influence on self-regulation of energy intake in children. These articles point to the importance of the interaction of the social environment (parents) with the self-regulation of weight-related behaviors in children and adolescents. S. B. Gesell and colleagues [24] report on a different aspect of the parent-child relation in the context of weight management. They show that over the course of a three-month obesity prevention trial parents form new social ties with parents of children with similar body types. Thus, parents of obese children were more likely to become friends with parents of other obese children and parents of normal-weight children would befriend parents of other normal-weight children more often.

Another central topic in self-regulation is an individual's motivation. Two articles examined the role of external motivation, namely, monetary incentives for weight regulation. M. M. Crane and colleagues [25] showed somewhat surprisingly that small monetary incentives did not influence autonomous or controlled motivation for participation in a 1-year weight loss trial. In contrast, the findings by A. C. Moller and colleagues [26] demonstrate that participants in a three-week health behavior improvement program who reported being more motivated by a monetary incentive had higher body weight at 17 weeks followup. Finally, J. Y. Breland and colleagues [27] suggest the Common-Sense Model of Self-Regulation as a framework for organizing existent tools and creating new means to improve long-term weight regulation.

We believe this special Issue will enhance our understanding of psychological—especially motivational and self-regulatory—factors in weight management and, collectively, provide an interesting snapshot of research in this area, with a good share of innovative empirical findings (e.g., [18, 23, 26]) and fresh conceptual discussions (e.g., [20, 23, 27]).

As a final note, it is important to remember, especially when dealing with issues involving individual self-regulation, that our society protects human freedom of choice. Biomedical ethics, the legal system in the US, and medical professionalism protect patient autonomy in health care and in research studies and have recently agreed that it should be a primary outcome of all health care interactions

([28–31]). The need to respect patient autonomy in all health care interventions is mandated and thus is not a choice for whether practitioners, policy makers, or researchers will support it in a particular intervention. Thus, more research is needed to understand how autonomous self-regulation is affected by public health messaging, clinical and community programs, food industry advertising, economic rewards and punishments, and genetics. Also, health care is delivered in a free choice paradigm; thus, interventions must focus on helping participants to choose options that help them maintain their weight or weight loss and which they want to continue to choose after the intervention's end. To determine the success of an intervention, researchers are strongly encouraged to document the effect of their interventions for a period of at least 6 months after the intervention ends. For obesity, known for its high recidivism, this period might be even longer.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 298067, 12 pages
doi:10.1155/2012/298067

Research Article

Parents' Readiness to Change Affects BMI Reduction Outcomes in Adolescents with Polycystic Ovary Syndrome

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Received 5 December 2011; Revised 23 April 2012; Accepted 6 June 2012

Academic Editor: Pedro J. Teixeira

Evidence supports the importance of parental involvement for youth's ability to manage weight. This study utilized the stages of change (SOC) model to assess readiness to change weight control behaviors as well as the predictive value of SOC in determining BMI outcomes in forty adolescent-parent dyads (mean adolescent age = 15 ± 1.84 (13–20), BMI = 37 ± 8.60; 70% white) participating in a weight management intervention for adolescent females with polycystic ovary syndrome (PCOS). Adolescents and parents completed a questionnaire assessing their SOC for the following four weight control domains: increasing dietary portion control, increasing fruit and vegetable consumption, decreasing dietary fat, and increasing usual physical activity. Linear regression analyses indicated that adolescent change in total SOC from baseline to treatment completion was not predictive of adolescent change in BMI from baseline to treatment completion. However, parent change in total SOC from baseline to treatment completion was predictive of adolescent change in BMI, ($t(24) = 2.15$, $p = 0.043$). Findings support future research which carefully assesses adolescent and parent SOC and potentially develops interventions targeting adolescent and parental readiness to adopt healthy lifestyle goals.

1. Introduction

Obesity is the most common chronic health condition in pediatrics. In the United States, approximately 17% (or 12.5 million) of children and adolescents aged 2–19 years are obese (body mass index ≥95th percentile), and the prevalence of obesity has nearly tripled since 1980 [1]. The necessity of effective prevention and treatment programs cannot be overstated, particularly when considering the severity and expense of obesity-related medical conditions in children and adolescents (e.g., diabetes mellitus, asthma, and high blood pressure). Polycystic ovary syndrome (PCOS) is a common, chronic condition often associated with obesity that affects approximately 6–10% of women of reproductive age [2]. PCOS is characterized by anovulation, hyperandrogenism, and insulin resistance, and approximately 70–74% of adolescents with PCOS are obese [3]. It is increasingly being recognized in adolescent girls who seek treatment for symptoms of hyperandrogenism [4].

Lifestyle modification encouraging dietary and physical activity change is the standard treatment for overweight and obese youth [5, 6]. Consequently, readiness to change eating and activity behaviors likely impacts obesity treatment outcomes. This may be particularly important for adolescents with PCOS, as the condition is associated with depression in nearly half of the diagnosed cases, and this may impact readiness to make behavioral change [7–11]; thus it is important to understand how to help patients make effective lifestyle changes.

The transtheoretical or Stages of Change (SOC) model describes individuals' readiness to make behavioral changes

[12]. In this model, the process of change is explained as a series of stages. These stages of change, as defined by DiClemente and Prochaska [12], are *precontemplation* (unaware of problem and without intention to change), *contemplation* (aware of problem and with intention to change), *preparation* (planning for change), *action* (implementing behavior change for less than six months), and *maintenance* (implementing behavior change for more than six months). The stages of change describe change as an unfolding process, one that is fluid and does not necessarily move in a linear fashion from one stage to the next.

There is support for considering SOC in adult weight management. First, SOC has been shown to capture current weight-related behaviors such as fat intake, effectively characterizing adults into pre-action (*precontemplation or contemplation*) or *action* stages according to participants' self-reported current dietary fat intake and confidence in their ability to make changes to their dietary fat intake in the future [13]. SOC also has substantial support as a predictor of positive lifestyle changes in adults, such as predicting readiness to make broad health changes learned in a diabetes educational program [14], as well as improved nutrition [15, 16]. More specifically, results from Glanz and colleagues [15] indicate that SOC was a significant predictor of dietary habits for adults, explaining 93% of the variance in dietary intake for fat and 73% of the variance for fruits and vegetables, even after controlling for important covariates such as BMI and demographics. Additionally, Greene and colleagues [16] found a positive association between SOC and fruit and vegetable intake, particularly a linear increase in intake from individuals in the *precontemplation* stage to individuals in *action/maintenance* stages. SOC has also been used to predict level of physical activity in adults, including minutes of moderate to very hard intensity, as well as increased physical activity based on stage-tailored physical activity interventions [17–21].

While the literature involving interventions in adolescents is considerably less robust than that for adults, there is a growing body of work describing promising interventions for adolescents for a range of health-related behaviors including smoking cessation [22], weight control [6, 23–26], and metabolic control in adolescents with diabetes [27]. Furthermore, there are a growing number of studies assessing SOC in adolescents. The aforementioned paragraph demonstrated that SOC predicts dietary and physical activity habits in adults, yet evidence shows that readiness to change may also be predictive of success in interventions targeting the improvement of glycemic control in adolescents with diabetes [28], lowering dietary fat intake in adolescents [29], and decreasing snack/dessert consumption in overweight and obese adolescents [30].

Despite the evidence that SOC may help predict outcomes in adolescents' readiness to make healthy lifestyle changes, these changes do not happen in isolation. Parents' dietary and physical activity SOC may also be influential for their adolescents' behaviors. Research indicates that family eating and lifestyle habits may provide an "obesogenic" environment for children and adolescents [31]. It has been shown that children who are more physically active are more likely to have physically active parents [32] and that the fruit and vegetable intake of young girls is positively related to parental fruit and vegetable intake [33]. Parents typically play a critical role in the home food environment as they are often the ones purchasing food and preparing meals. Furthermore, parental readiness to change eating behaviors is potentially important to adolescent outcomes because adolescents may adopt behaviors modeled by their parents [34]. Conversely, adolescents may be limited in their healthy food choices within the home given the type of food provided by parents. Thus, adolescents who are ready to make positive changes to their lifestyle choices may be stalled by parental SOC. However, little work has been conducted on the relationship between parent and adolescent SOC for weight management. Thus there is a need to fill this gap in the literature.

In addition to the potential influence of parent practices on adolescent SOC, there are a number of other factors that may impact adolescent readiness to change weight-related lifestyle choices. Co-occurring medical conditions such as type 2 diabetes and asthma may be associated with a higher SOC for adolescents, as positive weight management practices improve physical illness symptoms. On the other hand, common comorbid psychiatric disorders such as depression may decrease adolescents' motivation to make healthy changes [35, 36]. Given that this sample consists of adolescents with PCOS (a possible positive medical motivator) and depressive symptoms (a possible negative marker), it allows for the opportunity to elucidate the importance of SOC in a challenging, yet real world sample. The presence of a positive medical motivator like PCOS may also be an influential factor for mothers, who made up the majority of parent participants in the present study and who may have had PCOS themselves. Given these issues, the current study allows us to descriptively examine how simultaneous medical and psychiatric diagnoses may influence adolescents' SOC.

Taken together, the evidence reviewed suggests the importance of considering the impact of both parent and adolescent SOC on adolescents' abilities to make weight-related changes. Although family-based treatment programs have demonstrated success in the pediatric obesity literature, and supporting evidence indicates that parents' commitment to weight management is the best predictor of children's weight management success [37], there is little evidence with regards to the relationship between parents' readiness to change weight control behaviors and weight loss in their adolescent children. Given the strong support for family-based treatment programs, but the relative paucity of information on the utility of parent and adolescent SOC in weight management interventions, it is important to fill this gap in the literature. In this study we aimed to: (1) examine SOC in adolescents and parents participating in a pediatric weight management intervention at baseline and treatment completion, and (2A) examine associations between both adolescent and parent total baseline SOC and adolescent change in BMI at study completion, as well as (2B) examine associations between both adolescent and parent change in total SOC from baseline to treatment completion and change in adolescent BMI at treatment completion. Specifically, we

hypothesize that (1) adolescent baseline total SOC scores will predict adolescent change in BMI from baseline to treatment completion (six months) and (2) parent baseline total SOC scores will be a stronger predictor of adolescent change in BMI from baseline to treatment completion (six months). Additionally, since the stages of change are described as an unfolding, fluid process, one that may be influenced by motivational interviewing techniques, it is possible that baseline total SOC is not correlated with SOC across the course of treatment. Thus, exploratory analyses were conducted to measure associations between changes in adolescent BMI and changes in total SOC from baseline to treatment completion for both adolescents and parents.

2. Methods

Data for this investigation came from a larger 11-session family-based intervention employing Cognitive Behavioral Therapy (CBT) and Motivational Interviewing (MI) to target weight management and mood improvement in obese adolescents with polycystic ovary syndrome (PCOS) and comorbid depression (K12-HD043441 and K23HD061598 (DLR)). The larger study was approved by the University of Pittsburgh Institutional Review Board.

2.1. Participants. This study analyzed data from forty adolescent-parent dyads who agreed to participate in a psychosocial treatment study for adolescents with PCOS. The majority of adolescents in this sample were obese as defined by the Centers for Disease Control and Prevention criteria (BMI ≥95th percentile, for children of the same age and sex [37]), while three cases were categorized as overweight (95th percentile > BMI ≥ 85th percentile, for children of the same age and sex [37]). These adolescents were English-speaking females ages 13–20 (mean age = 15 ± 1.84 [12–19], BMI = 37 ± 8.60; 70% white, 22% African American, 8% biracial) primarily recruited for treatment at the Polycystic Ovary Syndrome Center or Adolescent Medicine Clinic at an urban Mid-Atlantic Children's Hospital. All participants had a confirmed diagnosis of PCOS based on clinical and laboratory evidence of hyperandrogenism and co-occurring, clinically significant depressive symptoms per a semistructured interview (K-SADS-PL [38]; see Measures). After receiving a comprehensive explanation of the study protocol and course of treatment, participants and/or their parents signed informed consent. The intervention was provided free of charge, and participants were compensated for completion of study measures; see Table 1 for inclusion and exclusion criteria.

2.2. Procedures. The intervention consisted of one-on-one sessions between adolescents and study interventionists, who were Masters- and Ph.D.-level clinicians trained as therapists, dieticians, and/or exercise physiologists. Sessions consisted primarily of CBT and MI for four weekly sessions, four biweekly sessions, and three monthly booster sessions (see Table 2 for a description of sessions). An engagement session, which occurred at the first meeting with each participant, allowed for presentation of the key principles of MI: suspension of the clinician's assumptions, utilizing open-ended questions, expression of empathy and reflective listening, working with patients' resistance, discussing change and adherence, and supporting the patients' self-efficacy [39]. This engagement session served the purpose to enhance the likelihood that adolescents with PCOS would enter, attend, and participate actively in the CBT protocol. For the purposes of this intervention, CBT and MI served as complementary approaches: CBT served as the empirically-validated therapeutic approach, teaching adolescents to reduce their physical and emotional disturbances, while MI was used to elicit health behavior change by enhancing intrinsic motivation [40]. Given MI's emphasis on increasing internal motivation for change, the techniques of MI may allow clinicians to assess the degree of motivation associated with individuals' readiness to make and maintain behavioral changes (albeit not synonymous with SOC) [41]. This is important in the context of SOC, as MI may help elucidate underlying aspects of readiness to change that lead to one's initial SOC and, perhaps more importantly, that stimulate subsequent movements between SOC throughout the course of treatment; for example, wanting to look more attractive or wanting to learn and implement strategies to improve diet and exercise [41]. Thus the tenets of MI are likely very useful in assessing and promoting specific areas of readiness to change that may lead to the evolution of SOC in individuals seeking treatment in a weight management program.

The eleven sessions, roughly an hour each, were intended to concurrently address mood and weight management in order to address the bidirectional relationship between managing weight and managing emotions. The overarching aim of the program was to encourage participants to increase their physical activity and make better nutritional choices in an effort to reduce weight as well as obtain skills to help them manage their emotions. Overall, the program employed a family-based approach, and the participation of at least one invested parent/guardian was strongly recommended for all participants, even those over 18 years of age. In addition to parent/guardian participation at the end of each session, during adolescent sessions one, four, and eight, parents were given the opportunity to participate in 30-minute sessions (with or without their child present) with the study interventionist. These three family-based sessions corresponded to the adolescent sessions and provided suggestions for how parents could support and encourage their adolescents' weight-related changes. The sessions were particularly focused on (1) creating a more optimal home environment for weight loss and increased physical activity (e.g., stimulus control, healthy cooking at home, and healthy eating when dining out), (2) facilitating more effective parenting using behavioral strategies (e.g., increasing praise/reinforcement and setting limits and rules to help adolescents make positive weight-related changes), and (3) summarizing the program and looking ahead (e.g., discussing strategies for nutrition and physical activity that could assist lifestyle changes, such as logging daily activity and foods eaten). Pilot data for the intervention indicated a significant reduction in weight, $t(11) = 6.6$, $p < .05$ with

Table 1: Inclusion and exclusion criteria.

Inclusion criteria	(1) Confirmed PCOS diagnosis by a board-certified physician (2) BMI percentile < 85 (3) CDI or CDI-P < 10 (4) DSM-IV diagnosis of minor or major depressive disorder as reported on the K-SADS-PL (5) Presence of at least one parent or guardian if ≤18 years of age (6) Age between 11 and 21, inclusive
Exclusion criteria	(1) History or current episode of bipolar disorder or psychotic disorder by DSM-IV criteria (2) Suicidality with plan or of severity requiring immediate psychiatric hospitalization or significant act involving intentional self-harm (e.g., cutting or overdose, resulting in medical attention) (3) Unacceptable risk for dangerousness to others as indicated by homicidal (or other violent) ideation, intent or plan or action, or use of illegal weapons

CDI: children's depression inventory; CDI-P: children's depression inventory-parent version; K-SADS-PL: Kiddie schedule for affective disorders and schizophrenia-present and lifetime version.

Table 2: Description of adolescent treatment sessions.

Session	Week	Session content
Session 1	Week 1	Overview of the program, description of healthy eating and physical activity, and difference between dieting and lifestyle change
Session 2	Week 2	Logging food and movement, reading food labels, and avoiding food traps
Session 3	Week 3	Managing emotions, avoiding sneak eating, and psychological versus physiological hunger
Session 4	Week 4	Tools to increase health and wellness (e.g., Stoplight Eating Plan, Healthy Plate)
Session 5	Week 6	Staying motivated, increasing physical activity, everyday lifestyle movement, and decreasing sedentary behavior
Session 6	Week 8	Changing self-talk to be more positive, developing a healthy body image and self-esteem
Session 7	Week 10	Being more self-aware with regards to eating, being active, and staying positive
Session 8	Week 12	Overcoming barriers, planning ahead for healthy meals, special occasions, and eating out
Booster Session 1	Week 16	Coping with PCOS
Booster Session 2	Week 20	Planning for the future
Booster Session 3	Week 24	Reflecting on the intervention

an average loss of 1.2 (±.3) kilograms over the course of the intervention, with a promising effect size of .45. For additional information about the intervention, refer to Rofey et al. [23].

Overall, seven adolescent-parent dyads included in the present study did not have data at treatment completion. The sample that completed the intervention was younger ($M = 15$ versus $M = 16$, $p < .05$) and had a lower BMI ($M = 35$ versus $M = 44$, $p < .05$). Using an intent to treat analysis, there was a trend for greater change in BMI ($M = 1.78$ versus $M = 0.25$, $p = .087$), and no differences on race ($t(39) = -.370$; $p = .714$).

2.3. Instruments

2.3.1. General Information Sheet (GIS). The GIS has been used in previous studies and includes age, race, gender, religion, school placement, and SES using an occupation-based measure, the Revised Duncan (TSEI) [42, 43]. Contact information was requested, which may be used for locating subjects in the future.

2.3.2. Psychiatric Screener. Participant screening involved a two-step process. The first step was based on self-report on the *Children's Depression Inventory* (CDI) [44], given that this study was part of a larger intervention aimed to address the connection between mood and weight. The CDI consists of 27 items assessing depressive symptomatology; inter-item reliability: ($\alpha = .75$). The total score on the CDI had to be at least 10 at recruitment [44]. This cut-off CDI score was chosen to be consistent with the usual cut-off scores for depressive symptoms in other physically ill populations [45–47]. The second step in the screening process was a semistructured psychiatric interview, *the Kiddie Schedule for Affective Disorders and Schizophrenia-Present and Lifetime Version* (K-SADS-PL) [38]. The K-SADS-PL is a semistructured interview designed to ascertain present episode and lifetime history of psychiatric illness according to DSM-IV criteria [48]. Inter-rater and test-re-test reliability have been established, as well as convergent and discriminant validity [49–51]. This measure was used to document the presence of specific pre- and post-treatment symptoms. Participants who endorsed symptoms commensurate with a diagnosis of minor or major depressive disorder were offered entry into the intervention portion of the study. Participants that were not eligible or chose not to participate were referred, if clinically appropriate, for the appropriate clinical services.

2.3.3. Weight Loss Behavior-Stage of Change Scale (WLB-SOC) [52]. Adolescents and parents completed the WLB-SOC [52] at baseline and intervention completion (six

months). The WLB-SOC is a self-report measure that assesses SOC on the following five weight control domains: increasing dietary portion control, decreasing dietary fat, increasing fruit and vegetable consumption, increasing usual physical activity, and increasing planned exercise. Although there are two physical activity domains, increasing usual physical activity and increasing planned exercise, we use only the increasing usual physical activity domain in the current study, as it is validated [52]. The portion control, fruits and vegetables, and usual physical activity subscales have nine items, while the dietary fat subscale has 11 items. Reliabilities for the subscales on the adolescent measure were generally high and ranged from $\alpha = .70$–$.87$ at baseline and $\alpha = .75$–$.91$ at treatment completion. For the parent measure, reliabilities ranged from $\alpha = .67$–$.86$ at baseline and $\alpha = .70$–$.89$ at treatment completion. Participants responded to items that assess health behaviors they currently perform or plan to perform in the future, such as drinking a glass of water before meals or using low-fat salad dressing.

Participants responded to examples of behaviors within each domain using a 1-to-5 rating scale that corresponds to the five SOC. The response set ranged from 1 = "I do not do this at least half the time now and I have no plans to do this" (*precontemplation*) to 5 = "I do this at least half the time now and I have been doing this for more than 6 months" (*maintenance*), for example, in response to the item "Eat at least 5 servings of fruits and vegetables per day." An overall SOC score was then determined for each of the four weight control behaviors, using guidelines provided by Sutton and colleagues [52]. The overall SOC scores for each domain were then added together to provide a "total SOC" score, representing an individual's overall readiness to engage in behaviors related to weight loss. Higher "total SOC" scores represented greater readiness to engage in weight loss-related behaviors.

2.4. Data Analysis. For the portion control, dietary fat, fruits and vegetables, and usual physical activity domains, Chi Square analyses were conducted to provide the distribution of adolescents and parents in early SOC (*precontemplation, contemplation, and preparation stages*) versus later SOC (*action and maintenance stages*) at baseline and treatment completion (six months). Extant data indicate that there is a difference between those who express an intention to change a problem behavior in the near future *(preparation)* and individuals already in the process of making changes *(action)*. Thus, we chose to divide the stages into "pre-action" (early SOC) and "action" (later SOC) groups [53]. Linear regression analyses were conducted using adolescent total SOC and parent total SOC as predictors of adolescent change in BMI from baseline to treatment completion (six months). Two sets of linear regression analyses were conducted with both adolescent total SOC and parent total SOC predictors. First, total baseline SOC (dietary portion control score + dietary fat score + fruits and vegetables score + usual physical activity score) for both adolescents and parents was analyzed as a predictor of adolescent change in BMI. Second, *changes* in adolescent and parent total SOC scores were used as predictors of change in adolescent BMI. Samples for *Chi Square* ($n = 31$) and linear regression analyses ($n = 40$) differed due to missing adolescent and parent SOC data at treatment completion.

3. Results

Age, race, and BMI did not significantly differ between participants included in Chi Square analyses and those included in the linear regression analyses [age ($t(69) = -.745$; $p = .459$), race ($t(69) = .286$; $p = .776$), BMI ($t(69) = -.567$; $p = .572$)]. Mean total baseline SOC for adolescents was 9.92 ($SD = 2.73$) and for parents was 11.79 ($SD = 3.46$), on a scale ranging from zero to twenty. Total SOC score is not indicative of a particular SOC (e.g., *contemplation*); it provides information that an individual is in some respects changing "more" or "less" in relation to others. Thus an increase in total SOC score suggests that a person is moving closer to a later SOC, such as the *action* stage or beyond. Mean total change in SOC from baseline to treatment completion for adolescents was 2.64 ($SD = 2.64$) and for parents was 2.04 ($SD = 3.21$). Paired samples t-tests indicated that both adolescents and parents significantly increased their SOC by an average of two points throughout the course of the intervention ($p < .001$ and $p = .005$, respectively). On average, adolescent BMI scores decreased by 0.52 ($SD = 2.18$) and BMI percentile decreased by 0.94 ($SD = 2.41$) percentile units from baseline to treatment completion. Preliminary analyses revealed outliers for mean change in adolescent BMI from baseline to treatment completion, therefore data were analyzed both with and without outliers. Results for descriptive analyses are reported using the full sample (outliers included), as results without outliers were not significantly different. Primary analyses (Hypotheses 1 and 2) and exploratory analyses were conducted both with and without outliers. Results significantly differed across these analyses, therefore both sets of results are presented in Table 4. Mean total baseline SOC was 9.85 ($SD = 2.88$) for adolescents and 11.80 ($SD = 3.62$) for parents, on a scale ranging from zero to twenty. Mean total change in SOC from baseline to treatment completion for adolescents was 2.77 ($SD = 2.69$) and for parents was 2.48 ($SD = 2.89$). Paired samples t-tests indicated that both adolescents and parents significantly increased their SOC by an average of two points throughout the course of the intervention (for both groups, $p < .001$). On average, adolescent BMI scores decreased by 0.17 ($SD = 1.30$) and BMI percentile decreased by 0.51 ($SD = 1.36$) percentile units from baseline to treatment completion. Age, race, and BMI did not significantly differ between outliers and nonoutliers: age ($t(38) = .426$; $p = .672$), race ($t(38) = 1.27$; $p = .212$), BMI ($t(38) = .081$; $p = .936$).

The first aim of the current study was to examine SOC in adolescents and parents at the initiation of a weight loss intervention. The distribution of adolescents and parents in early versus later SOC at *baseline* is presented in Figure 1, which illustrates that the majority of adolescents and parents were in early SOC for all four weight control behaviors at baseline.

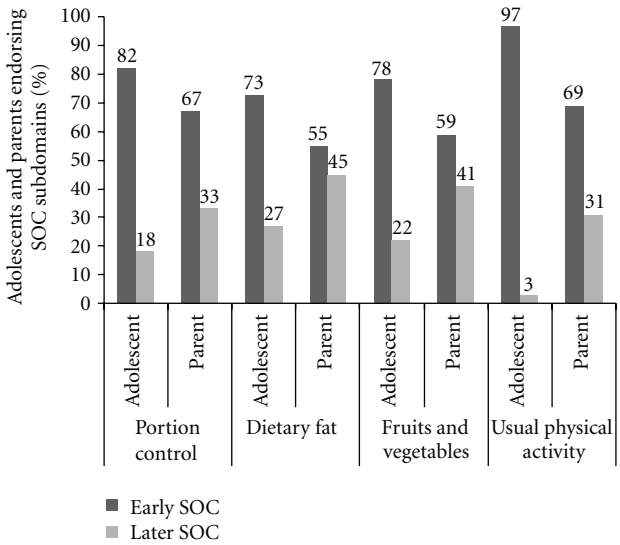

Figure 1: Distribution of Adolescents and Parents in Early SOC versus Later SOC at Baseline.

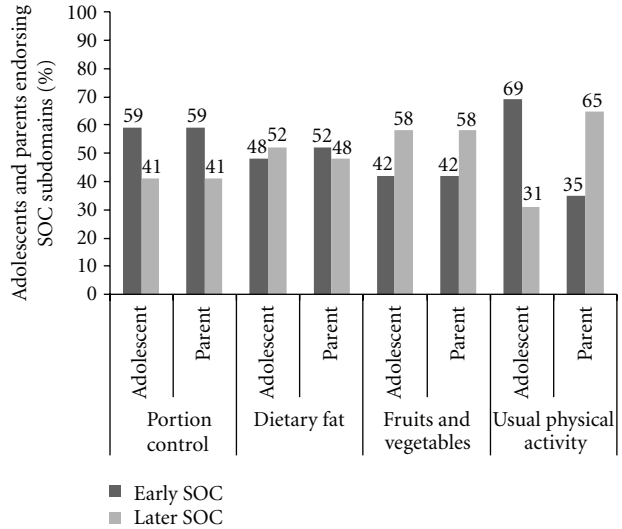

Figure 2: Distribution of Adolescents and Parents in Early SOC versus Later SOC at Treatment Completion.

Figure 2 presents data on the distribution of adolescents and parents in early versus later SOC at treatment completion, following the six-month intervention. As indicated in Figure 2, the majority of adolescents were still in early SOC for increasing dietary portion control and increasing usual physical activity at *treatment completion* but endorsed later SOC for decreasing dietary fat and increasing fruit and vegetables. With regard to parent distributions in early versus later SOC at treatment completion, the majority of parents were in later SOC for the fruits and vegetables and usual physical activity domains, but not for the portion control or dietary fat domains (Figure 2).

3.1. Primary Analyses. Results shown in Table 3 indicate that adolescent total baseline SOC did not significantly predict change in adolescent BMI from baseline to treatment completion. Given our proposal that baseline SOC may not be the best predictor of change in BMI, it was equally important to look at change in SOC over time. Thus, we also examined *change* in total adolescent SOC from baseline to treatment completion as predictors of change in adolescent BMI. Results shown in Table 3 indicate that adolescent change in total SOC did not significantly predict adolescent change in BMI from baseline to treatment completion. Overall, the data presented in Table 3 do not support our hypothesis that adolescent baseline SOC scores would predict adolescent change in BMI from baseline to treatment completion (with outliers removed, there were no differences in results for adolescent predictors; see Table 3). Additionally, change in total adolescent SOC from baseline to treatment completion also did not predict change in adolescent BMI (Table 3).

Results shown in Table 4 indicate that parent total baseline SOC also did not significantly predict adolescent change in BMI from baseline to treatment completion. However, when we examined *change* in total parent SOC from baseline to treatment completion as a predictor of adolescent change in BMI, results (Table 4) indicated that change in parental total SOC reports from baseline to treatment completion significantly predicted adolescent change in BMI from baseline to treatment completion ($t(24) = 2.15$, $p = 0.043$; $\eta^2 = 0.42$). To determine which weight control domains were driving this effect, we subsequently analyzed change in parent subscale SOC scores as predictors of adolescent change in BMI from baseline to treatment completion. As indicated in Table 4, a main effect of change in parent dietary fat SOC scores from baseline to treatment completion on change in adolescent BMI approached statistical significance ($t(26) = 1.76$, $p = 0.091$; $\eta^2 = 0.23$). However, change in portion control SOC, fruits and vegetables SOC, and usual physical activity SOC did not significantly predict adolescents' change in BMI from baseline to treatment completion. With outliers removed, a main effect of change in parental total SOC reports from baseline to treatment completion on adolescent change in BMI from baseline to treatment completion approached statistical significance ($t(21) = 1.81$, $p = 0.087$; $\eta^2 = 0.53$); additionally, a main effect of change in parent SOC score for fruits and vegetables on adolescent change in BMI from baseline to treatment completion also approached statistical significance ($t(21) = 1.95$, $p = 0.066$; $\eta^2 = 0.32$), see Table 4. Although the data presented in Table 4 did not support Hypothesis 2, exploratory analyses revealed that change in total parent SOC from baseline to treatment completion significantly predicted change in adolescent BMI from baseline to treatment completion. Additionally, a trend emerged for change in parent dietary fat SOC as a predictor of adolescent change in BMI. With outliers removed, trends emerged for change in parent total SOC and change in parent fruit and vegetable SOC as predictors of adolescent change in BMI from baseline to treatment completion.

4. Discussion

The key aim of the current investigation was to examine the relation between adolescents' and parents' self-reported readiness to change health-related behaviors and change in

Table 3: Regression analyses for adolescent change in BMI by stage of change from baseline to treatment completion.

Adolescent predictors	Outliers included				Outliers removed			
	R^2	B	Beta	p	R^2	B	Beta	p
Main effect								
Total baseline SOC	.014	.093	.117	.483	.013	.051	.116	.514
Total change in SOC	.000	.008	.013	.947	.016	.054	.126	.539

$^{*}p < 0.05$; total baseline SOC: sum of SOC scores for four SOC subscales (portions + dietary fat + fruits and vegetables + physical activity); total change in SOC: difference of total baseline SOC and total SOC at treatment completion.

Table 4: Regression analyses for adolescent change in BMI by stage of change from baseline to treatment completion.

Parent predictors	Outliers included				Outliers removed			
	R^2	B	Beta	p	R^2	B	Beta	p
Main effect								
Total baseline SOC	.020	.094	.141	.426	.006	.028	.076	.690
Total change in SOC	.173	.283*	.416	**.043**	.147	.168^{t}	.383	.087
Change in portion control SOC	.001	.061	.039	.851	.005	.063	.072	.746
Change in dietary fat SOC	.114	.483^{t}	.338	.091	.063	.242	.250	.249
Change in fruits and vegetables SOC	.114	.695	.337	.107	.166	.479^{t}	.408	.066
Change in physical activity SOC	.081	.369	.285	.177	.035	.139	.188	.414

$^{*}p < 0.05$; $^{t}p < 0.10$; total baseline SOC: sum of SOC scores for four SOC subscales (portions + dietary fat + fruits and vegetables + physical activity); total change in SOC: difference of total baseline SOC and total SOC at treatment completion; change in (portions, dietary fat, fruits and vegetables, or physical activity) SOC: difference of SOC subscale at baseline and at treatment completion.

adolescent BMI during the course of a weight management intervention. Specifically, this study focused on adolescents and parents participating in a family-based weight management intervention for obese female adolescents with PCOS. Readiness to change was assessed using the SOC model [12]. Results revealed that the majority of adolescents and parents endorsed early SOC (versus later SOC) for all four weight control behaviors at baseline (increasing dietary portion control, decreasing dietary fat, increasing fruit and vegetable consumption, and increasing usual physical activity). Overall, these findings are consistent with evidence that individuals entering weight management programs have not yet implemented weight-related behavior changes consistent with being in a later SOC, for example, *the action stage* [54]. Prior to the end of the intervention, it is possible that adolescents and parents thought changes were important, but were not adequately confident in their abilities to complete these changes. At treatment completion, the majority of adolescents were still in early SOC for increasing portion control and increasing usual physical activity, compared to being in later SOC for decreasing dietary fat and increasing fruits and vegetables. Parents at treatment completion were still in early SOC for increasing portion control and decreasing dietary fat intake, while they endorsed later SOC for increasing fruit and vegetable intake and usual physical activity. Ultimately, both adolescents and parents endorsed later SOC for increasing fruit and vegetables and early SOC for increasing portion control. It is likely that increasing fruits and vegetables is relatively easy to change because it involves a specific dietary behavior, while increasing portion control may be difficult for both adolescents and parents as it may be a more comprehensive (and daunting) change that affects most dietary choices.

At treatment completion, adolescents and parents reported identical distributions in early versus later SOC for increasing portion control and increasing fruits and vegetables, with the majority of groups endorsing early SOC for portion control and later SOC for fruits and vegetables. Furthermore, roughly half of adolescents and parents endorsed later SOC for decreasing dietary fat (see Table 4) at treatment completion. However, the groups differed drastically in their readiness to change usual physical activity. The majority of adolescents were still in early SOC for increasing physical activity at treatment completion, while the majority of parents endorsed later SOC for this domain. It is possible that adolescents who are motivated to change dietary behaviors do not necessarily want to focus (or are *ready* to focus) on physical activity, which was indicated by our finding no correlation between adolescents' readiness to increase usual physical activity and their readiness to increase portion control or fruit and vegetable intake.

Considering adolescents' readiness to increase engagement in physical activity is separate from other weight-related behaviors, it is necessary to highlight the finding that the majority of adolescents were still in early SOC for increasing usual physical activity at treatment completion. This may suggest that increasing usual physical activity is a particularly challenging lifestyle change for adolescents and potentially requires extra attention from interventionists. Extant data suggests that physical activity is the key predictor in weight loss, especially for adults who plateau in their weight loss and/or individuals attempting to maintain weight loss [55]. On the other hand, engagement in sedentary behaviors may have negatively impacted adolescents' readiness to increase physical activity. Research in children has shown that engagement in sedentary behaviors is one of the greatest barriers to engagement in physical

activity [56, 57], perhaps because obese youth find sedentary behaviors more reinforcing [58]. Easy access to sedentary behaviors (e.g., computer, television, video games), limited access to opportunities to engage in physical activity (e.g., gyms, recreational facilities, parks), and comparatively low immediate reinforcing value of physical activity are potential reasons why obese adolescents find sedentary leisure-time activities more reinforcing, which consequently leads to weight gain. Previous work has indicated that reducing sedentary behaviors in children is associated with increases in physical activity that are similar to increases found when targeting physical activity directly [59–61]. Since the majority of adolescents in the present study were still in early SOC for increasing physical activity at treatment completion, future interventions may consider focusing on decreasing sedentary behaviors as a means to increase physical activity, instead of targeting physical activity alone. Additionally, this result supports the importance of curriculum-based physical activity in school as an avenue for providing adequate time for exercise in adolescents who may not be getting this outside of school.

Our hypothesis that adolescent baseline SOC scores would significantly predict adolescent change in BMI from baseline to treatment completion was not supported. Exploratory analyses examining the association between adolescent change in total SOC from baseline to treatment completion and change in adolescent BMI from baseline to treatment completion were also not significant. Given that this sample of adolescents had comorbid depressive symptoms consistent with a diagnosis of subclinical or clinical depression, they may have lacked sufficient motivation to make health-related changes. This is a salient factor to consider in a sample of obese adolescents whose depressive symptoms may inhibit their ability to experience significant weight loss and subsequent weight management. As stated above, there is a paucity of evidence regarding how depressive symptoms may affect adolescent motivation or SOC. Therefore, the present study helps to inform future research targeting female adolescents with physical and psychiatric diagnoses and may ultimately inform standard treatment of this population. While depression typically negatively affects motivational factors, our sample of adolescents with PCOS has preliminarily shown that their depressive symptoms may be weight driven and, therefore, may be a more positive motivational factor, such that these adolescents may feel more positive if they are able to succeed with weight loss [62, 63].

Our hypothesis that parent baseline SOC score would be a stronger predictor of adolescent change in BMI from baseline to treatment completion was not upheld. However, exploratory analyses revealed that *change* in parent total SOC from baseline to treatment completion did significantly predict change in adolescent BMI from baseline to treatment completion. It is likely that both adolescents and parents are less ready to make weight control changes prior to starting an intervention because they are less aware of important weight control behaviors and how they can incorporate them into their lives. Thus the change in total SOC variable may reflect the impact of the intervention itself on change in BMI and be a better predictor of subsequent adolescent change in BMI than total SOC at baseline. This finding also highlights the importance of examining change in SOC throughout the course of a weight management intervention, as well as the importance of using client-centered approaches.

Overall, the finding that parent change in total SOC from baseline to treatment completion significantly predicts adolescent change in BMI from baseline to treatment completion is consistent with previous evidence for the importance of parent involvement in and commitment to child weight management interventions [37]. Although this significant finding became a trend after the removal of the four outliers, it is possible that in a larger sample the significant association could be upheld. In support of how powerful parental influence may be for weight management in children, Golan and colleagues [64, 65] found that targeting the parent as the primary agent of child weight loss compared to targeting children as the primary agent resulted in significantly more child weight loss at program termination and at 1-, 2-, and 7-year follow-up. Similarly, a review by Epstein et al. [66] presented support for family-based programs for both short- and long-term weight loss among youth. Consequently, there is demonstrated support for the role of family-based treatment in child weight management, yet there has been very little work with regard to the role of parents in treatment for adolescents. Although parents generally have less influence on adolescent behavior, as compared to child behavior, the present findings illuminate the possibility that parent involvement does play a salient role in the success of weight management interventions for adolescents. Thus these results indicate the necessity for further research into the parent-adolescent dyad and more specifically into the impact of parent readiness to make weight-related changes on the effectiveness of adolescent weight management.

Parent change in readiness to decrease dietary fat intake and to increase fruit and vegetable intake from baseline to treatment completion emerged as *specific* weight control behaviors related to change in adolescent BMI. These trends may be indicative of true associations and could potentially be substantiated if tested in a larger sample. Since parents making changes in one specific weight control domain translated to adolescent weight change, it is likely important for parent-interventionist sessions to involve discussing specific, succinct behavioral changes and setting goals [64, 65].

4.1. Clinical Implications. The importance of parent involvement in adolescents' weight management is potentially important to future pediatric weight management interventions. Our results highlight the salient role parents play in adolescents' weight management and may even suggest that future interventions emphasize using MI principles with parents, or at the very least, a parent-only group [29, 67, 68]. Because MI is a client-centered therapeutic approach that aims to meet persons at their current SOC and help solve ambivalence surrounding making a behavior change [39], it may serve as a particularly useful technique for enhancing readiness to change. Its directive, nonjudgmental approach allows interventionists to meet adolescents in their particular stage and work through their ambivalence to move

to later SOC. Furthermore, MI allows for the possibility of movement back and forth between different stages, thereby alleviating any pressure related to a fear of failure. Future interventions that implement assessment of SOC with an MI spirit are strongly suggested over psychoeducational programs. Psychoeducation may lead to overestimating an individual's readiness to change, and MI may increase the likelihood of parents serving as a supportive coach for their adolescents as they instill family-based changes in the household. Furthermore, using MI techniques with parents may advance their readiness to make positive weight-related changes, which may directly influence their adolescent's readiness to also make changes. Assessment of parent and adolescent SOC allows for tailored interventions that are congruent with participants' individual stages of readiness, which can in turn improve treatment outcomes [54].

4.2. Study Limitations and Future Directions. This investigation was subject to a number of limitations. First, this study specifically focused on obese adolescent females with PCOS and comorbid depression. Thus, it is possible that these results are not generalizable to other populations, particularly obese male adolescents or adolescents without co-occuring physical or psychiatric diagnoses. The use of self-reported questionnaire data may have increased response bias motivated by social desirability factors. This study did not investigate parent BMI or parent change in BMI as predictors of adolescent change in BMI, which may be important factors in adolescents' readiness to make weight-related behavior changes and in change in BMI. Additionally, while using BMI z-score is generally recommended for ages 2–19, our sample ranged in age from 13 to 20 years therefore we chose to use change in BMI as our outcome measure. Furthermore, it is unclear if the parents' readiness to change reflected motivation to make weight-related changes for themselves *or* possibly their motivation to make changes on behalf of their daughters. It would be valuable to elucidate which aspect of parents' motivation is more predictive of adolescent change in BMI, to better inform and structure parent involvement in treatment. It is also possible that the depression experienced by the adolescents and/or their medical diagnosis of PCOS may have influenced their motivation to make weight-related changes. Future research may resolve these questions by examining the following: first, if depression is related to adolescents' readiness to make health changes; second, the directionality of that relationship; third, how the presence of a medical diagnosis is related to readiness to make changes. Finally, although SOC was shown to predict change in adolescent BMI, the present study did not indicate SOC as a predictor of actual behavior (e.g., portion control SOC as a predictor of actual changes in portion control behavior). Although it is likely that, individually, each SOC subscale is more related to readiness to engage in the actual behavior (e.g., decreasing dietary fat) than overall change in BMI, it is important to note that weight control involves a complete lifestyle change. This supports the use of examining the four subscales together as *total* SOC, as a composite score of overall readiness to change one's lifestyle, which may better predict subsequent change in BMI.

Study results lend to suggestions for future research directions. First, it may be important to evaluate adolescent and parent SOC at multiple time points throughout a pediatric obesity intervention, possibly to tailor the progress of the intervention to focus more directly on SOC subscales (e.g., physical activity) that adolescents and parents are still not yet ready to change. Second, given that parent SOC significantly changed from baseline to treatment completion and adolescent SOC did not, future investigations might focus on first increasing parent readiness to change as a means to subsequently increase adolescent readiness to change. It may also be informative to examine how techniques such as MI could improve patient and/or parent SOC with regard to behaviors necessary for successful weight management or if SOC could be useful in predicting the effectiveness of MI compliant therapists in initiating change. Finally, future studies may examine the correlation between depressive symptoms (using both self-report and clinical interview assessments) and SOC scores, to determine how depression influences readiness to change weight control behaviors, particularly adolescents' motivation and perceived self-efficacy for making broad weight-related changes.

Despite the aforementioned limitations, our results that parent readiness to change plays an integral role in adolescent weight loss substantially contribute to the literature. Future studies should consider broadening the study sample to include boys, assessing parent and adolescent SOC at multiple time points and examining the role adolescent depression plays in motivation for lifestyle change. Treatment programs will potentially benefit from implementing assessment of SOC and MI. Overall, parent readiness to change weight-related behaviors is more predictive of adolescent change in BMI than adolescent readiness to change. These findings have important implications for future research and possibly prevention and treatment efforts for obese adolescents with co-occurring physical illness and depression.

Conflicts of Interest

The authors declare that they have no Conflicts of Interest.

Acknowledgments

These data are supported by K12-HD043441 (DLR) and K23HD061598 (DLR). The authors wish to acknowledge the Polycystic Ovary Syndrome Center of Children's Hospital of Pittsburgh, as well as Marguerite O'Hara, M. A. and Ronette Blake, M. S., for their assistance with this research project, including data management.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 846401, 10 pages
doi:10.1155/2012/846401

Research Article

Eating and Psychological Profiles of Women with Higher Depressive Symptoms Who Are Trying to Lose Weight

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Received 5 December 2011; Revised 23 April 2012; Accepted 15 June 2012

Academic Editor: Jutta Mata

The aim of this study was to determine whether women with higher depressive symptoms differed from women with lower depressive symptoms on early weight-loss, eating behaviors and psychological profiles. Among a sample of 45 overweight/obese women who had undertaken a self-initiated weight-loss attempt, two groups were formed based on scores from the Beck Depression Inventory (BDI-II), one with lower depressive symptoms (BDI-II < 10; $n = 21$) and one with higher depressive symptoms (BDI ≥ 10; $n = 24$). Even if some women in the higher depressive symptom group did not reach the clinical cut-off for depression (BDI = 14), this group tended to lose less weight in the first two months of their weight-loss attempt and to show a more disturbed eating and psychological profile compared to the group with lower depressive symptoms. In addition, among women with higher depressive symptoms, eating and psychological variables were systematically related to one another whereas these variables were not related among the other group. Results highlight the relevance of considering the presence of depressive symptoms as a marker of clinical severity among the overweight/obese population, and suggest that the BDI-II could be an interesting screening instrument to identify this particular subgroup.

1. Introduction

Obesity jeopardizes public health worldwide [1]. Despite the numerous weight-loss programs available, prevalence rates of obesity and overweight relentlessly increase, which suggests that, as many as they are, current weight-loss programs do not succeed in reducing, or even stabilizing, the proportion of individuals who are overweight or obese. One potential explanation might be that most individuals are not able to achieve or maintain weight-loss recommendations in the long term. Individual characteristics could account for these difficulties to regulate body weight. In fact, overweight/obese individuals seem to form a particularly heterogeneous population divided into specific subgroups that can be characterized by distinctive psychological features [2–4].

In particular, women suffer more from their weight problems than men and report more weight preoccupation and body dissatisfaction, regardless of their age, ethnic group, education level, and body mass index (BMI) [3, 5–7]. Women are also overrepresented in weight-loss programs, where 85 to 90% of participants are women [8–11]. In weight-loss studies, obese women also show greater distress than men; for example, they generally show more depressive symptoms and are more likely to report repetitive and unsuccessful dieting in the past [12, 13]. These considerations suggest that women represent an at-risk subgroup of obese individuals.

Another subgroup of obese individuals that may present distinctive features leading to strenuous weight regulation is the one characterized by a higher level of depressive symptoms. Overweight/obese women seem to be more vulnerable to depressive symptoms when compared to overweight/obese men and to normal-weight women [14]. Yet, all obese women are not systematically characterized by depressive symptoms, and the correlation between obesity and depression is significant but weak. In fact, while some studies reported a positive association [15–20] as well as a longitudinal bidirectional relationship between these two concepts [21], other studies reported a weak or no association at all [3, 22, 23]. These findings may suggest that, while some overweight/obese women are asymptomatic, another subgroup of women does show depressive symptoms, which may interact with other factors affecting eating behaviors and weight-loss efforts. Recently, several research groups have

observed the eating and the psychological differences between these two groups.

Werrij and her colleagues [24] studied this phenomenon among a sample of 166 women seeking treatment at a weight-loss center. Half of the sample was categorized as the higher depressive symptoms group, whereas the other half was identified as the lower depressive symptoms group on the basis of the Beck Depression Inventory score (median = 10). Women with higher depressive symptoms had higher weight, shape, and eating concerns as well as lower self-esteem. They also reported higher dietary restraint and greater binge eating. However, in this sample, women with higher depressive symptoms presented a higher BMI than the other women, which could account for the observed differences.

Subsequent studies have corroborated these results. Cluster analyses led to the identification of a higher negative affect group and a lower negative affect group among a sample of obese/overweight women from the community [25, 26]. Women with higher negative affect were younger and reported higher weight, shape and eating concerns, more binge eating, and lower self-esteem. Moreover, when exposed to negative mood induction, only women in the higher negative affect group presented disinhibited eating. These differences between the two groups could not be attributed to body weight, since groups had similar BMI.

Another study conducted among a sample of 156 overweight/obese weight-preoccupied women, involved in a Health-at-Every-Size program [27] replicated previous findings, and went further by showing that women with higher depressive symptoms presented some particular personality traits, notably high neuroticism and low agreeableness as well as problematic coping strategies, such as more emotion-oriented and avoidance strategies, and less task-oriented strategies. Again, these differences could not be attributed to body weight since there was no difference in BMI between groups. However, in this study, numerous exclusion criteria were used to identify eligible participants (e.g., no eating disorders, stable weight for two months, no clinical depression, etc.), which may limit the representativeness of the sample. Thus, taken altogether, these results suggest that women who present higher depressive symptoms may exhibit distinctive features that could impede weight-loss efforts.

Other studies support the hypothesis that depressive symptoms could be related to less successful weight-loss outcomes [13, 28–31]. Indeed, there is a significant, though weak, negative correlation between weight-loss and depressive symptoms ($r = -0.15$; $P < 0.01$) [13]. In the same order of idea, it has been shown that women with higher depressive symptoms are less likely to complete a weight-loss program or to succeed in losing weight [29–51]. Fabricatore and his colleagues [29] suggested that demands which are inherent to weight-loss programs may be too challenging for women with significant depressive symptoms.

Up until now, no study has dichotomized women based on depressive symptoms to observe their weight-loss outcomes. Moreover, most weight-loss studies have been conducted using well-controlled, randomized protocols, and structured weight-loss programs. Yet, some authors suggest that outcomes from controlled studies using structured weight-loss programs may differ markedly from what happens to women who try to lose weight on their own. In fact, these women are likely to be less rigorous and to lose smaller amount of body weight [13, 32, 33].

The study aimed at deepening the understanding of subgroups of overweight/obese women separated on the basis of depressive symptoms. Specifically, the objective of this study was to determine, in a naturalistic study, whether women with higher depressive symptoms differed from women with lower depressive symptoms on early weight-loss outcomes as well as on eating and psychological profiles, and to examine the links between all these variables among the different groups. We expected that higher depressive symptoms women would lose less weight compared to women with lower depressive symptoms and that they would present more problematic eating behaviors and less positive psychological features.

2. Method

2.1. Participants. Forty-five women who corresponded to inclusion criteria (being premenopausal, i.e., reporting a regular menstrual cycle for the last three months, having a BMI of 25 kg/m^2 or more, and having initiated a weight-loss attempt in the last week) completed baseline measures (questionnaires and physical measurements) (week 1). Thirty-six women came to the subsequent weighing visits (week 2 to week 8). Among women who dropped out of the study (n = 9), four moved away, two decided to stop for personal reasons and three could not be reached by the research team during the course of the study.

Women were aged between 21 and 56 years (M_{age} = 37.6 ± 9.6). Twenty-four (53.3%) were in a relationship (married or in couple) while 21 (46.6%) were not (i.e., single, separated, or divorced). All women completed a high-school diploma, and 26 (57.3%) completed a university degree. At baseline, mean BMI was 30.58 ± 4.83 (M_{BMI} for the lower depressive symptoms group = 31.05 ± 4.79; M_{BMI} for the higher depressive symptoms group = 30.16 ± 4.93). All women had initiated a weight-loss attempt one week or less before the baseline visit. Weight-loss methods ranged from reducing portions or trying to exercise more by themselves (n = 29), enrolling in commercial weight-loss programs with strict eating rules such as Weight Watchers and Minçavi programs (n = 13), or reading self-help books (n = 3). There was no significant difference between groups concerning the methods that were used to lose weight (Pearson chi-squares were not significant, P = 0.688 to 0.905). Only six women (13.3%) had never tried to lose weight before. Women had become preoccupied with their weight around the end of their adolescence or at the beginning of adulthood ($M_{\text{age of first preoccupations}}$ = 17.69 ± 7.71 years).

2.2. Procedure. For recruitment, advertisements were placed in commercial weight-loss and fitness centers, as well as in different places on the Laval University campus. In addition,

emails were sent to all students and staff of the university campus.

All participants were met at baseline (week 1), were told about the aims and procedures of the study, and were asked to read and sign the consent form approved by the ethics committee of the university. Subsequently, detailed questions regarding their current weight-loss attempt were asked. Participants were then measured and weighed. They were asked to complete self-reported questionnaires at baseline only. Participants came back once a week for the first six weeks (week 2 to 6), and once, two weeks later (week 8), to be weighed. Weekly weighing for the first six weeks was proposed in order to carefully monitor the early weight-loss process as well as to improve women's motivation to participate in the study.

2.3. Measures

2.3.1. Physical Measurements. Height and weight were measured and BMI was calculated based on standard procedures [34].

2.3.2. Sociodemographic and Weight-Loss-Related Information. Sociodemographic information such as age, education, and marital status was collected. Age at first weight concerns and first weight-loss attempt, number of previous weight-loss attempts, and description of current weight-loss method were included in the sociodemographic questionnaire.

2.3.3. Depressive Symptoms. The Beck Depression Inventory (BDI-II [35]), a 21-item questionnaire, was used to measure depressive symptoms. The BDI-II presents a good internal consistency ($\alpha = 0.92$ in a nonpsychiatric population) and a good test-retest reliability (one week: $r = 0.93$) [35]. Severity of depressive symptoms increases with scores (0–13 = minimal symptoms; 14–19 = mild depression; 20–28 = moderate depression; 29 or more = severe depression).

2.3.4. Eating Behaviors. The Three-Factor-Eating Questionnaire (TFEQ [36]), a well-known 51-item questionnaire divided in three subscales (Cognitive dietary restraint, Disinhibition, and Susceptibility to hunger), was used to measure eating behaviors. The internal consistency is good for the three factors of the questionnaire ($a = 0.92$, 0.91, and 0.85) [36].

2.3.5. Motivation. The Global Motivation Scale (GMS [37]), a 24-item questionnaire, was used to evaluate six different types of motivation (intrinsic, integrated, identified, introjected, external motivation, and amotivation), based on the Self-Determination Theory of Deci and Ryan [38]. Reliability and validity of the GMS have been established by five independent studies [37]. The Regulation of Eating Behaviors Scale (REBS [39]) was used to evaluate motivation to regulate eating behaviors specifically. The REBS internal consistency is good (a between 0.72 and 0.95 depending of the subscale [39]).

2.3.6. Quality of Life. The Impact of Weight on Quality of Life Questionnaire (IWQOL-Lite [40]) is a 31-item questionnaire that measures quality of life related to weight. The IWQOL-Lite shows high internal consistency ($\alpha = 0.96$ for total score) and satisfying convergent and discriminant validity [41].

2.3.7. Body Esteem. The Body-Esteem Scale (BES [42]), a 23-item questionnaire used to measure the level of satisfaction of individuals toward their body image, is divided in three subscales: Appearance, Weight, and Attribution. Very high internal consistency coefficients ($\alpha = 0.92$, 0.81, and 0.94) as well as good temporal stability have been demonstrated for each scale ($\alpha = 0.89$, 0.92, and 0.83) [42].

2.3.8. Self-Esteem. The Rosenberg Self-Esteem Scale (RSES [43]) was used to measure self-esteem. The 10-item questionnaire measures the global self-concept and the feeling of personal worth. Internal consistency varies from 0.83 [44] to 0.99 [45] and test-retest reliability is 0.82 [46].

2.3.9. Personality. The Temperament and Character Inventory (TCI [47]) was used to measure pathological and nonpathological dimensions of personality in terms of Temperament (Harm avoidance, Novelty seeking, Reward Dependence, and Persistence) and Character (Self-Determination, Cooperativeness, and Self-Transcendence). The TCI shows a good internal consistency ($a > 0.80$ depending of subscales) [48].

2.4. Statistical Analyses. First, descriptive analyses were computed for the whole sample. Means, standard deviations and Pearson's correlations between the different variables were computed with the SPSS software (version 13.0). As suggested by Werrij and her colleagues [24], two groups of women were formed based on the BDI score (median = 10); a first group, with a BDI score of less than 10 ($n = 21$) and a second group, with a BDI score of 10 or more ($n = 24$). To test differences between groups, univariate analyses of variance were computed for the following dependent variables: baseline BMI, number of previous weight loss attempts, percentage of weight loss, and impact of weight on quality of life. Multivariate analyses of variance were computed for age variables (model 1 = current age, age at first weight concerns, age at first weight-loss attempt), eating behaviors (model 2 = cognitive dietary restraint, disinhibition, susceptibility to hunger), body- and self-esteem (model 3 = self-esteem, body esteem related to appearance, weight and attribution), personality (model 4 = novelty seeking, harm avoidance, reward dependence, persistence, self-determination, cooperativeness, self-transcendence), motivation to regulate eating behaviors (model 5 = intrinsic, integrated, identified, introjected, external motivation and amotivation), and global motivation (model 6 = intrinsic, identified, introjected, external motivation, and amotivation). Bonferroni correction was used to correct for the number of comparisons, ($\alpha = 0.05/10$ tests $= 0.005$), meaning that results were considered significant if $P < 0.005$.

Table 1: Differences between groups for age-, weight, and eating-related variables.

Variables	Lower depressive SX ($n = 21$) M (ET)	Higher depressive SX ($n = 24$) M (ET)	Anova MANOVA	P
Baseline BMI	31.05 (4.79)	30.16 (4.93)	$F(1,43) = 0.37$	0.548
Age[a]	41.56 (8.82)	35.50 (9.38)	$F(1,43) = 4.07$	0.050
Age of first weight concerns[a]	20.56 (7.85)	14.45 (6.14)	$F(1,40) = 7.25$	0.011
Age of first weight-loss attempts[a]	24.69 (9.23)	17.59 (6.06)	$F(1,38) = 8.20$	0.007
2-month weight loss				
(in %)	2.74 (2.43)	1.13 (1.66)	$F(1,34) = 5.41$	0.026
(in pounds)	5.05 (5.01)	1.93 (3.00)		
Number of previous weight-loss attempts	5.41 (4.77)	8.04 (10.43)	$F(1,38) = 0.79$	0.380
TFEQ-Restraint[b]	10.19 (3.23)	9.67 (4.87)	$F(1,43) = 0.18$	0.678
TFEQ-Disinhibition[b]	8.10 (3.49)	11.21 (2.75)	$F(1,43) = 11.17$	0.002*
TFEQ-Hunger[b]	3.52 (3.08)	8.58 (3.54)	$F(1,43) = 25.84$	<0.001*

* $P < 0.005$ (Bonferroni correction); [a]MANOVA 1; [b]MANOVA 2.

Table 2: Differences between groups for psychological variables.

Variables	Lower depressive SX ($n = 21$) M (ET)	Higher depressive SX ($n = 24$) M (ET)	Anova MANOVA	P
BES—Appearance[c]	1.69 (0.65)	1.10 (0.65)	$F(1,43) = 9.27$	0.004*
BES—Weight[c]	1.21 (0.63)	0.69 (0.50)	$F(1,43) = 9.44$	0.004*
BES—Attribution[c]	1.99 (0.52)	1.68 (0.57)	$F(1,43) = 3.58$	0.065
RSES[c]	34.52 (4.38)	27.38 (6.86)	$F(1,43) = 16.80$	<0.001*
IWQL	79.38 (10.88)	68.34 (16.00)	$F(1,43) = 7.11$	0.011
TCI—Novelty Seeking[d]	21.14 (4.27)	21.29 (7.54)	$F(1,43) = 0.06$	0.937
TCI—Harm Avoidance[d]	13.19 (4.56)	16.92 (7.98)	$F(1,43) = 3.56$	0.066
TCI—Reward Dependence[d]	15.19 (3.78)	15.21 (4.27)	$F(1,43) = 0.00$	0.988
TCI—Persistence[d]	5.00 (2.02)	5.54 (2.15)	$F(1,43) = 0.75$	0.391
TCI—Self-Determination[d]	35.48 (3.67)	23.88 (8.89)	$F(1,43) = 31.08$	<0.001*
TCI—Cooperativeness[d]	37.33 (2.54)	32.04 (5.93)	$F(1,43) = 14.38$	<0.001*
TCI—Self-Transcendence[d]	11.29 (6.24)	12.08 (6.95)	$F(1,43) = 0.16$	0.689

* $P < 0.005$ (Bonferroni correction); [c]MANOVA 3; [d]MANOVA 4.

Effect sizes (Cohen's d) were also calculated; an effect size of 0.3 was considered a small effect, 0.5, a medium effect, and 0.8, a large effect [49]. The number of previous weight-loss attempts was logged 10 transformed to correct for skewness.

3. Results

Means and standard deviations for each group (higher versus lower depressive symptoms) concerning age-, weight˜, and eating-related variables, as well as psychological and motivational variables are presented, respectively, in Tables 1, 2, and 3. The mean BDI score for the overall sample was 11.29 ± 1.58. For the lower depressive symptoms group, the mean BDI was 3.62 ± 0.58, ranging from 0 to 8, whereas for the higher depressive symptoms group, the mean BDI was 18 ± 2 ranging from 10 to 50. In accordance, even though this group's mean score was above the clinical cut-off of 14 for mild depression, some women of this group did not reach this clinical cut-off (score between 10–13; $n = 12$), meaning that the group cannot be labelled as "depressed." Among other women belonging to the high depressive symptoms group, four presented mild depression (score between 14 and 19), five reported moderate depression (score between 20 and 28), and three were severely depressed (score over 29).

First, participants from both groups did not differ regarding baseline BMI, $F(1,43) = 0.37$, $P = 0.548$, meaning that differences between groups cannot be attributed to body weight. Second, women tended to be different on age variables, $F(1,43) = 3.16$, $P = 0.037$. Women with higher depressive symptoms tended to be younger, $F(1,43) = 4.07$, $P = 0.050$, to report having made their first weight-loss attempt earlier, $F(1,38) = 8.20$, $P = 0.007$, and having started earlier to be preoccupied with their weight $F(1,38) = 7.25$, $P = 0.011$, compared to women presenting lower depressive symptoms. Even though these differences were not significant with the Bonferroni correction, effect sizes were 0.67, 0.89, and 0.87, which correspond to moderate to large effects. In addition, women' current age was significantly related to their age at first weight concerns, $r = 0.33$, $P = 0.035$, which means that the younger women started to be preoccupied with their weight, the younger they were when

Table 3: Difference between groups for motivational variables.

Variables	Lower depressive SX ($n = 21$) M (SD)	Higher depressive SX ($n = 24$) M (SD)	MANOVA	P
REBS—Intrinsic[e]	5.15 (1.44)	4.34 (1.44)	$F(1,43) = 3.58$	0.065
REBS—Integrated[e]	5.33 (1.22)	4.24 (1.51)	$F(1,43) = 7.03$	0.011
REBS—Identified[e]	6.36 (0.73)	5.88 (1.09)	$F(1,43) = 2.95$	0.093
REBS—Introjected[e]	3.02 (1.03)	3.98 (1.71)	$F(1,43) = 4.98$	0.031
REBS—External[e]	1.54 (1.02)	2.40 (1.86)	$F(1,43) = 3.54$	0.066
REBS—Amotivation[e]	1.17 (0.37)	1.65 (0.91)	$F(1,43) = 5.08$	0.029
GMS—Intrinsic[f]	5.64 (1.15)	5.14 (1.19)	$F(1,43) = 2.01$	0.164
GMS—Identified[f]	5.51 (0.94)	5.16 (0.94)	$F(1,43) = 1.50$	0.228
GMS—Introjected[f]	3.43 (1.31)	4.10 (1.26)	$F(1,43) = 2.98$	0.092
GMS—External[f]	3.43 (1.31)	4.10 (1.26)	$F(1,43) = 2.98$	0.092
GMS—Amotivation[f]	1.59 (0.61)	2.20 (1.39)	$F(1,43) = 3.36$	0.074

[*] $P < 0.005$ (Bonferroni correction); [e]MANOVA 5; [f]MANOVA 6.

they enrolled in the study. In addition, age at first weight concerns and age at first weight-loss attempt were strongly related for both groups (lower depressive symptoms group, $r = 0.73$, $P = 0.001$; higher depressive symptoms group, $r = 0.86$, $P < 0.001$), which means that being preoccupied earlier with body weight was related to an early weight loss attempt.

Results also showed that, following a two-month self-initiated weight-loss attempt, women with higher depressive symptoms tended to lose less weight than the other women, $F(1,34) = 5.41$, $P = 0.026$. Even though the difference was not significant after the Bonferroni correction, the effect size was 0.77, which is a moderate effect. However, women with higher depressive symptoms did not differ regarding the number of previous weight-loss attempts, $F(1,38) = 0.79$, $P = 0.380$.

Women with higher depressive symptoms also showed significantly more problematic eating behaviors, $F(1,43) = 8.71$, $P < 0.001$, with higher scores on disinhibition, $F(1,43) = 11.17$, $P = 0.002$, and susceptibility to hunger, $F(1,43) = 25.84$, $P < 0.001$. Effect sizes for eating behaviors were large, respectively, of 0.99 and 1.52. From a psychological standpoint, women with higher depressive symptoms tended to report a significantly more negative self-perception, $F(1,43) = 4.25$, $P = 0.006$, with lower scores regarding self-esteem (RSEQ), $F(1,43) = 16.80$, $P < 0.001$, body esteem (BES) related to appearance, $F(1,43) = 9.27$, $P = 0.004$, and body esteem related to body weight, $F(1,43) = 9.44$, $P = 0.004$. Effect sizes for these differences were, respectively, of 1.24 (Self-esteem), 0.91 (Body esteem-appearance), 0.92 (Body esteem-weight), which correspond to large effects. They also tended to present lower quality of life (IWQL-Q), $F(1,43) = 7.11$, $P = 0.011$. Even though this difference was not significant with the Bonferroni correction, the effect size was 0.81, which corresponds to a large effect.

Concerning personality, significant differences between groups were observed, $F(1,43) = 6.05$, $P < 0.001$, women with higher depressive symptoms reporting significantly lower Self-Determination, $F(1,43) = 31.08$, $P < 0.001$, and Cooperativeness, $F(1,43) = 14.38$, $P < 0.001$, on the TCI, which means that women with higher depressive symptoms reported being less confident in their power to influence their own life and less prone to accept and understand others, and to be empathic and altruistic. Effect sizes for these differences were, respectively, of 1.71 and 1.16, which correspond to large effects.

In general, results showed that there was no significant difference concerning global motivation, $F(1,43) = 1.47$, $P = 0.229$, and marginally significant differences between groups regarding motivation to regulate eating behaviors (REBS), $F(1,43) = 2.12$, $P = 0.074$. Women with higher depressive symptoms tended to show more introjected motivation to regulate their eating behaviors than women with lower depressive symptoms, $F(2,30) = 4.98$, $P = 0.031$, meaning that they may put on themselves some pressure to adopt particular eating behaviors in order to avoid feeling guilty and ashamed. Women with higher depressive symptoms also tended to report more amotivation, $F(1,43) = 5.08$, $P = 0.029$, which suggests that they may feel a lack of control over their own eating behaviors. These women also tended to report lower integrated motivation, $F(1,43) = 7.03$, $P = 0.011$, meaning that they may engage in eating behaviors without having integrated the importance and value of these behaviors. Effect sizes for these differences were, respectively, of 0.68, 0.69, and 0.79, which correspond to moderate effects.

Finally, correlational analyses were computed separately for each group (Table 4). In general, in the higher depressive symptoms group, variables were more closely associated with one another than in the lower depressive symptoms group. For example, among women with higher depressive symptoms, self-esteem, body esteem related to weight, body esteem related to appearance, quality of life, and susceptibility to hunger were systematically related to depressive symptoms and correlated to one another, whereas these associations were clearly not significant among the lower depressive symptoms group. Likewise, among women with higher depressive symptoms, Self-Determination (the feeling to have an influence on one's life) was strongly related to disinhibition, susceptibility to hunger, self-esteem, and

Table 4: Correlation matrix for each group between depressive symptoms, eating behaviors, body esteem, self-esteem, quality of life, self-determination, and motivation to regulate eating behaviors.

	1	2	3	4	5	6	7	8	9	10	11	12
(1) Dep. symptoms	—	−0.022	0.370	**0.481***	**−0.708*****	**−0.649*****	**−0.613*****	**−0.668*****	**−0.702*****	**0.642*****	**0.647*****	0.184
(2) Dietary restraint	−0.332	—	−0.046	0.027	0.061	0.080	0.167	0.148	0.284	−0.014	−0.045	−0.081
(3) Disinhibition	0.004	−0.086	—	**0.420***	−0.357	0.294	**−0.407***	**−0.428***	**−0.444***	**0.409***	0.053	0.143
(4) Hunger	0.354	**−0.523***	**0.493***	—	**−0.563*****	**−0.456***	**−0.507***	−0.356	**−0.421***	**0.589****	0.292	0.336
(5) Self-esteem	−0.132	0.236	0.186	0.116	—	**0.706*****	**0.681*****	**0.720*****	**0.631*****	**−0.758*****	**−0.416***	−0.141
(6) BE-appearance	−0.088	0.041	−0.167	0.112	0.333	—	**0.638*****	**0.727*****	**0.568****	**−0.759*****	**−0.433***	−0.106
(7) BE-weight	−0.062	0.022	−0.103	0.037	0.311	**0.854*****	—	**0.567****	**0.588****	**−0.665*****	**−0.494***	−0.241
(8) Quality of life	−0.163	0.180	0.056	0.118	**0.550*****	**0.699*****	**0.463***	—	**0.590****	**−0.806*****	**−0.503***	−0.367
(9) Self-determination	**−0.648****	0.283	0.266	−0.152	0.301	0.195	0.179	0.305	—	**−0.505***	**−0.594****	−0.387
(10) Introjected mot.	0.248	0.096	0.090	0.217	−0.421	−0.374	−0.367	−0.285	−0.297	—	**0.530****	0.196
(11) External mot.	0.111	0.184	0.340	0.065	**−0.455***	0.023	0.024	−0.098	0.206	0.261	—	**0.452***
(12) Amotivation	0.068	−0.081	−0.258	0.074	−0.112	0.112	−0.050	0.160	−0.062	0.080	0.025	—

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$. Notes. Higher depressive symptoms group above the diagonal; Lower depressive symptoms group below the diagonal.

body esteem related to weight and appearance as well as to quality of life, whereas these associations were again not significant among women who are less symptomatic. As demonstrated in Table 4, several other associations followed the same pattern.

4. Discussion

The objective of the present study was to compare two groups of overweight/obese women formed on the basis of depressive symptoms on initial weight-loss outcomes as well as on eating and psychological profiles. Several results from the present study confirmed what has been previously found [25, 26]. Women with higher depressive symptoms were more prone to lose control over eating (disinhibition), were more inclined to eat in the presence of perceptions or feelings of hunger (susceptibility to hunger), reported a lower general feeling of self-worth (self-esteem), were less satisfied with their appearance and their weight (body esteem), and presented a lower quality of life related to weight [24, 26, 27] and thus, despite the fact that they did not differ with regard to body weight compared to women with lower depressive symptoms. For women with higher depressive symptoms, other factors, besides body weight, may influence body esteem and quality of life; among this group, quality of life and body esteem related to weight were both significantly associated with depressive symptoms and disinhibition, which suggests that negative affect toward one's self and disinhibited eating associated to a feeling of loss of control could hinder body esteem and perceived quality of life, regardless of weight.

Results also suggested that, compared to women with lower depressive symptoms, those with higher depressive symptoms were younger, have been concerned earlier by their weight (i.e., from the age of 14 for women with higher depressive symptoms and from the age of 21 for women with lower depressive symptoms), and have undertook weight-loss attempts earlier (i.e., almost seven years before, from the age of 17). In accordance, for the overall sample, current age was related to the age at first weight concerns and to the age of the first weight-loss attempt, which could explain why other studies have also found a younger age among participants from the higher depressive symptoms group. However, groups did not significantly differ regarding the number of previous weight-loss attempts, as was evidenced in previous studies [50]. This could be attributable to the small sample size and the fact that most women from both groups had undertaken many weight-loss attempts at the time of their participation in the study.

In addition, women with higher depressive symptoms tended to lose less weight than women from the other group during the two first months of a naturalistic weight-loss attempt. To our knowledge, this is the first study that examined whether subgroups separated on the basis of depressive symptoms could differ on weight-loss outcomes following a self-initiated weight-loss process. In the literature, it is suggested that depressive symptoms, even if of subclinical severity, may negatively influence weight loss [12, 28–31, 51], but up until now, no study had yet documented this issue. Since it is well established that early weight loss is a significant predictor of long-term weight loss [30], we may hypothesize that women from our higher depressive symptoms group may experience more difficulties in the long-term pursuit of their weight lost. In fact, their initial failure may portend their long-term failure.

One potential explanation for this difference in terms of early weight loss is that, among women with higher depressive symptoms, all variables such as eating behaviors, self-esteem, body esteem, and quality of life were closely related to one another, whereas it was not the case among less depressed women. Results suggest that among women with higher depressive symptoms, these variables interacted to form a negative spiral, which worsens the overall picture and creates a vicious circle of distress and negative self-perception that may subsequently hinder weight-loss efforts.

In addition, women with higher depressive symptoms tended to endorse less integrated motivation, more introjected motivation, and more amotivation to regulate their eating behaviors. According to Pelletier, Dion, and colleagues [39], individuals who present these types of extrinsic motivation are more likely to endorse sociocultural pressure towards thinness and to show more problematic eating behaviors and more psychological distress than individuals presenting more intrinsic motivation types. Our results are coherent with Pelletier and colleagues' work [39], since among women with higher depressive symptoms, the adoption of a more extrinsic motivation was related to more psychological distress, a lower self-esteem, more problematic eating behaviors (i.e., more disinhibition, more susceptibility to hunger), and a lower quality of life. Previous unsuccessful weight-loss attempts may have convinced these women that their efforts to regulate their eating behaviors had no influence on their life, or that results were depending on external forces not under their control, which would reinforce the extrinsic motivation.

Finally, it seems that Self-Determination, a personality trait, plays a central role in the psychological profile of overweight/obese women with higher depressive symptoms. Indeed, among these women, Self-Determination was linked to the majority of studied variables (depressive symptoms, disinhibition, susceptibility to hunger, self-esteem, body esteem, quality of life), whereas these links were not significant among women with lower depressive symptoms (except the link between Self-Determination and depressive symptoms). These results suggest that the incapacity to set goals for oneself and to take proper actions to achieve these goals, as well as the feeling of having no control over one's life, is crucial among women with higher depressive symptoms. It is also interesting to interpret this result in view of results regarding motivation. Indeed, it might be that since women with higher depressive symptoms are less competent in setting goals for themselves and have less confidence in their capacity to influence their life, they rely more on external sources than on their personal resources to motivate themselves. Besides, Self-Determination was negatively linked to introjected and external motivation to regulate eating behaviors. These women who reported being

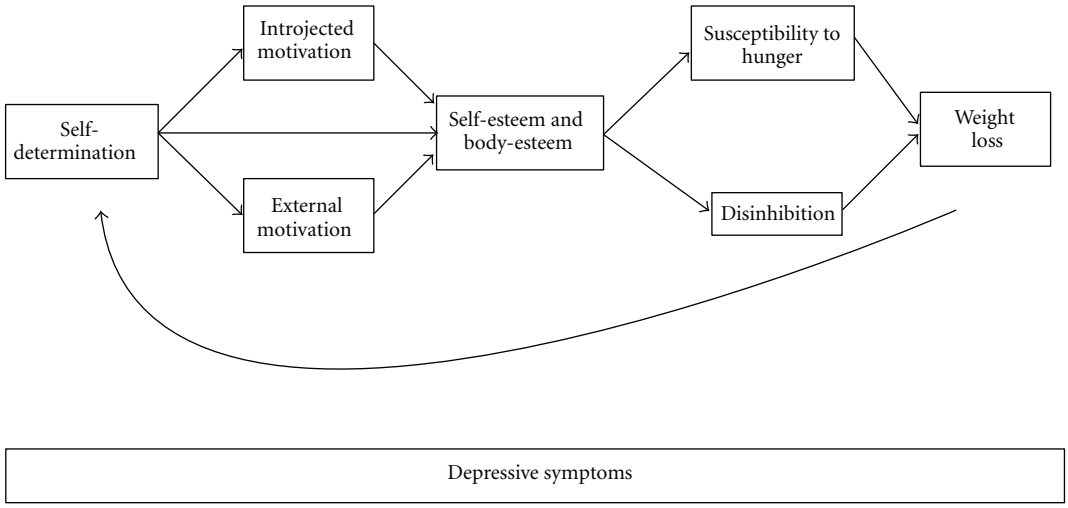

Figure 1: Links between self-determination, motivation to regulate eating behaviors, self/body-esteem, eating behaviors, and weight loss.

less effective (Self-Determination) and presented a more extrinsic motivation also reported more negative self-esteem and body esteem, as well as a feeling of lacking control over eating (disinhibition and susceptibility to hunger), which could impede weight-loss attempts. In the end, the repetitive failures to lose weight might exacerbate the feelings of helplessness and negative self-perception that were already present. Figure 1 represents a model of the links between Self-Determination, motivation, self-perception, eating behaviors, and weight loss. Future studies will be needed to test this model in a larger sample.

However, this study also has important limitations. First, the sample size was relatively small, and after Bonferroni correction, most differences did not reach statistical significance. Yet, for the majority of these differences, effect sizes were moderate or large, suggesting that substantial differences existed between groups and could be evidenced in larger samples. Additional differences could also be evidenced with a larger sample. For example, an *a posteriori* power analysis revealed that both groups should have been formed of at least 40 participants in order to detect significant differences concerning motivation to regulate eating behaviors. Second, ecological validity was favoured in the present study, which means that internal validity was reduced in comparison to more controlled experimental designs. Since weight-loss methods were well diversified, the efficacy of the efforts undertaken by participants could not be measured, and their adherence to recommendations was not taken into account. Finally, according to the design of the study, it is not possible to infer causal relationships between studied variables. Future studies should explore the temporal links between these variables.

In conclusion, the presence of depressive symptoms, even if they are not clinically significant, is clearly an important marker of severity regarding several eating and psychological variables among overweight/obese women. The Beck Depression Inventory seems to be useful to identify this group of women who are more vulnerable to experience difficulties during weight-loss process.

Acknowledgments

We would like to thank Simone Lemieux for her careful revision of the manuscript

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 710427, 8 pages
doi:10.1155/2012/710427

Review Article

Applying a Common-Sense Approach to Fighting Obesity

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Received 16 December 2011; Revised 25 April 2012; Accepted 9 May 2012

Academic Editor: Jutta Mata

The obesity epidemic is a threat to the health of millions and to the economic viability of healthcare systems, governments, businesses, and nations. A range of answers come to mind if and when we ask, "What can we, health professionals (physicians, nurses, nutritionists, behavioral psychologists), do about this epidemic?" In this paper, we describe the Common-Sense Model of Self-Regulation as a framework for organizing existent tools and creating new tools to improve control of the obesity epidemic. Further, we explain how the Common-Sense Model can augment existing behavior-change models, with particular attention to the strength of the Common-Sense Model in addressing assessment and weight maintenance beyond initial weight loss.

1. The Magnitude and Distribution of the Problem

Almost two-thirds of adults in the United States are overweight (body mass index; BMI $\geq 25\,\text{kg/m}^2$) or obese (BMI $\geq 30\,\text{kg/m}^2$) [1], and rates of overweight and obesity have increased considerably since the 1980s [1]. Although the trend appears to be slowing [1], it remains disturbing as obesity is associated with numerous chronic illnesses, including type 2 diabetes, hypertension, respiratory problems, and various cancers. It is also the second leading cause of preventable death in the United States [2]. Worldwide, roughly 1 billion people were overweight or obese in 2010 and that number is expected to grow to 1.5 billion by 2015 [3]. Further, overweight and obesity are linked to a large portion of the chronic disease burden in many countries and now account for more deaths than underweight [3]. Overweight and obesity are also associated with significant psychological burden as these patients often face and internalize considerable stigma [4]. Additionally, treating obese patients costs roughly $1,429 more than treating normal weight patients and the cost of obesity to the US medical system approached $150 billion in 2008 [5].

2. Treating Obesity

Given the social, health, and economic burden of obesity and overweight, numerous interventions have been designed for obese patients. These interventions usually recommend a combination of diet and/or physical activity with behavioral support, but can also include surgery and/or medication [6]. Although many of these interventions result in weight loss (e.g., [6–11]), available data raise two critical questions: (1) is the weight loss clinically significant? And (2) can it be maintained? A recent thorough review of weight loss interventions for overweight or obese adults [6] suggests that the answer to the first question is unclear as there is no consensus on the definition of clinically significant weight loss. With respect to the second question, the review suggests that many patients are unable to maintain weight loss for more than 3 years [6]. Additionally, successful programs, such as the Diabetes Prevention Program [12], are too costly and time intensive to be implemented outside of academic settings [13]. Further, interventions conducted in standard care settings have had poor results; for example, attempts to train primary care physicians to provide brief weight loss counseling have been relatively unsuccessful [14].

3. Conceptual Framework for the Control of Obesity: A Common-Sense Approach

Although a "one size fits all" approach makes little sense for controlling the obesity epidemic, it would be useful to identify a set of underlying self-regulation principles common to both population and individual, behavioral approaches for prevention and intervention. If such principles exist, it would create an opportunity to integrate "public" messages for prevention and the messages and interventions delivered by individual practitioners, and to increase the impact of both. The Common-Sense Model of Self-Regulation (CSM) [15], a model of the cognitive and affective mechanisms underlying chronic illness management, provides a set of concepts and tools we believe will be useful for this integration. The CSM translates the intra- and interpersonal processes of illness management into objective indicators and as such is a useful tool for generating and testing hypotheses. The diabetes world has found the CSM useful for promoting blood glucose monitoring and management [16, 17], and it may prove to be as useful for the treatment of obesity. However, in order for any theory to effectively inform research and practice, it must be understood and used properly. Therefore, the goal of this commentary is to present the CSM in such a way that it will inspire and be used in future work related to weight management. First, we describe the CSM and how it could be used to augment the assessment and long-term management strategies used in current behavioral treatments. Next, we discuss studies that have investigated the CSM and obesity. Lastly, we describe how the CSM might be used in clinical practice and research.

4. The CSM and Assessment

At its core, the CSM suggests that patients use information from the following five domains to understand and respond to health threats (e.g., obesity): (1) the *identity* of the threat (e.g., labeling excess body fat "obesity"); (2) the *cause* of the threat (e.g., overeating or inactivity); (3) the *consequences* of the threat (e.g., heart disease or stigma); (4) whether the threat can be *controlled/cured* (e.g., believing dieting is effective); (5) the *time line* associated with the threat (e.g., whether obesity is viewed as an acute or chronic condition or whether it develops and changes rapidly or slowly). Patients' ongoing experiences in these domains develop *illness representations,* personal "common-sense" understandings of conditions. Numerous findings have demonstrated that illness representations are associated with and predictive of a variety of health behaviors [18]. A more recent meta-analysis of research with cardiac patients, whose treatment often includes changes in diet and exercise, demonstrated that patients with strong beliefs in the control, identity and consequence domains were more likely to attend cardiac rehabilitation [19]. Further, Petrie et al. [20] found that an intervention addressing cardiac patients' illness representations reduced pain and time spent away from work.

Patients use similar domains to develop representations of treatment based on experiences with self-generated and prescribed treatments. These experiences and the resulting representations are modified by the illness's representation and threat level. For example, asthma patients who believe they only have asthma when they have symptoms are less likely to use maintenance inhalers [21]—why take a chronic medication for an "acute" problem? In fact, it has been suggested that the link between illness representations and asthma is strong enough to merit a Cochrane Review [22]. The CSM suggests that the results would be similar for obesity [23]; for example, obesity interpreted as a result of poor eating habits might result in a change in diet; whereas obesity interpreted as the result of stress may be seen as inevitable and untreatable. That is, the links between illness and treatment representations are not random; they are based on a "common-sense" match between the perceived cause of the illness and the treatment perceived as most likely to address that underlying cause. "Common-sense matches" activate expectations in each of the five domains; that is, the symptoms and/or functions that will improve, the rapidity of change, the need to continue action to maintain achieved benefits, and expectations about experienced consequences, benefits, and losses, over time from both treatment and illness.

Thus, the CSM suggests that in order for weight loss interventions to be effective, they must either match patients' illness and treatment representations of obesity or provide a compelling case for patients to change their illness and/or treatment beliefs. In this way, the CSM could be used to augment existing obesity treatments during the behavioral assessments that have been a core component of behavioral treatments for decades [24]. Careful assessment of the presenting problem facilitates the identification of appropriate treatment targets and assessing patients early and often allows clinicians to track early responses to treatment, a factor highly correlated with positive outcomes [25]. The CSM's five illness and treatment domains are associated with health behaviors and could therefore provide clinicians with a roadmap for this assessment. The domains map onto areas routinely assessed by physicians during medical visits, making them easy to add to usual care. Initial studies report that primary care physicians favorably view addressing patient goals and using action plans, which are key components of the CSM [26]. Further, patients are more satisfied when their physicians address illness and treatment representations [27] and a recent study reported better adherence to treatment one-month after-visit for patients whose internists addressed illness and treatment representations [28]. Some of the latter study's participants were prescribed diet and physical activity changes, suggesting that assessing and addressing illness and treatment beliefs could improve adherence to weight loss treatments. Additional studies are clearly needed.

5. The CSM and Weight Maintenance

According to the CSM, illness and treatment representations function in relation to interactions among the various feedback systems responsible for human behavior. Some of these feedback systems involve partially or fully conscious, deliberative decisions (e.g., reading and interpreting food

labels). These conscious and deliberative systems are the focus of our conversations about everyday actions, such as discussions about diet between a patient and a practitioner and messages about diet on television or menus. These deliberative feedback systems are also of central concern to investigators examining the effects of medical/health literacy on the understanding of treatment, decision making, and adherence to lifestyle changes.

However, while these conscious deliberative processes are the focus of many obesity interventions [6], the CSM suggests that conscious/deliberative activity regulates but a small fraction of the everyday behaviors associated with weight loss. Rather, much of human behavior is driven by systems that function automatically (e.g., one does not consciously decide to digest food) or, more importantly, are habitual (e.g., the semiautomatic sequences involved in bringing a fork to one's mouth). For example, making the decision to go out to a fast food venue for dinner involves at least one conscious decision; however, the actions involved in going out to dinner are mostly automatic and semiautomatic habitual behaviors (e.g., the sensation of hunger, traveling to the restaurant, putting food into one's mouth, finishing a large meal without attending to cues of satiety). In short, most of what happens in everyday life involves well-learned habits that can initiate and maintain behavior with little deliberative decision making. Thus, examining obesity through the lens of CSM control systems, suggests that altering food intake and physical activity to prevent and treat obesity requires replacing existent, potentially "toxic" automatic procedures with procedures associated with healthy outcomes.

In other words, the CSM suggests that overweight and obese patients must replace habitual patterns in everyday life that lead to weight gain with those that do not. Planning (i.e., observing and/or mapping) daily life sequences for eating—beginning with where one shops and what one buys, through how food is prepared, plated and eaten and replacing harmful with helpful actions—is at the "common-sense" core of creating action plans for weight loss. The CSM suggests that the detection of changes both at a given time and most importantly over time, with clear records based on function, somatic sensations, and/or pictures, are critical for motivating behavioral change at the outset and most importantly, for sustaining it over time. The significance of daily and ongoing benchmarks is detected in everyday comments such as, "It was a bad day," and "I barely had enough energy to make it through," "I skipped breakfast and had a smaller than usual lunch and I'm still hungry." Providing benchmarks for these momentary appraisals of the daily self and a clear vision of changes over time can affect behaviors, such as uncontrolled late night snacking, that are critical for weight regulation. The focus on addressing habitual and deliberate behavior is similar to cognitive behavioral therapy-(CBT-) based weight loss treatments that attempt to increase awareness of habitual behaviors through self-monitoring [6] informing the compatibility of the CSM with traditional CBT.

Also similar to behavioral approaches (e.g., [29]), the CSM suggests that replacing unhealthy behaviors with healthy behaviors requires examining an individual's daily environment to identify: (1) the initiating and maintaining factors for unhealthy and healthy eating and sedentary and active behaviors and (2) available sources of non-toxic foods and safe places to engage in physical activity every day. However, some of the earliest findings regarding the CSM [30] demonstrated that action plans based on these steps are not sufficient for behavior change. Rather, action plans need to be linked to motivating representations, for example, evidence that the self is less symptomatic (e.g., better joint function) or exposed to lower disease risk (e.g., improved blood pressure). The need to combine action plans with concrete evidence that motivates has been replicated numerous times [31] and suggests a third step necessary for weight loss and maintenance: to identify outcomes associated with toxic foods and sedentary activities, increase their negative valence and identify and increase the positive valence of outcomes associated with healthy foods and physical activity. Physician visits present an opportunity to address these three steps as well as an opportunity to devise a tailored action plan for change, as described in the next section.

As with other effective weight loss theories [6], the CSM suggests that weight loss must be presented and achieved in a step-by-step fashion, that is, patients must recognize that *change takes time*. However, one major difference between the CSM and other theories is the role of constant feedback in developing *long-term* action plans that will maintain behavioral changes. A potentially novel contribution of the CSM is the hypothesis that a sole focus on weight loss will make weight maintenance problematic because weight changes too slowly and fluctuates too often to serve as an effective daily reinforcer. The CSM suggests that long-term change requires more than simply telling patients that change takes time, rather, patients need to know how to monitor change and how to get feedback from the scale, their bodies (e.g., fewer symptoms of strain, improved function, better fit of clothes), the environment, their physicians and peers. Additionally, the CSM suggests that this feedback will only result in continued engagement in healthy behaviors if it "makes sense." For example, while one outcome for any individual trying to lose weight will be the number on the scale, it may be equally, if not more important to create a record of intermediate outcomes that are clear benchmarks of progress, such as the presence of healthy foods in the house, individual healthy food choices, slowed eating, the enjoyment of healthy foods and the subjective sense of gains in ease of movement and vigor associated with even small improvements in physical function.

The CSM suggests that presenting weight loss as incremental will help patients focus on and be reinforced by the smaller steps that are necessary to both initiate and maintain weight loss. Each change would represent movement towards creating an environment in which healthy eating replaces the habit of unhealthy eating. Using an approach in which replacement makes use of the properties of old habits, but changes a few features, allows new and conscious decisions to co-opt and replace old, highly automatic habits that should maintain over time. For example, a patient could alter

grocery-shopping habits to engender more healthful eating. That is, instead of automatically putting foods into the shopping cart, the patient would make food choice a conscious process. He or she would be instructed to look at nutrition labels (a habit which is associated with decreased calorie consumption [32]) and use that information to purchase foods, leaving healthy foods as "the available" choices when it's time to eat. The small steps involved in buying healthier foods on repeated shopping trips, will eventually result in a lower number on the scale. Observing a lower number on the scale in turn both validates the behavioral changes and "strengthens" the new habits (i.e., patients get proof that the new behaviors work). Thus, another potentially novel contribution of the CSM is the explicit incorporation of multiple feedback systems that integrate these habits into the sense of self. This provides coherence between specific actions and feelings of self-efficacy related to controlling diet, activity, and the ability to achieve a less heavy and healthier self in the present and future.

6. Existing Research on the Common-Sense Model and Obesity

Although many of the techniques described above are based on empirically tested relationships [33, 34], none of the tests have been validated in the arena of weight regulation. A search of major scientific databases (e.g., PubMed, PsychInfo, MedLine, and ISI Web of Knowledge) for "common-sense model" and "obesity" resulted in zero citations. Knowing, however, that patients respond positively when physicians explore their "common-sense" perceptions about illnesses [27], signals a troublesome warning in relation to Ogden and Flanagan [23] findings that general practitioners (GPs) and lay people appear to have different beliefs about the causes of and treatments for obesity. Although both believed that behavioral factors caused obesity, significantly more lay people described biological factors as a significant causal factor for obesity while almost no GPs did. Further, while both groups were ambivalent about the effectiveness of obesity treatments, GPs were more likely to believe that behavioral treatments are indicated for obesity. Given GPs' beliefs that behavioral factors were critical causal factors for obesity, GPs' beliefs were more coherent. The authors suggest that GPs' stronger beliefs in behavioral treatments may actually inhibit them from counseling patients on weight loss: they may think it is not within their purview. Another study [35] found a high level of incoherence between beliefs about obesity and treatment among children—these children did not see inactivity as a cause for obesity, but did view increases in activity as treatment. It is possible that GPs may avoid confronting these discrepancies to avoid conflict and being seen as "blaming the patient."

To our knowledge, only two studies investigated relationships between obesity related illness beliefs and behaviors. The first [36], found that while perceiving obesity as chronic (*time line)*, severe (*consequences*), and out of one's *control* was associated with less confidence in the ability to lose weight during a dietitian-led group weight loss program, none of these beliefs were associated with actual weight loss. The second [37], which included over 3,500 participants, found that individuals who endorsed behavior as a cause of obesity reported higher levels of physical activity; whereas individuals who endorsed a genetic cause of obesity reported lower levels of physical activity and lower levels of fruit and vegetable consumption. Although there is clearly a need for more research to determine whether and how clinicians should use the CSM in practice, studies in areas other than weight control point to the potential value of assessing and augmenting representations of illness (e.g., obesity) and treatment (e.g., weight loss) during medical visits and in weight management programs as patients are more adherent to treatments when their illness and treatment beliefs are coherent [18] and addressed by clinicians [28, 38].

7. How the Common-Sense Model Might Be Used in Clinical Practice

We view CSM as a framework for integrating clinically validated procedures for behavioral change, rather than as a "stand alone" approach to weight loss. The following sections highlight some of the ways in which this integration can proceed in medical settings, though it could be applied to other venues, for example, specialty weight loss clinics.

Step one in applying the CSM involves the assessment of patients' representations of obesity (i.e., the five domains listed above and italicized below) and actions related to each of the five content areas, for example, causal actions, actions controlling onset or reducing obesity, time frames for outcomes, and actions controlling the diverse consequences of obesity. The information obtained from this assessment will provide insights into the patients' habits, for example, where they likely shop for food, what they eat, the foods they consider unhealthy and which they are willing and/or unwilling to change. The assessment may also provide clues regarding treatment preferences, untainted perhaps, by the "social desirability" present when patients respond to direct questions such as, "What would you do to reduce weight?" Patients' representations of obesity can also help clinicians understand patients' perceptions of the effectiveness of specific actions for controlling weight and their levels of self-efficacy for initiating and maintaining each. This information can be used to tailor treatments to fit patients' unique belief systems. Further, assessing the actions associated with the five domains can clarify motivations for change and suggest specific action plans for initiating and sustaining healthy behaviors [31]. We believe this process is best demonstrated by reviewing a sample visit between a female clinician and a male patient. Additionally, Table 1 provides suggestions for specific questions that can be used to assess each illness domain and help patients develop action plans. Necessary and corollary research is described in the next section.

8. Describing Weight as a Health Threat

It is critical to assess whether the patient *identifies* his weight as a threat to his health. A simple question, such as, "are you concerned about your weight?" is most likely sufficient to

Table 1: Questions that can be used to assess patients' illness representations and action plans.

Illness domain/action plan	Questions
Identity	Are you concerned about your weight?
	Do you think you weigh too much?
	Have others mentioned your weight?
Cause	What caused you to gain weight?
	Why do you think you are overweight?
Consequences	How do you think your weight is affecting your health?
	How do you think your weight will affect your health over the next few years?
	How do you think your weight is affecting your emotional wellbeing and your relationships with others?
Control/cure	Have you tried anything to lose weight, or keep from gaining more weight?
	How well has it worked?
	What do you think you could do to control your weight?
	What can you do to keep from gaining weight, or to lose weight?
Time line	How long have you felt that your weight has been a problem?
	How long do you think it will take to change your eating/physical activity habits?
	How long do you think it will take for you to lose weight?
Action plan	Can you pick one aspect of your diet or physical activity to work on before we next meet?
	Where and when can that plan fit into your daily schedule?
	What do you need in order to complete that plan?
	How will you know whether the plan worked?

open the topic and begin assessment. Ideally, the patient will agree that his weight is a threat, however because his weight is a health threat—whether he recognizes it or not—it is important for the clinician to present it as such, for example, by describing the threat's identity (names, symptoms and functional declines) and time lines (e.g., at what age is loss of mobility most likely, diabetes and its consequences). She should also emphasize how these threats to quality of life and life itself can be reduced and hopefully avoided. By discussing these concerns, the clinician enriches the patient's illness representation of obesity by bringing his awareness to the experienced *consequences* of obesity, and likely *time lines* and *causes*. Further, the clinician can directly assess the patient's beliefs about these domains (*consequences*, *control/cure*, *time lines*, and *causes*) using concrete and direct questions, like those listed in Table 1. That is, she would use the CSM as a framework to guide the assessment inherent to any behavioral weight loss plan by focusing on what the CSM suggests are the most important beliefs when trying to affect weight.

9. Creating an Action Plan

A careful assessment of the patient's illness representation of obesity allows the clinician to create and share with the patient at least two distinct "maps": one of his life course with obesity and one of his daily patterns of eating, sitting, and moving about physically. The life-course map is an image for motivating and sustaining behavioral changes. The map of daily living depicts the setting in which to introduce these changes. The action plan that emerges from this latter step provides the clinician and the patient with information on the foods now consumed and identifies specific substitutes. It also provides a picture of the local environment in which to engage in new, specific physical activities. Thus, the patient's tailored action plan is built on his model of obesity and the features of his daily environment. For example, if the patient believes that inactivity is the cause of his current weight, he might be best served by focusing on ways to increase his activity levels, even at the expense of discussing food choices, as if he consumes the same number of calories, but expends more energy he should lose weight and perhaps more importantly, develop the sense of self-efficacy that can serve as a basis for changes in diet. Similarly, if the patient is completely unaware of how to *control* his weight, time may be best spent describing the relationship between calories consumed and energy expended or by referring the patient to a nutritional specialist.

It is important that the clinician use the development of the action plan as a time to integrate the patient's conscious choices and semiautomatic habits. It is also a time to clarify the problems and barriers in replacing existent, semiautomatic habits with conscious choices and the time frames for the latter to become semiautomatic. Thus, the effectiveness of an action plan, particularly its ability to sustain action over time, depends upon its fit between the patient's daily experiences and his conceptual or deliberative framework as well as the acceptance of occasional failures (similar to strategies used in Relapse Prevention [39]). The clinician must ensure that the action plan instructs the patient on how to tell whether the treatment is working; for example, she can suggest ways for the patient to identify

early evidence of the benefits of minor weight loss (e.g., rising from chairs more easily) and combine this with the self-monitoring that is often used in CBT treatments. In sum, a good action plan addresses several components of treatment representations as it identifies start points for action (*control*), validating cues (*identity*), and *time lines* for validation (*consequences and control*). This is especially important as eating is a repetitive action and control begins with the first bite of the day. The composition and quantity of that bite sets in motion processes assessing "progress," such as feeling full or wanting a snack. Increasing awareness of this pattern and the subjective cues driving the pattern will enhance control and improve the fit of the weight management action plan. The action plan is more likely to be internalized, that is, to be a cognitive, behavioral strategy for living, when it is personalized.

10. Putting It All Together

During a CSM-informed medical visit, the practitioner's task is to personalize assessment, counseling, and the construction of protocols for action for as many steps of the change process as possible. Thus, the clinician must describe the long-term goals of weight loss, that is, how much change is needed to avoid the most detrimental mental and physical outcomes of obesity. She must also identify pathways for moving towards a series of short and intermediate goals by clarifying start points; for example, by explaining that eating healthier begins by drawing up a shopping list before going to the super-market, not when one sits down to eat or that exercise begins by selecting a time and place to walk that fits into one's current sequence of activities. She should also describe time lines for monitoring progress. Further, the clinician must explain to the patient how and when to check progress (e.g., checking the amount of healthy food available in the home, monitoring weight once a week, and when and how to discuss lab results with a physician).

These techniques are similar to many of the behavioral techniques used in existing weight loss interventions (e.g., motivational interviewing [7] and behavioral weight loss treatments [6]). However, the primary strength of the CSM lies in the fact that it can help the clinician create an action plan framed by the patient's model of obesity and the behavioral treatments perceived to be most effective within that framework. This makes the risks of obesity concrete within each of the CSM content areas (e.g., the identities {symptoms and functional damage}, time of onset, and time living with proximal {amputation and blindness for years} and remote risks {death}). This process also defines an action plan with pathways for specific behaviors that are nested in daily life activities. The entire process needs to be implemented as a personalized program for an active lifespan, which we hypothesize will improve initiation and adherence to weight loss protocols and the maintenance of these changes (i.e., sustained weight loss). We also hypothesize that it would be relatively easy to integrate these methods into existing treatments. Physicians often assess these domains during routine visits [28], so it should not be an excessive burden or time constraint. Indeed, using the CSM as a framework for this assessment could streamline the process and save precious clinical time.

11. Future Research

The methods proposed above suggest several specific areas of future research on the CSM and obesity. First, we need more information on the basic components of common-sense models of obesity, that is, how people come, or fail to come, to feel and believe they are overweight, the risks they associate with overweight (what they are likely to experience, when and for how long), the procedures they perceive as effective for weight reduction and how they experience and judge the efficacy of their own and prescribed interventions. A better understanding of the evidence that patients use to judge efficacy (e.g., somatic experiences, time frames, consequences) and their interpretations of this evidence will allow investigators to relate those beliefs to motivation and action for initiating, sustaining or quitting specific weight reduction procedures and weight control programs.

This information should be acquired through a combination of qualitative studies embedded in a framework of hypothesis testing, longitudinal, and quantitative work that will lead to multicondition randomized experiments to test efficacy and effectiveness. For example, large cross-sectional studies could correlate existing and empirically validated measures of illness beliefs (e.g., the various forms of the Illness Perception Questionnaire (e.g., [40, 41])) with outcomes such as weight, past attempts at weight loss, diet and physical activity. This information could be used to determine which illness and treatment beliefs and domains are most closely linked to necessary weight loss behaviors, which would suggest important areas for clinicians to target during assessment and treatment. This research could also include qualitative interviews that would begin to address the dynamic nature of the relationships among illness and treatment beliefs and health behaviors. Longitudinal studies will allow for more objective information regarding the dynamics among CSM-related beliefs and health behaviors. For example, tracking the beliefs, behaviors, and weights of individuals over time could explain whether certain beliefs are differentially associated with successful weight loss and maintenance.

We hypothesize that all five domains will be linked to health behaviors and outcomes and that the research described above will lead to the development of a weight loss specific CSM-based screener that clinicians could use to streamline assessment in clinical settings. As is the case with myocardial infarction [19], which has a similar treatment regimen to obesity, we hypothesize that the identity, control and consequence domains will be associated with initiating weight loss treatment and correlated with BMI. The time line and cause domains may be most important for maintaining weight loss as patients who consider weight loss behaviors as short term may be more likely to return to old, unhealthful habits once "treatment" ceases. Similarly, patients who do not consider lifestyle as a cause of obesity will most likely be nonadherent to lifestyle treatments as they will not make "common-sense."

It will also be important to test for the efficacy and effectiveness of CSM-based techniques in clinical trials. As stated numerous times above, we hypothesize that the CSM will be most effective when combined with existing treatments. Therefore, the trials should compare an existing treatment with a CSM-enhanced version of that treatment (e.g., one that includes CSM informed assessment) to determine which is more effective at short and long-term weight loss. We hypothesize that there will be similar levels of effectiveness in short term weight loss, but that the CSM-enhanced conditions will outperform standard treatment with regards to long term goals because the framework for change presented to patients will lead to changes that start as deliberate procedures, but that become automatic and effortless.

Similar research is already underway in at least two studies, one that uses the CSM to tailor weight loss interventions for patients on antipsychotic medications [42] and another that uses the CSM as the theoretical basis for an intervention to increase walking in patients with intermittent claudication [43]. The latter study is assessing illness beliefs and both studies could assess these beliefs at the beginning, middle and end of treatment and could then correlate CSM beliefs with outcomes and potentially test mediating effects. Having more information on the basics of patients' common-sense models could also provide clinicians with a variety of "shortcuts" during medical visits (e.g., if a specific illness domain is unrelated to outcomes, it need not be assessed).

12. Conclusion

The Common-Sense Model provides a framework for representing how people manage threats to health in everyday life; it is a "situated" cognitive behavioral model [44]. Therefore, in addition to providing a framework for conceptualizing and implementing clinical research across illnesses, the CSM has the additional virtue of addressing the language of the clinical encounter. It captures the intrapersonal processes involved in illness management as well as in the interpersonal discourse between patients and clinicians (in reviewing presenting problems and the formal review of systems, practitioners and patients use the language of the CSM). Thus, the CSM can track exchanges among patients and providers from diagnosis to the evaluation of treatment. This makes the CSM a self-regulation framework that is useful for increasingly precise predictions and is readily shared with clinicians and investigators interested in formalizing our approach to behavioral change for improving the health of individuals and populations. (We can be contacted for collaboration or further references.)

Acknowledgments

This paper was supported by the National Institute of Minority Health and Health Disparities (Grant R24 MD001691). The authors would like to thank the study team, members of the East Harlem Partnership for Diabetes Prevention Community Action Board, and the study participants.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 274068, 14 pages
doi:10.1155/2012/274068

Research Article

Psychobehavioural Factors Are More Strongly Associated with Successful Weight Management Than Predetermined Satiety Effect or Other Characteristics of Diet

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Received 8 November 2011; Revised 5 March 2012; Accepted 16 April 2012

Academic Editor: Simone Lemieux

This study aimed to investigate factors associated with weight management, especially whether satiety value of food as a part of a weight-maintenance diet would affect self-regulation of food intake and weight management. Altogether 82 obese subjects completed the study consisting of weight-loss and weight-maintenance (WM) periods. During the WM, subjects were randomized into higher- and lower-satiety food groups. No differences were observed in the changes in body weight, energy intake, or eating behaviour between the groups, even despite the different macronutrient compositions of the diets. However, when regarding all study subjects, success in WM was most strongly associated with a greater increase in the flexible control of eating and experience of greater easiness of WM and control of food intake and a greater decrease in uncontrollable eating and psychological distress. Psychobehavioural factors seem to be more strongly associated with successful weight management than the predetermined satiety effect or other characteristics of the diet.

1. Introduction

Success in weight management is challenging. Even after successful weight loss, weight regain is very common [1, 2]. Therefore it is important to identify factors that are associated with and could enhance the self-regulation of food intake and other behaviours related to weight management.

Because obesity is always a result of an imbalance between the energy intake and energy expenditure, decreased energy intake is generally required for successful weight loss. Regulation of energy balance is very complex, however, with multiple mechanisms maintaining homeostasis and resisting changes in the energy balance [3]. Therefore, during negative energy balance, that is, when energy intake is lower than energy requirements, orexigenic pathways in the organism are activated [4], a usual consequence of which is a regain of reduced body weight. Successful long-term management of weight thus requires safe and effective means to counteract these compensatory regulatory mechanisms to reduce appetite and enhance satiety.

Various foods, even regardless of their energy content, may differ in their capacity to regulate satiety [5]. This can be accounted for multiple characteristics of food, such as energy density, macro- and micronutrient composition, palatability, food form, and structure [6–10]. Among different food characteristics, especially dietary fibre and protein have

recently raised much interest as potential factors capable of increasing the satiating value of food [11, 12].

Indeed, higher protein intake has been shown to sustain or increase satiety both during the periods of energy restriction [13] or during the periods of isocaloric [14] or *ad libitum* energy intake [15]. Greater satiating effect of protein has been ascribed to greater meal-induced thermogenesis after protein-rich meals than after meals rich in carbohydrates or fat [16, 17]. Protein also efficiently stimulates the expression of various gastrointestinal satiety hormones, and amino acids serve as precursors for specific neurotransmitters involved in appetite or are directly involved in pathways regulating food intake.

High dietary fibre intake has also been shown to contribute to increased satiety and reduced energy intake [12, 18]. Among key mechanisms, dietary fibre increases satiety and reduces energy intake by decreasing the energy density of the diet as well as by retarding nutrient absorption, gastric emptying, and intestinal passage times in the gastrointestinal tract [18]. Dietary fibre enhances satiety also through increased oral stimulation due to longer chewing time.

Several studies have shown that higher intake of dietary protein and fibre can contribute to greater weight loss or better maintenance of reduced weight [11, 12, 19, 20]. Greater weight loss with high-protein or high-fibre diets has been ascribed in part to their higher satiating effects and thereby to better dietary compliance and ability to reduce spontaneous energy intake.

However, in spite of the large number of short-term studies linking various food properties to increased satiety, it is still poorly known whether the satiety value of food has an impact on the self-regulation of food intake and thereby on the regulation of body weight also at the longer term.

Different features of eating behaviour, such as restraint and disinhibition of eating, are also strong determinants of weight management [21–24]. Dietary restraint and disinhibition are psychological constructs that assess behavioural control and attitudes toward food and eating [25, 26]. Dietary restraint refers to a tendency to consciously restrict or control food intake, whereas dietary disinhibition is a tendency to overeat in the presence of, for example, palatable foods, emotional stress, or other disinhibiting stimuli. Dietary disinhibition has been linked to higher body weight and increased risk of weight regain [22, 24], whereas increased dietary restraint with greater weight loss or better maintenance of reduced body weight [23, 27, 28]. Other features of eating behaviour, such as emotional eating and greater susceptibility to sensations of hunger or external food-related cues, have also been associated with greater risk of obesity and difficulties in weight management [29–32].

Therefore, the aim of the present study was to investigate factors that are associated with successful weight management in middle-aged obese men and women. We were especially interested in investigating whether foods with higher predetermined satiety values, when ingested as a part of a weight-maintenance diet, contribute to better self-regulation of food intake and reduced body weight. The study consisted thus of two distinct, consecutive phases: determination of satiating values of foods in a controlled laboratory setting to select foods with lower and higher satiating values for the intervention and an intervention including weight-loss and weight-maintenance periods whereby the satiety-tested foods were used as a part of a weight-maintenance diet.

Table 1: Baseline characteristics of the subjects completing the study.

	Mean ± SD	Range (min–max)
n (males/females)	82 (21/61)	
Age (years)	49.5 ± 9.3	31–63
Height (cm)	166.7 ± 8.6	150.0–192.0
Body weight (kg)	95.2 ± 11.9	71.1–122.8
Body mass index (kg/m^2)	34.2 ± 2.5	29.7–40.0

2. Subjects and Methods

2.1. Subjects in the Intervention Study. Originally 99 (28 males, 71 females) obese (inclusion criteria being body mass index (BMI) 30–40 kg/m^2, age 30–65 years) subjects were recruited into the intervention study. They were recruited by an announcement in a local newspaper and among the eligible subjects who had participated previously in the studies performed at the University of Kuopio, Kuopio, Finland (currently University of Eastern Finland). The exclusion criteria of the subjects were BMI >40 or <30 kg/m^2, pregnancy, type 1 or 2 diabetes, abnormal liver, thyroid or kidney function, polycystic ovary syndrome, less than 6 months since coronary event or operation, myocardial infarction, susceptibility to arrhythmia, diagnosed eating disorder, neuroleptic or oral cortisone medication, and excess alcohol consumption (women > 16, men > 24 portions/week). The subjects could not have any other diseases, medications, or life situations that would have potentially prevented them to successfully complete the study.

Altogether 82 subjects completed the whole intervention and form the study group of this study. Baseline characteristics of the completers are shown in Table 1.

The study was performed in accordance with the standards of the Helsinki Declaration. The Ethics Committee of the District Hospital Region of Northern Savo and the Kuopio University Hospital approved the study plan, and all participants gave written informed consent for their participation.

2.2. Selection and Satiety Testing of Foods for Intervention

2.2.1. Selection of Foods for Satiety Testing. Because the satiating value of food cannot be directly estimated based on the nutritional composition or other characteristics of foods [20, 33], satiety tests were performed to identify foods with different satiety values for the intervention. Satiety tests were performed in a laboratory setting to control for potential confounders known to affect satiety measurements [32, 33]. Satiety values were determined for food products from seven categories (yoghurt-type dairy products, crisp bread, soft bread, cheese, cold cuts, beverages, vegetable meal

components). These food categories were selected so that the test foods would represent diversely different parts of the mixed diet. However, due to practical reasons a limited number of foods (altogether 22 foods, 2–5 foods per food category) could be included into the satiety tests. The foods were provided by Finnish food manufacturers, and they represented both commercial products as well as products at the stage of product development.

In the selection of foods for satiety testing, the following factors were considered: the difference between foods regarding the amount of dietary fibre or protein per 700 kJ portion should be as large as possible, since based on literature dietary fibre and protein play an important role in the satiating effect of foods [11, 20]. Furthermore, we chose an isocaloric portion size of 700 kJ, which was in our previous study shown to be an energy level at which different satiety effects of test foods can be distinguished [34]. At this energy level we tried to keep portion sizes (weight or volume) as similar as possible. However, if the sizes of tested isocaloric portions differed, the volume or weight of food with potentially greater satiety value should be greater than that with potentially lower satiety value, due to possible independent effect of volume or weight on postprandial satiety [35]. Also, within each food category, the foods with potentially different satiety values should otherwise be as similar as possible.

2.2.2. Satiety Testing. The satiety values of the test foods were assessed at VTT, Espoo, Finland, before the intervention study. Altogether 35 subjects (20 males, 15 females, aged 23.3 ± 2.2 (range 19–28) years) recruited mainly from the Helsinki University of Technology participated in the tests. The subjects were healthy, normal-weight ($n = 27$), or at most moderately overweight ($n = 8$, mean BMI 23.3 ± 2.3 (range 19.1–29.7) kg/m^2) due to potentially attenuated satiety responses in obese as compared with lean individuals [32]. The subjects followed normal dietary and exercise patterns and did not have any dietary restrictions or abnormal eating behaviour based on individual interviews and the Three-Factor Eating Questionnaire [25]: cognitive restraint 7.5 ± 4.2 (mean ± SD), disinhibition of eating 5.1 ± 2.8, hunger 4.9 ± 2.5.

Subjects participated in the satiety tests in the morning, after a minimum of 8 hours overnight fast. There was at least one day between the consecutive test sessions. Before the actual satiety tests, the subjects were familiarized with the procedure and trained to use the rating scales using typical Finnish rye bread as the practice product. The satiety tests lasted for 3 hours, during which the subjects rated their satiety-related perceptions before consuming the test product and after 20, 40, 60, 90, 120, 150, and 180 min from the beginning of the consumption. At each session, subjects ate the whole portion of the test food with 2 dL of water. With crisp breads subjects consumed 50 g of slices of cucumber and 1.5 dL of water. Each subject participated in the maximum 25 testing sessions, including two practice sessions.

The satiety-related sensations were evaluated using a 10-unit scale (0 = not at all, 10 = extremely) before the consumption of the test product. Immediately after the consumption and during the following 180 min, sensations were rated as a change from the starting value with a −10–0–+10 scale (−10 = a lot less than that in the beginning, 0 = as much as that in the beginning, +10 = a lot more than that in the beginning) where 0 represents the baseline value [34]. A total of six satiety/hunger and thirst-related attributes were rated (hunger, thirst, desire to eat something, satiety, fullness, desire to eat the test food). The data were collected using a computerized data-collecting system (CSA, Computerized Sensory Analysis System, Compusense, Guelph, Canada, Compusense 5, version 4.6.702 SP3).

Results were analyzed as the changes in the satiety-related sensations from the baseline levels as a function of time, and the area under curve (AUC, cm × min) was calculated. The possible area under or over the baseline level was subtracted. All curves followed the same pattern with the lowest or highest ratings 20 min after eating the sample, and then scores increased or decreased, respectively, during the 3-hour follow-up time. Finally, 8 food pairs with significant difference in the overall 3 h response of the feelings of hunger or satiety were selected to be the test foods in the intervention (Table 2).

2.3. Study Protocol of the Intervention. The intervention study consisted of two periods, weight loss and weight maintenance. Subjects were informed that the aim of the study was to examine the effect of various food characteristics on the management of body weight and food intake and related mechanisms. Since satiety is a highly subjective sensation, the subjects were not told about the different satiety values of the test foods to avoid any bias due to that information.

2.3.1. Weight-Loss Period. The weight-loss period was performed by using very-low-calorie-diet (VLCD) products (Nutrifast, Leiras Finland Ltd) providing 600 kcal/day. In addition, the subjects were allowed to consume *ad libitum* low-energy vegetables and noncaloric beverages. The VLCD products were given free of charge, and they were consumed for 7 weeks, followed by a 2-week transition phase during which subjects gradually finished using the VLCD products and switched back to the mixed food diet. During the weight-loss period, the subjects were given dietary counselling in group sessions, 7 times during the whole period. The group sessions, lasting for 1.5 hours, were held in the evenings. Altogether 8–10 subjects participated in each group. The same experienced nutritionist tutored all the groups. Different themes were discussed at each session (Table 3).

2.3.2. Weight-Maintenance Period. After the weight-loss period, the subjects were randomized, stratified by age and sex, into two diet groups: higher-satiety food group (HSF) and lower-satiety food group (LSF) (Table 4). The baseline characteristics of the subjects in the HSF and LSF groups are presented in Tables 4, 6, and 7 (baseline). There were

Table 2: Foods selected to the intervention and their tested portion sizes, macronutrient and dietary fibre contents and 3 h satiety/hunger responses (3 h AUC; mean ± standard error). Energy content of all tested food portions was 700 kJ.

	Dairy, yoghurt type		Bread			Cheese	Cold cuts	Vegetable meal component
HSF	Pear flavour $n = 35$	Lingonberry flavour[a]	Rye crisp bread $n = 32$	Soft rye bread (1) $n = 30$	Soft rye bread (2) $n = 29$	Hard cheese $n = 30$	Smoked ham $n = 35$	Vegetable patty (fibre-rich) $n = 35$
Portion size, g	280	280	52	82	70	88	140	104
Protein, g	30.6	30.6	5.6	5.9	5.6	29.90	31.6	9.2
Fat, g	0.6	0.6	1.2	1.1	1.4	4.4	4.5	10.7
Carbohydrates, g	11.2	11.2	31.0	31.1	32.7	1.3	2.3	8.7
Dietary fibre, g	5.6	5.6	8.9	9.0	10.5	0	0.4	6.9
Satiety, 3 h AUC	464 ± 65	—[a]	237 ± 60	289 ± 56	224 ± 62	103 ± 60	400 ± 72	231 ± 53
Hunger, 3 h AUC	−503 ± 67	—[a]	−313 ± 67	−275 ± 54	−278 ± 75	−148 ± 61	−463 ± 86	−259 ± 59
LSF	Vanilla flavour $n = 35$	Strawberry flavour $n = 32$	Wheat crisp bread $n = 35$	Soft wheat bread $n = 35$	Thin rye crisp bread $n = 35$	Soft sliced cheese $n = 30$	Sausage $n = 35$	Vegetable patty $n = 35$
Portion size, g	230	200	44	61	52	58	108	93
Protein, g	8.3	7.1	4.6	5.4	5.8	11.6	9.7	4.3
Fat, g	4.6	4	3.5	2.9	5.8	12.8	9.7	11.5
Carbohydrates, g	23	26	31	28.8	33	0.9	8.9	10.1
Dietary fibre, g	0	0	2.8	2.0	9.9	0	0.3	3.1
Satiety, 3 h AUC	111 ± 47	179 ± 59	154 ± 50	114 ± 49	122 ± 51	−2 ± 62	146 ± 54	93 ± 62
Hunger, 3 h AUC	−173 ± 48	−148 ± 65	−186 ± 55	−130 ± 59	−161 ± 55	−1 ± 72	−171 ± 63	−124 ± 65

HSF: higher-satiety food group; LSF: lower-satiety food group; AUC: area under the curve: positive values represent area above the baseline level, negative values represent area under the baseline level; [a]a flavour variant for pear-flavoured yoghurt, not tested in the satiety tests.

Table 3: The themes discussed in the group sessions during the weight-loss period.

Group session	Theme
(1) Session	Principles of the very-low-calorie diet (VLCD, 600 kcal); tasting and choice of the most pleasing options of available VLCD products for the weight-loss period
(2) Session (start of VLCD)	Energy requirement and energy consumption, physical exercise, vegetables in the diet; VLCD products delivered to the subjects
(3) Session (1 week at VLCD)	Control of food intake, meal rhythm, snacks, and beverages
(4) Session (3 weeks at VLCD)	Thoughts and attitudes as barriers for weight management
(5) Session (5 weeks at VLCD)	Good and bad dietary fats, package labelling
(6) Session (7 weeks at VLCD; start of transition phase)	Transition phase diet (800 kcal), control of food intake
(7) Session (start of weight-maintenance period)	Principles of the weight-maintenance diet and the use of test foods

no significant differences at the baseline between the groups except for external eating, which was greater in the HSF than in the LSF group ($P = 0.02$), and the proportion of daily energy from carbohydrates, which was greater in the LSF than in the HSF group ($P = 0.03$). However, the total carbohydrate intake was the same in both groups.

Neither of the diets was considered a control diet. During the 24-week weight-maintenance period, subjects were instructed to maintain their weight loss but not to continue actively losing weight. The subjects in the HSF consumed the test foods with higher satiety value the subjects in the LSF consumed the test foods with lower satiety value as a part of their weight-management diet. The way of using the test foods and all dietary counselling was otherwise the same in both groups.

The test foods aimed to cover about 30% of the individually estimated daily energy requirements. The proportion of test foods was tested in the pilot study performed prior to the intervention study to find out what was the highest realistic amount of the test foods that could be consumed as a part of the diet. 19 subjects (5 men, 14 women) of same age (51.2 ± 10.0 years) and BMI (31.3 ± 4.4 kg/m^2) as the subjects in the intervention study participated in the pilot and used the test foods for two weeks as a part of their

habitual diet. At the end of this period, they were interviewed about their experiences, and the intervention protocol was further modified using this information.

The individual energy requirements were estimated by calculating the basal metabolic rate by the formula of Mifflin St-Jeor [36]. To take into account the likely reduction of the energy expenditure due to the recent marked weight loss [37], the resultant values were deducted by 5%. The results were then multiplied by factor 1.3 to take into account the energy requirements due to any physical activity. Based on the experiences from the pilot study, the resultant values were then deducted by the value 333.45 kcal to take into account the difference between the calculated energy requirements and the reported energy intakes. Thus the final equations for the calculation of the energy requirements were [(9.99 ∗ weight (kg) + 6.25 ∗ height (cm) − 4.92 ∗ age (yrs) + 5) ∗ 0.95 ∗ 1.3] − 335.45 kcal for men and [(89.99 ∗ weight (kg) + 6.25 ∗ height (cm) − 4.92 ∗ age (yrs)−161) ∗ 0.95 ∗ 1.3] − 335.45 kcal for women. The resultant individual energy levels were rounded up to the nearest 100 kcal and varied from 1200 kcal to 2300 kcal/day. The amounts of portions of different test foods used per day were calculated and advised based on these energy levels.

The subjects received the test foods free of charge from the University of Kuopio (current the University of Eastern Finland) every two weeks. The test foods were given as the blank packages so that the subjects could not identify their exact content on the basis of, for example, comparable commercial products. During every visit, the subjects' body weight was measured, and they were given written instructions about the use of the test foods as well as the weight-management diet in general.

The written instructions included the numbers of the portions of each test food and the recommendations of the number of servings within each food group (vegetables/berries/fruit, dairy, potatoes and cereals, meat/fish/poultry, fat) to be consumed each day so that the total energy intake would cover the individually estimated daily energy requirement. The subjects were, however, informed that the diet was otherwise freely selected. In addition, to allow the possible satiety effect of test foods to function, subjects were told that they could increase or decrease the number of food servings (other than test foods) if still hungry or if sated, respectively.

Table 5 shows the portion sizes and typical numbers of daily portions of each test food as instructed to be consumed during the intervention. The portion sizes could be different from those used in the standard satiety tests because the foods were used as a part of a diet and were therefore targeted to represent typical portion sizes of each food. The number of the portions/day varied among different energy levels and from day to day. In addition, in order to reduce the risk of monotony and boredom due to the continued and frequent use of a quite limited number of test products, test foods within each list varied so that each two weeks list included 6 out of 8 test foods. On each week, the subjects were allowed to have one day free of the use of the test foods, if they wished. The subjects recorded the use of the test foods for the whole duration of the weight-maintenance period. These recordings were used when calculating the compliance (i.e., the use of the test foods as compared with the instructed use).

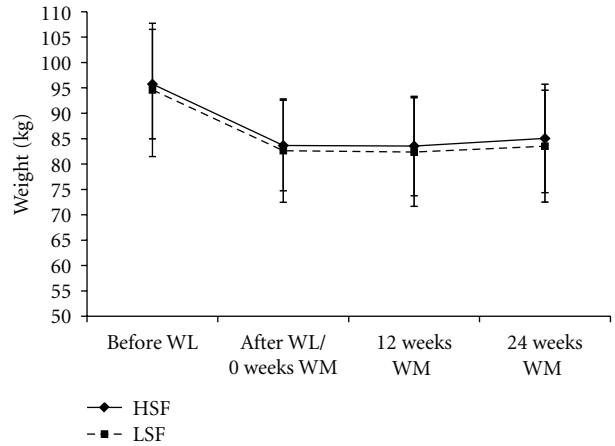

Figure 1: Changes in the body weight during the study. No significant differences between the groups. HSF: higher-satiety food group ($n = 42$); LSF: lower-satiety food group ($n = 40$); WL: weight loss; WM: weight maintenance.

The subjects were not given any specific instructions about physical activity but were advised to keep it at their habitual level.

2.4. Measurements in the Intervention

2.4.1. Anthropometric Measurements. Body weight was measured in the morning after 12 hours fast after voiding in the normal indoor clothing using a digital scale (Vogel & Halke, Hamburg, Germany) with the weighing accuracy of 0.1 kg. The measurements were done at the separate study visits in the beginning of the weight-loss period before any weight loss had occurred, at the end of the weight-loss period (i.e., the beginning of the weight-maintenance period), and at 12 and 24 weeks after the beginning of the weight-maintenance period (Figure 1). Height was measured using a wall-mounted stadiometer to the nearest 0.1 cm in the beginning of the weight-loss period. Body mass index (BMI) was calculated (weight (kg)/height $(\mathrm{m})^2$).

2.4.2. Dietary Intake. Subjects completed 4-day food records altogether five times during the study: before the weight-loss period and at 6, 12, 18, and 24 weeks from the beginning of the weight-maintenance period. The portion sizes were estimated using household measures. Nutrient intake was calculated with Diet32 analysis program (Aivo Finland Oy) using the Finnish Food Composition Database, Fineli (National Institute for Health and Welfare).

2.4.3. Eating Behaviour and Psychological Distress. Various features of eating behaviour were evaluated by standardized and validated self-report questionnaires. Three-Factor Eating Questionnaire (TFEQ) was used to measure cognitive restraint of eating and divided also to the flexible and rigid parts of the restraint [38], disinhibition of eating, and

Table 4: Subjects in the higher-satiety food (HSF) and lower-satiety food (LSF) groups. Mean ± SD.

	HSF	LSF	P^a
n (males/females)	42 (12/30)	40 (9/31)	0.53[b]
Age (years)	49.6 ± 9.5	49.1 ± 9.1	0.83
Height (cm)	167.6 ± 8.0	165.8 ± 9.3	0.35
Body weight (kg), before weight loss	95.7 ± 10.8	94.6 ± 13.1	0.67
Body weight (kg), after weight loss	83.7 ± 8.9	82.6 ± 10.2	0.63
Body mass index (kg/m^2), before weight loss	34.0 ± 2.3	34.3 ± 2.7	0.60
Body mass index (kg/m^2), after weight loss	29.8 ± 2.1	30.0 ± 2.3	0.63

[a] Student's *t*-test; [b] Chi-square.

Table 5: Instructed portion sizes, possible numbers of daily portions, and their energy and macronutrient contents per portion during the intervention.

	Portion size, g	Number of portions/day[a]	Energy, kcal	Protein, g	Fat, g	Carbohydrates, g	Dietary fibre, g
			HSF				
Yoghurt (pear flavour)	150	1-2	90	16.5	0.3	6.0	3
Yoghurt (lingonberry flavour)	150	1-2	90	16.5	0.3	6.0	3
Rye crisp bread	12.9	1–3	41	1.4	0.3	7.7	2.2
Soft rye bread (1)	43	1–3	86	3.1	0.6	16.3	4.7
Soft rye bread (2)	30	1–3	75	2.4	0.6	14.0	4.5
Hard cheese	125	0.25–0.75	238	42.5	6.3	1.9	0
Smoked ham	6.2	4–10	7.5	1.4	0.2	0.1	0.2
Vegetable patty (fibre-rich)	60	1-2	96	5.3	6.2	5.0	4.0
			LSF				
Yoghurt (vanilla flavour)	130	1-2	91	4.7	2.6	13.0	0
Yoghurt (strawberry flavour)	110	1-2	91	3.9	2.2	14.3	0
Wheat crisp bread	12.5	1-2	50	1.3	1.0	8.8	0.8
Soft white wheat toast bread	25	1–4	70	2.2	1.2	11.8	0.8
Thin rye crisp bread	6.3	2–10	20	0.7	0.7	4.0	1.2
Soft sliced cheese	19	1–3	55	3.8	4.2	0.3	0
Sausage cold cut	13.4	1–5	20	1.2	1.2	1.1	0.4
Vegetable patty	60	1-2	10.5	2.8	7.4	6.5	2.0

HSF: higher-satiety food group, LSF: lower-satiety food group; [a] range, the number of the portions varied from day to day and among different energy levels.

susceptibility to hunger [25]. The Dutch Eating Behaviour Questionnaire (DEBQ) was used to measure restraint of eating, emotional eating, and external eating [39]. Binge Eating Scale (BES) assessed the presence of binge eating [40]. The subjects filled in the questionnaires in the beginning of the weight-loss period and after 12 and 24 weeks of weight maintenance.

Psychological distress was evaluated by the General Health Questionnaire [41] in the beginning and at the end of the weight-loss period as well as after 12 and 24 weeks of weight maintenance.

During the weight-maintenance period, the subjects evaluated at the end of each week their overall well-being, bowel function, hunger, satiety, and easiness of control of food intake by the 9-point scale (1 = not at all/extremely bad, ..., 9 = a lot/extremely good). In addition, at the end of each dietary data collection day, the subjects rated how difficult/easy they had experienced control of food intake that day by using 7-point scale (1 = very difficult, ..., 7= very easy).

At the end of the study, the subjects filled in a final questionnaire to assess how they had experienced the weight-maintenance period in general (1 = very difficult, ..., 10 = very easy) and what they had liked about the test foods (1 = did not like at all, ..., 9 = liked very much).

2.5. Statistical Analyses. The statistical analyses were performed with SPSS for Windows software (SPSS for windows, version 14.0, USA). The results are expressed as mean and standard deviation (SD) with a value $P < 0.05$ as a criterion for the statistical significance, unless not otherwise specified.

In the satiety tests, paired samples *t*-test was used to evaluate the differences between the food pairs within each food category.

In the intervention study, independent samples *t*-test (Student's *t*-test) and Chi-square test were used to compare

the baseline values between the study groups. Linear mixed-effect modelling was used to compare the effect of the study group on the changes in the examined variables. The associations between the variables in the whole study population were analyzed by Spearman's correlation test and by partial correlation adjusted by the study group.

3. Results

3.1. Adherence and Compliance. Altogether 82 out of 99 subjects completed the intervention. There were 17 subjects who dropped out, three subjects (2 men, 1 woman) during the weight-loss period and 14 subjects (6 men, 9 women) during the weight-maintenance period. There were no differences in the dropouts during the weight-maintenance period between the HSF (8 (3 men, 5 women)) and the LSF groups (6 (2 men, 4 women)).

The use of test foods, as an indicator of compliance, was equal in both groups (% of the instructed use, calculated from the individual recordings during the weight-maintenance period: 100.8 ± 9.0% versus 99.1 ± 9.1%, HSF versus LSF), as well as the proportion of energy ingested from the test foods (mean during the weight-maintenance period: 30.7 ± 6.1% versus 29.0 ± 5.0%, HSF versus LSF). The subjects in the HSF group generally liked the test foods they used more than in the subjects in the LSF group (7.1 ± 1.0 versus 6.4 ± 1.0, $P = 0.003$).

3.2. Main Effects

3.2.1. Body Weight. Weight changes were comparable between the HSF and the LSF groups (Figure 1). The weight reduced by about 12 kg during the weight-loss period in both groups (HSF −12.5 ± 2.4%, LSF −12.4 ± 2.6% of the body weight at the baseline). During the weight-maintenance period, there was only a very slight regain in the mean body weight with no significant difference between the groups (HSF 1.3 ± 3.5%, LSF 0.9 ± 3.5%). The interindividual variation in the success to maintain the reduced body weight during the weight-maintenance period was large, with weight changes varying from 8.8% further weight reduction to 9.8% weight regain.

3.2.2. Dietary Factors. The overall energy intake was similar in both groups with no significant differences in overall energy intake during the intervention (Table 6). Only at the end of the study, the energy intake changed differently in the HSF and LSF groups, with continuing gradual increase in the energy intake in the HSF group and a small decrease in the LSF group ($P = 0.02$). Instead, the macronutrient composition of the diet changed differently in the HSF and the LSF groups. The intakes of dietary protein and fibre increased at the beginning of the weight-maintenance period in the HSF group whereas they remained about the same in the LSF group ($P < 0.001$ for all). The intakes of dietary fiber and protein were thus higher in the HSF than those in the LSF group for the whole duration of the weight-maintenance period ($P < 0.001$ for all). The intake of dietary fat decreased from the beginning of the study to the weight-maintenance period in both groups, the decrease being greater and thus overall fat intake lower in the HSF than in the LSF group during the weight-maintenance period ($P < 0.001$). The total carbohydrate intake decreased from the beginning of the study to the weight maintenance in both groups. The reduction was greater in the HSF group than that in the LSF group ($P = 0.04$). As the percentage of energy, carbohydrate intake remained about the same during the whole study being greater in the LSF group ($P < 0.001$). The alcohol intake decreased from the beginning of the study in both groups, being, as the percentage of energy, somewhat greater in the HSF group than that in the LSF group ($P = 0.04$).

The observed differences in dietary protein, fibre, fat, and carbohydrate intakes during the weight-maintenance period were due to the different macronutrient contents of the test foods (Table 5). The composition and energy intake of the freely selected part of the diet was the same in both groups (data not shown).

3.2.3. Psychobehavioural Factors. The subjects in the HSF and the LSF groups experienced the study very similarly based on their responses in the final questionnaire at the end of the study (estimated easiness of the weight maintenance period: HSF 7.1 ± 1.8, LSF 7.1 ± 1.9). Neither did they report any differences in the easiness of the control of food intake or other conditions that were evaluated along the study (overall wellbeing, bowel function, hunger, satiety).

Cognitive restraint of eating, both flexible and rigid, increased in both the HSF and the LSF groups after the weight-loss period, as measured by the TFEQ and the DEBQ questionnaires (Table 7). At the same time, disinhibition of eating, susceptibility to hunger, and binge eating as well as emotional and external eating decreased in both groups. There were no significant differences in the changes between the groups, except in the external eating which decreased more in the HSF group than those in the LSF group ($P = 0.007$) most likely due to higher scores in the HSF at the beginning of the study. Neither were there any significant differences between the groups in the changes in the psychological distress, as assessed by GHQ, which alleviated in both groups after the weight loss then gradually returning towards the baseline level.

3.2.4. Predictors of Weight Maintenance. Due to great interindividual variation in the success to maintain reduced body weight, irrespective of the study group, the predictors of weight maintenance were analysed in the whole study population. The changes in the eating behaviour during the study were significantly associated with the weight maintenance (Table 8). The success in weight maintenance was associated with the greater increase in the cognitive restraint of eating, especially in the flexible control of eating as well as the greater decrease in the disinhibition of eating, susceptibility to hunger, binge eating behaviour, external eating, and psychological distress. Most of these changes, that is, increase in the flexible control of eating and the decrease in susceptibility to hunger, binge eating behaviour,

external eating, and psychological distress, were associated with better weight maintenance also after adjusting for group membership during the weight-maintenance period (Table 8).

The self-reported easiness of the weight-maintenance period resulted to be a single factor which was most strongly associated with the successful maintenance of reduced body weight during the weight-maintenance period ($r = -0.47$, $P < 0.001$, $n = 82$). The association was significant, even slightly stronger, also after making adjustment for study group (partial correlation $r = -0.52$, $P < 0.001$). Those subjects who experienced the weight-maintenance period the easiest also managed better than those experiencing it more difficult. Similarly, the self-reported easiness of the control of food intake, as assessed at the different phases of the weight-maintenance period, correlated significantly with the weight maintenance (mean of weekly assessments, $r = -0.39$, $P < 0.001$, $n = 82$), also after adjusting for group membership (partial correlation $r = -0.39$, $P < 0.001$). The easier the subjective control of food intake, the more successful the weight maintenance.

Among the dietary determinants of successful weight maintenance, the compliance (i.e., the use of the test foods) correlated with the final outcome; the higher the compliance, the better the reduced body weight maintained during the weight-maintenance period ($r = -0.27$, $P = 0.02$, $n = 82$). This association was seen also after adjusting for the study group (partial correlation $r = -0.23$, $P = 0.05$). Lower energy intake according to the food diaries during the weight-maintenance period was also associated with the better maintenance of reduced body weight ($r = 0.24$, $P = 0.03$, $n = 82$) also when adjusted by group membership (partial correlation $r = 0.22$, $P = 0.047$).

4. Discussion

This study investigated dietary and psychobehavioural factors associated with the success in weight maintenance. More specifically, we were interested in whether foods with predetermined satiety values consumed in free-living conditions as a part of a weight-maintenance diet would affect self-regulation of food intake and thereby weight management. To our knowledge, no previous studies have been published on the issue. In contrast to expectation, the diet containing foods with higher predetermined satiety value did not contribute to better weight management. This was even despite the obvious differences in the macronutrient contents of the diets, especially the differences in the amounts of dietary protein and fibre, which by themselves could also have been expected to influence satiety or weight management [11, 12].

Nevertheless, the present results were interestingly in line with the findings of a recent large intervention comparing the effects of weight-loss diets differing in the proportions of dietary fat, protein, or carbohydrate [42]. In that study, no diet was superior in reducing body weight. There were also no significant differences in satiety, hunger, or diet satisfaction among the diets. Instead, the strongest determinant of successful weight loss was an attendance at the group sessions, suggesting that behavioural factors rather than the composition of the diet are more important for the success of weight loss. Also in the present study the successful maintenance of reduced weight was not primarily associated with the diet-related factor, but rather with the psychobehavioural variables related especially to eating behaviour. Also participants' subjective experiences about the easiness of the intervention and control of food intake were associated with better weight maintenance. The only diet-related factors that were significantly associated with the weight management were lower energy intake and better compliance of the use of the test products, which, on the other hand, could be seen also as behavioural factors similarly as the attendance at group sessions in the Sacks et al.'s [42] study. Thus, as Sacks et al. [42] also pointed out, behavioural and psychological factors rather than macronutrient metabolism seem to have the main influence on the success of longer-term weight management.

Changes in various features of eating behaviour were associated with the better success in weight management. All the observed changes, that is, increase in the cognitive restraint of eating and decrease in binge eating, external eating, disinhibition of eating, and susceptibility to hunger, were into the direction that could be suggested to represent better self-control of eating. These changes were also well in line with several previous findings, thus further confirming the important role of eating behaviour in the successful weight management [27, 28, 30, 31, 43]. When distinguishing cognitive restraint of eating into flexible and rigid forms of restraint behaviour [38], it was specifically the flexible restraint that was associated with the better maintenance of reduced weight. This is in accordance with the earlier findings [22, 27, 31, 38, 44] and also with the concept of flexible restraint. By definition, flexible restraint of eating is a form of eating behaviour characterized by a more graduated approach to eating, dieting, and weight in contrast to rigid control which is characterized by a dichotomous, all-or-nothing approach to eating, dieting, and weight [38]. A form of restrained eating in which flexible approach is adopted seems thus to be beneficial to effective weight control [31, 45]. The beneficial effect of flexible control of eating on weight management has been documented earlier both in cross-sectional and in prospective analysis. In cross-sectional settings, flexible restraint has been shown to predict lower fatness and BMI [22, 46]. In prospective studies, successful weight change has been more strongly associated with flexible than with rigid form of cognitive restraint of eating [31, 38, 46, 47]. Thus, as Teixeira et al. [31] concluded, sustained weight loss seems to require that subjects adopt a flexible eating self-regulation pattern that allows them to modify their eating behaviour and quite likely also their physical activity by appropriate ways in this complex food environment. Successful restraint of eating can also be linked with higher self-control capacity in general [45]. Therefore attempts to enhance self-regulation could be of value to those attempting to control body weight and food intake.

Table 6: Energy and macronutrient intake (mean ± standard deviation) in the HSF and LSF groups before the beginning of the study (baseline) and during the weight-maintenance period (WM, the weeks refer to the time since the beginning of the weight-maintenance period).

	HSF $n = 42^a$					LSF $n = 40^a$						
	Baseline	6 wks WM	12 wks WM	18 wks WM	24 wks WM	Baseline	6 wks WM	12 wks WM	18 wks WM	24 wks WM	P^b	P^c
Energy (goal), kcal	—	1581 ± 233	1581 ± 233	1581 ± 233	1581 ± 233	—	1555 ± 259	1555 ± 259	1555 ± 259	1555 ± 259	—	—
Energy (realization), kcal	2053 ± 526	1553 ± 348	1692 ± 404	1761 ± 439	1863 ± 573	1945 ± 558	1666 ± 407	1755 ± 386	1811 ± 490	1718 ± 405	0.96	0.02
Protein, g	86 ± 21	100 ± 18	105 ± 17	110 ± 23	110 ± 25	79 ± 21	77 ± 21	77 ± 20	81 ± 24	78 ± 20	<0.001	<0.001
Protein, E%	17 ± 3	26 ± 3	26 ± 4	25 ± 3	25 ± 5	17 ± 2	18 ± 2	18 ± 2	18 ± 3	18 ± 2	<0.001	<0.001
Fat, g	71 ± 26	46 ± 17	51 ± 18	57 ± 21	58 ± 25	69 ± 30	58 ± 17	62 ± 15	66 ± 20	64 ± 17	0.049	0.01
Fat, E%	31 ± 7	26 ± 5	26 ± 5	29 ± 5	28 ± 6	31 ± 6	31 ± 4	32 ± 3	33 ± 5	34 ± 5	<0.001	<0.001
Carbohydrates, g	223 ± 62	169 ± 39	188 ± 56	188 ± 52	194 ± 60	226 ± 62	198 ± 46	208 ± 48	211 ± 58	196 ± 48	0.09	0.04
Carbohydrates, E%	44 ± 7[d]	44 ± 5	44 ± 6	43 ± 6	42 ± 6	47 ± 7[d]	48 ± 4	47 ± 4	47 ± 5	46 ± 4	<0.001	0.98
Dietary fibre, g	23 ± 7	32 ± 8	34 ± 10	33 ± 9	32 ± 9	23 ± 10	24 ± 7	23 ± 7	23 ± 9	22 ± 7	<0.001	<0.001
Alcohol, g	21 ± 39	6 ± 11	6 ± 11	5 ± 9	14 ± 41	11 ± 15	3 ± 5	4 ± 9	4 ± 9	3 ± 6	0.08	0.15
Alcohol, E%	7 ± 10	3 ± 5	3 ± 5	2 ± 3	4 ± 10	3 ± 5	1 ± 2	2 ± 3	1 ± 2	1 ± 2	0.04	0.27

HSF: higher-satiety food group, LSF: lower-satiety food group; [a]HSF: 12 wks $n = 41$, 18 wks $n = 40$, LSF: 6 wks $n = 39$, 12 wks $n = 37$, 18 wks $n = 37$, 24 wks $n = 36$; [b]the difference between the groups,[c]the group versus time interaction, linear mixed-effect modelling; [d]at the baseline, the difference between the groups $P = 0.03$, Student's t-test.

Table 7: Scores of eating behaviour questionnaires (mean ± standard deviation) in the HSF and LSF groups before the beginning of the study (baseline) and during the weight-maintenance period (WM, the weeks refer to the time since the beginning of the weight-maintenance period).

	HSF (n = 42)				LSF (n = 40)					
	Baseline	0 wks WM	12 wks WM	24 wks WM	Baseline	0 wks WM	12 wks WM	24 wks WM	P^a	P^b
GHQ										
Psychological distress	11.2 ± 4.7	7.4 ± 3.7	9.4 ± 4.1[c]	9.9 ± 4.2	10.9 ± 4.6[c]	6.5 ± 2.5	8.5 ± 3.0[c]	9.1 ± 4.6	0.24	0.90
TFEQ										
Cognitive restraint of eating	9.7 ± 3.7	—	15.3 ± 3.4	15.5 ± 3.6	8.5 ± 3.2	—	14.9 ± 2.7	15.4 ± 3.0	0.30	0.38
Flexible restraint of eating	3.1 ± 1.4	—	5.1 ± 1.6	5.4 ± 1.6	2.6 ± 1.4	—	5.4 ± 1.1	5.2 ± 1.4	0.60	0.15
Rigid restraint of eating	3.2 ± 1.5	—	4.6 ± 1.6	4.7 ± 1.5	2.9 ± 1.2	—	4.4 ± 1.2	4.7 ± 1.3	0.45	0.56
Disinhibition of eating	9.2 ± 3.2	—	6.3 ± 3.5	6.3 ± 3.4	8.3 ± 3.1	—	5.4 ± 3.0	5.7 ± 2.9	0.19	0.78
Susceptibility to hunger	5.9 ± 2.9	—	2.8 ± 2.0	3.1 ± 2.6	5.8 ± 2.9	—	3.2 ± 2.5	3.0 ± 1.9	0.87	0.67
DEBQ										
Restraint of eating	28.4 ± 5.3	—	32.4±6.4[c]	34.5 ± 5.3	27.6 ± 6.3	—	32.3 ± 5.4	34.0 ± 3.9	0.57	0.89
Emotional eating	32.6 ± 12.1	—	30.2 ± 12.0[c]	28.2 ± 11.6	31.0 ± 10.0	—	26.8 ± 8.4	26.4 ± 9.0	0.31	0.45
External eating	32.1±5.0[d]	—	27.2 ± 6.5[c]	27.0 ± 6.0	29.4 ± 4.6[d]	—	28.1 ± 4.9	27.0 ± 4.7	0.55	0.007
BES										
Binge eating	13.4 ± 6.5	—	8.1 ± 5.4[c]	7.7 ± 5.6	13.2 ± 6.1	—	7.1 ± 5.4[c]	6.5 ± 5.1	0.48	0.59

HSF: higher-satiety food group, LSF: lower-satiety food group, GHQ: General Health Questionnaire, TFEQ: Three-Factor Eating Questionnaire, DEBQ: the Dutch Eating Behaviour Questionnaire, BES: Binge Eating Scale; [a]the difference between the groups,[b]the group versus time interaction, linear mixed-effect modelling; [c]HSF n = 41, LSF n = 39; [d]at the baseline, the difference between the groups P = 0.02, Student's t-test.

Table 8: Spearman and partial correlation coefficients between the changes in eating behaviour and psychological distress from the beginning of the study to the end of the weight-maintenance period and changes (%) in body weight during the weight-maintenance period ($n = 82$).

Change in	r^a	P	r^b	P
Three-Factor Eating Questionnaire				
(i) Cognitive restraint of eating	−0.23	0.04	−0.21	0.07
(ii) Flexible restraint of eating	−0.33	0.002	−0.31	0.006
(iii) Rigid restraint of eating	−0.003	0.98	−0.01	0.90
(iv) Disinhibition of eating	0.22	0.048	0.18	0.12
(v) Susceptibility to hunger	0.28	0.01	0.31	0.005
Dutch Eating Behaviour Questionnaire				
(i) Restraint of eating	−0.06	0.63	−0.06	0.59
(ii) Emotional eating	0.11	0.35	0.05	0.66
(iii) External eating	0.25	0.02	0.25	0.02
Binge Eating Scale				
(i) Binge eating	0.26	0.02	0.24	0.03
General Health Questionnaire				
(i) Psychological distress	0.24	0.03	0.23	0.04

[a] Spearman's correlation; [b] partial correlation, adjusted by study group.

Also recent brain imaging studies have confirmed links between body weight, restraint, and self-regulation. Individuals with high dietary restraint showed increased neural activity in the cortical and subcortical control and reward areas, especially at the dorsal prefrontal cortex and dorsal striatum, in response to meal ingestion [48] or pictures of palatable foods [49]. This suggests that the cognitive control of food intake is achieved by modulating neural circuits controlling inappropriate behavioural responses and food reward [48, 49]. This may also be the way to counterbalance the physiological compensatory changes, like reductions in energy expenditure and circulating mediators of appetite, which do promote weight regain after weight loss [4].

As a concept, self-control is close to the concept of self-efficacy which refers to an individual's belief that she or he can successfully execute a sequence of actions in a specified context [50]. Self-efficacy has been shown to be an important predictor of successful weight management [31, 51, 52]. Self-efficacy was, unfortunately, not measured in the present study. However, interestingly, the experience of greater easiness of weight maintenance as well as easiness of control of food intake was associated with the more successful maintenance of reduced body weight. This suggests that those experiencing intervention easier might also have felt themselves more competent and efficient in managing their attempts to maintain reduced body weight. As further support for this, greater improvement in psychological distress was also associated with better weight management. However, it should be noticed that the ratings of easiness of weight management or control of food intake are highly subjective measures and strongly susceptible to reverse causality or confounding. They could thus also be simply consequences of changes in other psychobehavioural variables or influenced by the body weight change itself. Nevertheless, tools and approaches which could enhance subjective experience of self-control and thereby likely also the experienced easiness of weight management should thus be taken into account to increase the long-term success of weight management. In current behavioural interventions, still fairly little attention has been devoted to, for example, psychological resources needed for the long-term management of body weight or other health-related lifestyle habits [53].

In the present study, except for the lower energy intake and better compliance of the use of the test foods, other dietary factors were not associated with better weight management. This was despite the fact that the differences in the protein and fibre contents of the study diets were comparable with those reported in previous studies yet demonstrating better weight management on the diets with higher protein [14, 54–56] or fibre content [12, 18]. Indeed, in a recent Diogenes study even smaller difference (4.5–6.5% versus 7.5%, Diogenes versus present study) in the dietary protein intake between the study groups was followed by significant, although relatively small (0.9 kg), difference in body weight regain after a successful weight loss [56]. No differences were, however, detected in satiety even in that study. The authors ascribed this to be due to too subtle satiety effects of the diets to be subjectively measured.

On the other hand, the positive association between protein intake and satiety has been suggested to be evident only when protein intake is greater than protein requirements [16, 57]. Thus the degree of satiation may be influenced by the absolute amount of protein. Indeed, Lejeune et al. [57] reported that the greater satiating effect of dietary protein was seen only when protein intake was as much as 2.6 g/kg. This is much more than what was the protein intake (1.3 g/kg) in the HSF group in the present study. It could therefore be argued that the protein intake was not enough to contribute to possible significant effect on long-term

satiety. However, much higher protein intake would have been impractical to achieve and would not have represented a normal balanced diet.

Howarth et al. [18] estimated that about 14 g increase in daily dietary fibre intake in *ad libitum* conditions was associated with about 10% decrease in dietary energy intake and consequent decrease in body weight. In the present study the HSF group increased their daily dietary fibre intake approximately by 10 g. It could therefore be argued that the dietary fibre content of the study diet was still not enough to contribute to more successful weight management, although already smaller amounts of dietary fibre have been demonstrated to be effective [12].

When interpreting the results, it should be noticed that the weight-maintenance diet was not totally *ad libitum* since the participants were given instructions about the recommended number of portions to be consumed within each food group. This could naturally have diminished the possible influence of dietary fibre and protein and their potential satiety effect on the self-regulation of food intake and thereby on the maintenance of reduced body weight. In line, most studies reporting greater weight loss after high-protein than low-protein diet have been those allowing *ad libitum* food intake, whereas only few of the studies that have provided isocaloric high- versus low-protein diets have shown significant weight loss results [14, 19, 32]. We cannot rule out that if the proportion of foods with different satiety values would have been greater than 30% of energy intake, a possible satiety effect could have been seen. This was, however, the highest amount of test foods that could be realistically included into the diet without an excessive risk of dietary noncompliance due to the continuous use of only limited number of test foods. On the other hand, the proportion of test foods should not be too high to limit freedom in the remaining diet to show potential differences in energy intake. Finally, all the other dietary counselling given to the subjects during the study, especially in the group sessions before the weight-maintenance period, might also have diminished the possible differences between the groups.

Another central methodological issue is that, to our knowledge, this was the first time to examine whether foods with predetermined satiety values could contribute to weight management. Thus, at the same time, the study examined the predictive value of a single satiety measurement of food on satiety during continued use in a free-living context. As the results suggest, the different predetermined satiety values of the test foods did not influence weight management in a free-living situation. No differences were seen either in energy intake or in the weekly ratings of hunger or satiety. Even the experienced easiness of weight management was virtually identical between the study groups. This confirms how much more difficult it is to get reliable data about satiety outside a controlled laboratory setting. It also raises issues as to how far laboratory data can really be extrapolated to free-living conditions [32]. Yet controlled laboratory testing is a general and recommended practice when assessing the satiety values of foods [33].

Naturally, the laboratory testing conditions are also of importance. In the present study, the satiety values of the test foods were determined in a separate group representing mostly relatively young, normal-weight subjects. The demographic characteristics of the subjects in the satiety tests and in the intervention were thus quite different. Normal-weight and overweight subjects were, however, selected for satiety testing instead of obese individuals due to potentially attenuated satiety responses in obese as compared with lean individuals [32], to be able to demonstrate actual differences in satiety values between the test products. Furthermore, in the satiety tests, the foods were tested as isocaloric portions, and, during the intervention, the recommended portion sizes were adjusted to represent typical portion sizes of each food relative to everyday food consumption. The test foods also varied in some other dimensions, such as macronutrient content and palatability. All this could have affected the behaviours observed over the weight-maintenance period and perhaps obscured the potential effect of satiety value of foods. Nevertheless, although satiety value of foods should ideally be tested in subjects and conditions representing the target situation as close as possible, controlling all the prevailing conditions comparable to free-living conditions may be unrealistic. Furthermore, most of the foods are rarely eaten as such but usually as a part of a mixed meal or a snack. Thus, the satiety values do vary also according to other prevailing, mostly uncontrollable circumstance-related factors.

It could be argued that factors that predict subsequent weight maintenance are not necessarily the same if weight loss is initially achieved rapidly with a VLCD compared with methods inducing more gradual weight loss. A recent study comparing factors associated with successful weight maintenance in relation to initial method of weight loss (i.e., VLCD versus commercial program or self-guided approach) did not, however, observe any differences across the methods on the changes in eating behaviour or dietary intake [58], which further supports the relevance of the present findings on the success of weight management.

5. Conclusions

Foods with higher predetermined satiety value, when ingested as a part of a controlled weight-maintenance diet, did not contribute to better weight maintenance. Instead, success in weight maintenance was associated with a greater increase in flexible control of eating and greater decrease in uncontrollable eating and psychological distress. Thus, means to support changes in these psychobehavioural factors are of essential importance in successful long-term weight management.

Acknowledgments

The authors gratefully acknowledge Eeva Lajunen for her excellent laboratory assistance and authorized nutritionists M.S. Anne Jääskeläinen, M.S. Tarja Martikainen, M.S. Reetta Mustonen, and M.S. Taisa Venäläinen for their excellent assistance in nutritional and other practical duties throughout the intervention study. The skillful assistance

of technicians Pirkko Nousiainen, Heidi Eriksson, and Ulla Österlund and M.S. Nora Ohls in conducting the satiety tests at VTT is also greatly appreciated. This work was supported by the Finnish Funding Agency for Technology and Innovation (Tekes, grant 40100/07) and Finnish food manufacturers (Atria Plc, Fazer Group Ltd, Arla Ingman Ltd, Valio Ltd, Sinebrychoff Ltd, Vaasan Ltd, Foodfiles Ltd, Leiras Finland Ltd) and partly by the SalWe Research Program for Mind and Body (Tekes grant 1104/10).

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 269320, 7 pages
doi:10.1155/2012/269320

Research Article

Situational Motivation and Perceived Intensity: Their Interaction in Predicting Changes in Positive Affect from Physical Activity

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Received 8 December 2011; Revised 20 April 2012; Accepted 28 April 2012

Academic Editor: Pedro J. Teixeira

There is evidence that affective experiences surrounding physical activity can contribute to the proper self-regulation of an active lifestyle. Motivation toward physical activity, as portrayed by self-determination theory, has been linked to positive affect, as has the intensity of physical activity, especially of a preferred nature. The purpose of this experimental study was to examine the interaction between situational motivation and intensity [i.e., ratings of perceived exertion (RPE)] in predicting changes in positive affect following an acute bout of preferred physical activity, namely, running. Fourty-one female runners engaged in a 30-minute self-paced treadmill run in a laboratory context. Situational motivation for running, pre- and post-running positive affect, and RPE were assessed via validated self-report questionnaires. Hierarchical regression analyses revealed a significant interaction effect between RPE and introjection ($P < .05$) but not between RPE and identified regulation or intrinsic motivation. At low levels of introjection, the influence of RPE on the change in positive affect was considerable, with higher RPE ratings being associated with greater increases in positive affect. The implications of the findings in light of SDT principles as well as the potential contingencies between the regulations and RPE in predicting positive affect among women are discussed.

1. Introduction

Physical activity (PA) has been identified as a hallmark contributor to individuals' quality of life [1], most notably among women [2]. Indeed, several research endeavours have converged on trying to understand the principal determinants of PA, and in particular, those factors that can be associated with individuals' volitional control of this specific behaviour. One factor that has been of mounting interest to behavioural scientists is that of affect and/or mood, which is defined as the *quality* of a subjective feeling state consisting of elements of valence (i.e., good/bad) and activation (i.e., high/low) [3]. Notably, studies have revealed associations between engaging in an acute bout of PA and immediate increases in *positive* affect [4]. In turn, basic affective reactions that are tied to a moderate intensity PA session (i.e., increases in positive affect) have been shown to predict futures bouts of PA six and twelve months later [5]. Indeed, repeated *positive* affective experiences associated with PA may sustain PA motivation over time and this can facilitate long-term PA participation [6, 7]. It follows then that studying positive affect in the context of specific PA sessions is an outcome worthy of investigation in its own right, and this within broader attempts to understand how to optimally predict sustainable patterns of PA behaviour for successful weight management and greater well-being.

However, experts have highlighted that not all individuals who participate in PA achieve more positive affective states and ensuing increments in general well-being [8]. Indeed, results have not been entirely consistent as some participants have witnessed no change or a worsening of their affect with exercise [9]. This may have long-term implications in terms of sustaining adequate amounts of PA as well as levels of well-being. This has led to researchers' attempts to isolate the conditions under which the specific affective benefits of exercise might be maximized or conversely, thwarted.

In particular, one line of research has focused on the intensity of PA and its relationship with exercise-related

affect. Meta-analytic findings have revealed that the effect of acute PA on positive-activated affect may be stronger at low-to-moderate intensities [4, 10]. In past studies, some researchers have attempted to uncover a "threshold of intensity" for the affective benefits of exercise, yet there is insufficient empirical evidence for an inverted U shape dose-response relationship [11]. From a more person-centered view, several researchers now argue that preferred/self-selected intensity might lead to stronger benefits in positive affect than prescribed PA intensities [12, 13]. Overall, the evidence is inconclusive as there appears to be significant inter-individual variability regarding the benchmark intensity level that is most conducive to increments in positive affect.

Another line of work that has specifically targeted such individual-based differences has also addressed a call for more theoretical research on possible psychological mechanisms underlying the PA-positive affect relationship [14, 15]. In particular, it has been suggested and recently emphasized that individuals' motivational styles toward PA may supply a missing and understudied link [16]. Self-determination theory (SDT), one recognized and well-supported motivational theory, distinguishes between two general types of motivation: self-determined motivation and controlled motivation (or regulation) [17]. Deci and Ryan [17] also classified motivation into several types of behavioural regulations that fall within these two broader categories. Overall, self-determined motivation is rooted in feelings of satisfaction, choice and volition. It is characterized as enjoying an activity for its own sake (i.e., intrinsic motivation) and/or assigning it value and personal importance (i.e., identified regulation). Controlled or non-self-determined motivation can be defined as engaging in an activity, such as exercise, so as to avoid self-inflicted shame or guilt, or to gain a personal reward, namely pride (introjected regulation) [18]. Controlled motivation can also be characterized by being motivated according to external demands (e.g., to obtain a reward; external regulation) [18]. Self-determination theory also postulates another type of motivation, amotivation, which was deemed less relevant in the present study with active participants as it is defined as lacking the intention to act [17].

Self-determination, namely, higher levels of intrinsic and identified styles of motivation, has been associated with healthy intentions to engage in health-promoting behaviours such as PA [19]. In women, identified regulation has also stood out as a predictor of the intensity of PA engagement [20]. Higher levels of these self-determined regulations have also been *positively* associated with desirable psychological variables including PA enjoyment [21] and post-PA positive affect [22], as well as a battery of well-being indicators such as greater self-esteem and lower depression and state anxiety levels [23].

On the other hand and under the more controlling classifications, introjected regulation is considered less favourable than self-determined motivational styles [18]. Indeed research has revealed an association between introjected motivation for PA and maladaptive outcomes that include poorer life satisfaction [24] and exercise-dependence symptoms such as strenuous PA [25]. Similarly higher scores on external motivation have been linked to self-esteem issues and higher levels of negative affect [26].

Although motivation toward PA and the perceived intensity of PA have seemingly been construed as independent influences, it could be that they exert an interaction effect on PA-induced affective changes. Such an interplay would be consistent with the expert-noted complexity of underlying mechanisms of the PA-affect (and well-being) relationship as well as new evidence regarding the relevance of motivational styles in predicting changes in affect following PA at self-selected intensities [15, 16]. Especially with introjected regulation, which theory proposes should not be directly linked to well-being (and affect), perceived intensity may exert a particular contributing influence [27]. While other research, albeit scant, has underscored the possible interplay between self-selected PA intensity and psychological factors such as personality [28] and self-efficacy [29], to our knowledge no empirical research has properly entertained the interaction with motivation. Indeed, an interplay between perceived intensity (self-selected) and motivation styles in predicting changes in affect with acute PA could reveal a sustainable mechanism for long-term PA and well-being that lies within individuals' volitional regulation and that also capitalizes on the physical properties of exercise.

Therefore, the purpose of this controlled laboratory study was exploratory and was to examine whether there was an interaction between SDT's motivational regulations to engage in a running activity and Ratings of Perceived Exertion (RPE; self-selected intensity) in predicting pre-to post-PA (i.e., running) changes in positive affect. The three types of motivation were targeted given evidence cited above as well as recently revealed associations between motivation types and intensity preferences. Lastly, this study was conducted with *active women* given that the link between PA and affect may be particularly evident in active individuals experienced with PA [30, 31] as well as among women [32, 33]. This would allow for a "model" sample to highlight the above underlying theoretical relationships; in addition, this would contribute to an important need to better understand how to develop successful of PA intervention strategies for women [34].

2. Methods

2.1. Participants. Fourty-one healthy and active women (i.e., >20 minutes of moderate to vigorous PA three times per week) with an average age of 40.98 (SD = 4.93) participated in this study. The Godin Leisure Time Exercise Questionnaire [35], a common and validated self-report measure of PA levels, was administered as a screening measure and the mean score for this sample was high at 59.71. The participants also had a low-average BMI of 22.47. To minimize confounding influences in the experimental protocol, it was necessary that participants self-report running as their preferred or most frequent exercise modality [36]. In their leisure time, the women reported running at a mean RPE of 13.37 (SD = 1.22). They also gave an average of 8.60 km for a usual run and/or 49.37 minutes per run. The women in this

sample were well-educated (82.9% with a university degree or higher) and all were employed outside of the home.

2.2. Measures

2.2.1. Positive Affect. The Positive Affect Negative Affect Schedule (PANAS) [37], comprised of 20 adjective words (10 positive, 10 negative), was used to assess participants' affect. According to the circumplex model, affect can be characterized by the dimensions of valence (positive, negative) as well as activation (low, high) and experts maintain that the PANAS focuses on the high activation component of affect [38]. For each adjective, participants rated their response from (1) not at all to (5) extremely using the stem *Indicate to what extent you feel this way right now, that is, at the present moment.* Examples of adjectives include: excited (positive) and upset (negative). Given the focus on *positive* affect in the present investigation, only these adjectives were summed and analyzed. In the present study, the Cronbach Alpha for the positive subscale pre- and post-running were .88 and .91, respectively.

2.2.2. Motivation. The Situational Motivation Scale (SIMS) [39] was employed to measure situational motivation to run. The SIMS is comprised of 16 items across four subscales that assess the different behavioural regulations (intrinsic motivation, identified, external, and amotivation). Introjected regulation was excluded from the original SIMS in order to have more succinct instrument for research purposes [39]. In the current study, an enhanced version of the SIMS with four validated items tapping this type of regulation was used [40, 41]. Items measuring introjection in the enhanced Situational Motivation Scale (SIMS) [41]: (1) because I would feel bad not doing it; (2) because I would feel guilty not to do it; (3) because I want to avoid feeling guilty; (4) because I would regret not doing it. Using a 7-point Likert Scale from (1) corresponds not at all to (7) corresponds exactly, participants respond to stem why are you currently [about to run], for items that included "Because I want to avoid feeling guilty" (introjection) and "Because I am doing it for my own good" (identified). Average score were calculated for intrinsic motivation, introjected regulation, and identified regulation. As expected from a sample of active participants, scores on external regulation and amotivation were low and variance levels were negligible, which contributed to low internal consistency values. No further analyses were conducted on these regulations. The Cronbach alphas of relevant subscales were acceptable to good with values of .65, .85, and .85 for identified regulation, introjected regulation and intrinsic motivation, respectively.

2.2.3. Perceived Intensity. The Rating of Perceived Exertion (RPE) Scale [42] was administered in the minutes immediately following the run to assess the perceived intensity/exertion of the running activity. More specifically, and similar to previous studies we employed what some experts have coined "session RPE", whereby participants were instructed to rate the overall intensity of the full running session [43, 44]. This was expected to minimize the influence of momentary fluctuations in how participants' perceived their exertion, which could contaminate the accuracy of the overall evaluation. Numerical values from 6 to 20 make up the [session] RPE scale which is also anchored at every odd integer with a brief descriptor (i.e., 7 = very, very light; 13 = somewhat hard; 19 = very, very hard). The validity and reliability of the RPE are well established given its frequent usage in studies of PA and mood [45].

2.3. Procedures. This study was approved by the Ethics Review Board of the University of Ottawa and was part of a larger project. Interested subjects attended an individual session at a university laboratory space. Upon arrival, participants provided written informed consent and promptly responded to the SIMS and the PANAS prior to the running activity. Participants were taken to a private exercise room equipped with a treadmill, a desk, and a chair and were explained the running protocol. In order to mimic a self-paced run and yet easily log the pace of the run to ensure that at least a moderate-intensity run was being met, the treadmill control panel was physically detached from the treadmill running belt. This allowed the researcher to easily adjust settings in response to any and all demands from the participant. The participants completed a 2-3 minute warm-up walk at an average speed of 5.17 km/hour. Next, the researcher sped up the belt to the participant's desired pace. The researcher remained in proximity in order to speed up or slow down the belt as frequently as necessary, the details and timing of which were duly noted. By weighting any change in pace by the ratio of elapsed time at that pace, an average running pace was computed. There was minimal conversation and eye contact between participant and researcher and the treadmill was maintained at a grade of zero. Participants ran for a 30-minute duration in order to stay consistent with previous inquiries on acute exercise and affective states (e.g., Bartholomew et al., 2005 [46]). Afterwards, the belt was slowed to the initial walking speed for a 2-minute cool-down and participants provided the session RPE for the 30-minute running component. Lastly, participants responded to the PANAS once again.

2.4. Analyses. All data were entered into SPSS Version 18.0; sums, means, and standard deviations were calculated. Initial data-screening procedures were conducted according to procedures outlined in Tabashnick and Fidell [47]. Namely, assessments were conducted for data entry errors, missing data, outliers, normality and the basic assumptions of regression analyses. Descriptive statistics and reliability analyses were calculated for affect and motivation variables. A repeated-measures t-test compared pre-run and post-run levels of positive affect as a preliminary examination of whether the run had a significant influence on participants' affect.

A standardized residual change score for positive affect was calculated for each participant in order to adequately account for participants' initial affect scores [48]. Namely, a predictor score was computed by regressing post-run affect on pre-run affect and then subtracting this from the observed

Table 1: Means and standard deviations (SD) for situational motivational regulations, positive affect, and rating of perceived exertion (RPE).

Variable	Mean	SD
Intrinsic motivation for running	5.80	.82
Identified regulation for running	6.35	.47
Introjected regulation for running	3.23	1.44
Prerun positive affect	33.39	6.36
Postrun positive affect	36.02	6.93
RPE	12.79	1.15

scores. The residual change score served as the outcome variable in three separate hierarchical multiple-regression models that were employed to test the interaction between RPE and situational motivation for running. Specifically, separate product terms for RPE and the three motivational regulations were created using standardized scores and each term was added as the last step in their respective regression models.

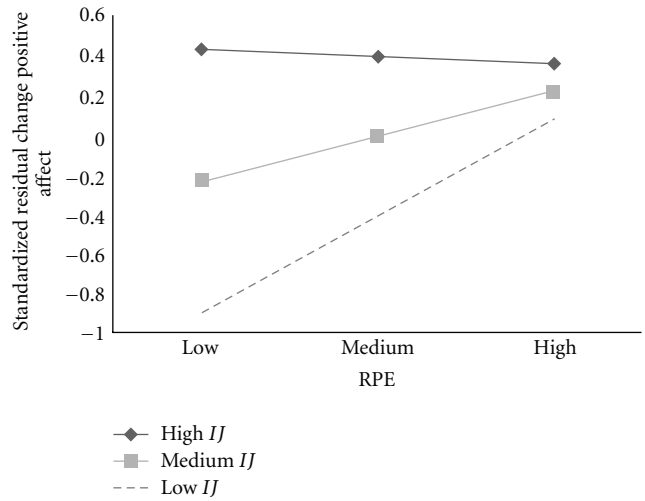

Figure 1: The interaction between introjected motivation for running (IJ) and Ratings of Perceived Exertion (RPE) on residualized change scores in positive affect.

3. Results

During the experimental running session, participants ran at an average pace of 9.66 km/hour and provided a mean RPE of 12.79. This value reflects a moderate to high intensity that was similar to the usual RPE achieved by the women outside of the laboratory. There were no univariate outliers on any of the variable. All assumptions regarding normality, linearity, and homoscedasticity were met and there was no evidence of collinearity. Positive affect increased significantly from pre- to post-run [$t(40) = 4.83$, $P < .001$]. See Table 1 for descriptive statistics.

Results of the hierarchical regression analyses showed no significant interaction between intrinsic motivation and RPE on residual change scores in positive affect [F_{change} $(1,37) = .23$, $P = .63$] nor between identified regulation and RPE [F_{change} $(1,37) = 1.82$, $P = .19$]. However, there was a significant interaction effect of RPE and introjection [$F_{\text{change}}(1,37) = 4.20$, $\beta = -.30$ $P < .05$] which explained an additional 9% of variance in the change in positive affect from the variables alone.

As displayed in Figure 1, when participants reported low introjection, the influence of perceived running intensity on the change in positive affect was considerable, with higher RPE being associated with a greater increase in affect from pre- to post-run. This effect became less pronounced with rising levels of introjection. That is, when participants reported high introjected regulation, the change in positive affect was elevated and fluctuated very little with rising RPE values, and even showed a trend toward diminishing slightly.

4. Discussion

The results of this experimental study revealed a significant interaction between RPE (i.e., intensity) and introjected regulation but not between RPE and intrinsic or identified styles of motivation in predicting changes in positive affect from pre- to post-running. To our knowledge, this is the first study to have examined this interplay, which builds on previous deliberations by Ekkekakis and Lind [49] regarding a potentially complex causal chain linking intensity, pleasure from exercise, and adherence, among other factors. In particular, our investigation offers an important adjunct to a study by Duncan and colleagues [20] that revealed associations between SDT's motivational regulations and PA intensity. Specifically, we considered the interaction *between* these variables in explaining a factor that is being increasingly recognized not only as an important consequence of PA but also as a viable determinant of future participation, namely positive affect [5]. Our results attest to recent suggestion that a person's motivational style for PA should be considered when attempting to maximize the affective gains of aerobic PA, especially at a self-selected intensity [16]. The strengths of this investigation include the self-paced nature of the running activity, a situational measure of motivation for running, and the use of a well-controlled laboratory environment.

Researchers have observed that up to very high exertion levels, there is a basic positive linear association between exercise intensity and affect [50]. While the basic linear relationship (RPE-positive affect) in this study was in fact positive for low and moderate levels introjection, it deviated markedly for those high in introjection, such that affective changes were fairly stable regardless of perceived intensity. While introjection has been associated with engaging in vigorous exercise [20], our results imply that this relationship may have little bearing on the acute mood changes that are experienced through PA, at least among avid female runners. This interplay may even be worrisome given a downward trend in positive affect as the RPE increased among highly introjected runners. This could suggest that active females that are high in introjection achieve some form of an immediate "feel-good" or "relief" effect from an activity such

as running that serves to prevent or relieve feelings of guilt, thereby materializing irrespective of perceived intensity. This was evidenced in our study by greater overall gains in affect for those high in introjection, which may be akin to what Sabiston and colleagues [51] referred to as the *reparative* properties of motivation from guilt.

On the other hand, among runners lower in introjected regulation, changes in positive affect were associated with greater variability in RPE which could indicate a greater appreciation of the sensations and physical properties of PA. Lind et al. [52] remarked that individuals usually choose to exercise at a pace that improves or maintains their mood. Our findings show that this may be more applicable for exercisers with lower introjection and who are less driven by internal pressures to exercise, thereby freeing them to experience the PA session more fully. Therefore, *in-task* affective states and sensation, which were not assessed in our study, could be a source of discrepancy between persons high and low in introjection. Future studies should consider open-ended probes during acute PA sessions in order to ascertain the pertinent sources of affective changes between individuals that differ in motivational style.

Despite its effect on positive affect in our study, as well its influence on sustaining high intensity PA [20], introjection has been associated with several negative psychological consequences that were not assessed in our acute exercise study (e.g., lower self-worth and life satisfaction) [24]. Thus, cautious interpretation of our results is warranted as immediate improvements in positive affect may not necessarily translate into benefits in general well-being [51]. This could be disconcerting if we consider that individuals with lower levels of well-being are generally less likely to engage in PA [53], thus initiating a questionable cycle of regular PA maintenance and compounding issues related to leading a healthy and active lifestyle.

On a different note, the results showing nonsignificant interactions between more self-determined motivational styles and RPE may be of theoretical significance. Similar to what was discussed above with respect to runners with lower levels of introjection, our results hint that those with higher levels of intrinsic and/or identified regulation could have less contingencies attached to their exercise engagement. In this regard, Burton and colleagues [54] found that being intrinsically motivated positively predicted well-being independently of the level of performance. Moreover, they found that fostering intrinsic motivation may diminish certain contingencies between one's perceived performance and their well-being. This is consistent with SDT principles and research revealing that despite variability in perceived competence for an activity, self-determined individuals show greater interest, pleasure, and confidence which is exhibited through greater well-being [55]. Thus the relationship between self-determined regulations and well-being is more likely of a direct nature, as indicated in the present study whereby perceived intensity, which could be view as an indicator of their performance, did not significantly shape post-PA changes in positive affect among the women higher on self-determined regulations. Other authors have also noted a direct relationship between identified and intrinsic motivation and post-PA affect as an indicator well-being [22]. In addition, and from a psychometric perspective, ceiling effects could be partly to blame for nonsignificant findings given the high means and low variances for these variables, especially identified regulation.

With respect other possible limitations of this study, there are variant opinions in the literature regarding the optimal time point(s) at which to assess RPE. We opted to assess session RPE immediately post-PA which is common practice among researchers [50, 56]. However, some authors such as Singh et al. [57] argue that post-PA RPE can vary significantly in the few minutes following exercise (e.g., between 5–10 minutes) and that evaluations of RPE taken 15–30 minutes after PA are more stable and valid indicators of participants' perceived intensity. Still, other experts gravitate away from session RPE altogether claiming that repetitive RPE measurements at regular intervals during a PA session provide a more representative measure of intensity [58, 59]. In future studies, researchers will need to address concerns over the optimal time point(s) for RPE measurement(s) in studying exercise-related affect and they may wish to supplement such inquiries with alternative and objective measures of intensity. Similarly, researchers might wish to consider the use of research designs that capitalize on longitudinal and in-task effects of motivation and intensity on indicators of well-being.

In addition, future studies will need to make use of larger samples and draw from groups of participants that are more diverse in terms of activity levels as this may alleviate some of the psychometric issues regarding the assessment of certain motivational styles. The use of only active, healthy-weight women could also be considered a drawback of the present study in terms of generalizability and it would be worthwhile to test the given interactions in overweight or obese individuals who may experience PA differently [60]. Researchers have already shown that autonomous regulations are associated with long-term weight management as well as indicators of well-being in obese populations [23, 61] and it would be worthwhile to examine the interplay with PA intensity in order to develop optimal interventions strategies for these individuals.

Yet it is also interesting to note that some studies have actually shown that affective experiences and pleasure from exercise might not significantly differ between normal weight and overweight women, at least at self-selected intensities [29, 49]. In addition, other experts mention that it is actually fruitful to study an active population as much can be learned regarding the determinants of successful PA engagement and associated consequences and this could then be targeted among the insufficiently active [20]. Moreover, the purpose of this study was to explore a theory-based interaction mechanism and therefore it was advantageous to select a sample that could maximize the postulated relationships. In sum, while women *higher* in introjection showed the greatest change in positive affect post-running, further reasoning as to why this increase was not particularly sensitive to the self-selected intensity of the run (RPE), as well as the long-term impact of this relationship on well-being and PA maintenance, is left to future inquiries.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 546459, 11 pages
doi:10.1155/2012/546459

Review Article

Physical Activity Behaviour: An Overview of Current and Emergent Theoretical Practices

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Received 21 November 2011; Revised 30 March 2012; Accepted 10 May 2012

Academic Editor: Amy A. Gorin

Physical activity research has been dominated by traditional cognitive rationale paradigms utilized within other domains. Though this approach to physical activity behavior has greatly enhanced our understanding of the key determinants, it has done little to eradicate the health problems we currently face. In order to achieve lasting change though, multilevel interventions may prove effective. Ecological perspectives have been proposed as an effective approach in combating current physical inactivity levels. Nevertheless, this approach is in its infancy and much has still to be learned. The aim of this paper is to provide an overview of the main behavioral models used within the physical activity domain while proposing the need for further models that will embrace the principles presented by ecological and complexity theories.

1. Introduction

The World Health Organization (WHO) rates physical inactivity as one of the main causes of premature death in developed countries, implicated in the aetiology of many chronic diseases such as cancer, cardiovascular disease, diabetes, and obesity [1]. Though the beneficial effects of physical activity (PA) on health are well known and firmly established, few are meeting current PA recommendations [2]. It is now appreciated that individuals face considerable barriers when changing complex behaviors such as PA [3]. Though early endeavours into the promotion of PA tended to be largely atheoretical, the need for interventions to be informed through appropriate theoretical underpinning and allow subsequent replication was essential. This paradigm shift saw subsequent authors focusing towards understanding the determinants and correlates of PA, in particular psychosocial influences [4]. As such, theories of behavioural change initially developed within social psychology have dominated the literature.

Though some models have been applied more frequently than others, the four most prominent theories utilized within a PA context are The Social Cognitive Theory (SCT), The Theory of Planned Behavior (TPB), The Self-Determination Theory (SDT), and The Transtheoretical Model (TTM) [5]. Undoubtedly the application of these theories has greatly enhanced our understanding of the psychological influences and processes which influence PA behaviour. Even so, this reliance upon traditional cognitive rationale paradigms has done little to eradicate current health problems.

What has become apparent within the last decade is that changing behavior is a complex and multifaceted phenomenon with multiple levels of influences. Thus, in order to achieve enduring changes in behavior multilevel interventions that focus on targeting individuals, social environments, physical environments, and policies have been proposed [6]. Since social ecological models of health behaviour focus on individual, as well as social, policy, and environmental influences [7, 8], researchers have recently embraced the use of such frameworks to inform interventions. It seems that, once again, the PA domain is at the tipping point of another paradigm shift.

Despite ecologically based multilevel interventions holding great potential in changing complex behaviors, certain issues associated with such an approach needs to be considered. For instance, though guiding frameworks such

as the social ecological theory are useful for considering behavioural determinants broadly, there is a lack of models available that provide specific mechanisms through which particular influences may interact and influence behavior. This is to be expected given that much research is still needed before an agreed consensus regarding the factors that exert the most influence on PA behavior, in a specific context, is formed. As the TTM and the TPB provide mechanisms and variables to target for influencing behavior, it is unsurprising that researchers have tended to rely heavily upon these theories when devising interventions. Thus, the purpose of this paper is twofold. First, a very brief critique of four popular cognitive-based theories used within the PA domain will be presented. Secondly, attention will be given to the emergent ecological models currently being proposed with further research directions being offered.

2. Current Theoretical Practice within Physical Activity

The two distinct approaches currently dominating the literature are the staged-based approach and the cognitive-based approach [4]. Whereas stage-based models propose that individuals go through stages in order to adopt or maintain complex behaviors like PA, cognitive-based approaches assume that complex behaviors are controlled by rationale cognitive activity. Within this approach interventions focus on indentifying determinants that can explain behavior. At this point it is important to recognize that other popular models exist including the Sports Commitment Model [9], the Schema Theory, the Psychological Continuum Model, the Social Support Model, the Enjoyment Model, and the Health Belief Model [6]. However, the TPB, the SCT, the SDT, and The TTM models represent those which have been tested and adopted most widely in the health behavior and PA literature [10]. Therefore it is felt that these four models are most worthy of attention and will be discussed within this brief paper.

3. The Social Cognitive Theory within Physical Activity

A widely used theoretical model of behavior change favoured by researchers is the SCT [11]. This model describes factors that may affect and determine behavior while also specifying mechanisms through which these factors work and how they may be altered into effective health behaviors. The structure and predictive utility of the SCT has been tested across numerous domains and populations [12, 13] and has emerged as one of the most prominent frameworks adopted in the study of motivation and behavioral outcomes. Consistently, research has shown self-efficacy as a key variable within the SCT and is said to be the most powerful factor to consider when predicting behavior [12]. Surprisingly, little research has involved the application of the SCT in its entirety within the PA domain. Of the research that has, only self-efficacy was found to have any predictive value on PA behaviour [14]. Thus, the remainder of this section will discuss the self-efficacy theory and consider its predictive utility and application within the PA domain.

4. The Self-Efficacy Theory within Physical Activity

Since its conception over 30 years ago literally hundreds of PA-related research has utilised the construct of self-efficacy as an antecedent, outcome, or process variable when trying to understand the motivational process involved in either sporting or exercise performance [15]. The reason for its popularity is twofold. As discussed, self-efficacy for PA has been shown to predict those individuals who will engage in such endeavours [14] but of greater value is that the construct of self-efficacy comes with specific guidelines for its development. This undoubtedly has appealing qualities for practitioners and researchers which may explain popularity of this construct in understanding PA behavior.

There is a diverse body of literature that has utilised the self-efficacy theory within a variety of health and PA contexts, such as weight loss [16, 17], exercise in older adults [18], and exercise in adolescent girls [14]. Specifically, self-efficacy is thought to influence the goals people set, their ability to persist in the face of obstacles, and their capacity to cope with setbacks and stress and as such, directly influence behavioral engagement. Evidence is now clear in support of this. For instance, Dishman et al. [14] evaluated the effects of a school-based intervention on variables of the SCT, designed to emphasise changes on instruction and the school environment. The authors found that the manipulation of self-efficacy had a direct increase in PA levels among adolescent girls and encouraged the use of self-efficacy as a variable that should be targeted to raise PA levels within this population group. Similarly, self-efficacy for PA has been shown to predict engagement in walking and identify adherers and dropouts in PA interventions [14, 16].

While the evidence clearly supports the use of self-efficacy as a powerful predictor of behavior, further research has been suggested, particularly in regards to the measurement of self-efficacy. As proposed within the theory, self-efficacy will vary along the dimensions of magnitude, strength, and generality. Though previous research has measured the strength of self-efficacy [12, 14], few have included measures of magnitude and generality. As such, the predictive utility of self-efficacy may be misinterpreted. For instance, consider the findings of Dishman et al. [14] who noted that increased self-efficacy, albeit small, had a direct effect on increasing PA behavior. The authors included a variety of activities deemed popular with high school girls such as aerobics, weight training, dance, and self-defence classes but failed to measure the generality of efficacy between each of these situations.

It could be that the level of efficacy for participants was high when performing aerobics but relatively small when performing weight training. Providing an overall measurement of efficacy from the four activities, and not activity-specific measurements, could explain the relatively small increases in self-efficacy noted by the authors. It is clear

that more work is needed in the assessment of self-efficacy in relation to specific behaviors, particularly if the magnitude of self-efficacy towards a specific activity is to be accurately measured.

In summary, research has found a consistent relationship with efficacy and exercise participation in a variety of contexts. The predictive power and ease of operation has made the self-efficacy theory one of the most consistent predictors of health-related behaviours. What is abundantly clear is that while self-efficacy has been studied extensively, it has usually been incorporated into other behavioral models. Researchers have recognised the predictive utility of self-efficacy and feeling that the predictive power of their own theories may be limited, have incorporated self-efficacy. The TPB is one such exemplar and will now be discussed.

5. The Theory of Planned Behaviour within Physical Activity

Identifying the decision making process is at the forefront of research into increasing PA levels. One such model that has been used extensively to understand the influencing factors of adoption, motivation and adherence to PA is The TPB [19]. The development of this theory was built upon previous work, The Theory of Reasoned Action (TRA) [20]. The initial model proposed that performance of volitional behaviors (acting without constraints) such as PA is best predicted from an individual's stated intention to participate in that activity. The authors believed that intention is the most immediate or proximal determinant of behavior influenced by two social cognitive variables, attitude and subjective norm. Despite receiving widespread support in predicating intentions and behaviour across a range of health behaviors including smoking, sexual behavior, and food choice [21], the model was expanded upon through the inclusion of the perceived behavioral control (PBC) construct. Though the theory was initially developed to predict volitional behaviors, the inclusion of PBC is important as it helps identify personal and environmental factors not under complete volitional control. To summarise, propositions of the TPB include the following: (a) individuals will engage in a behavior when they evaluate it positively (attitude), believe that significant others want them to engage in it (subjective norm), and perceive it to be under their control (perceived behavioral control); and (b) strong intention and PBC will increase the likelihood of a behavior.

Evidence to date has shown that both the TRA and the TPB perform well in explaining intentions in a range of populations [22]. Specifically within PA, meta-analytic reviews have been conducted and have consistently found the TPB to be superior in the prediction of behavior over the TRA [23, 24]. While there is certainly abundant evidence supporting the use of TRA/TPB within the PA domain, it has not been without criticism.

Several conceptual and methodological concerns have emerged regarding the effectiveness of the TRA and TPB for explaining intention and behavior. Firstly, there seems to be discrepancies in the literature regarding measurement of the time interval between intention and behavior. Previous meta-analytic reviews [24] found that the strength of the intention-behavior association did not decline over time which contradicts earlier recommendations that intention should be measured as close in time as possible to the behavior [20]. Recent evidence however suggests that intention-behavior relationships do weaken over time [25]. In their recent meta-analytic review, Downs and Hausenblas [26] did attempt to address this criticism by reviewing 111 TRA/TPB studies carried out within the exercise or PA domain and specifically examined the predictive utility of the intention-behavior relationship. As the authors predicted, the intention-behavior association was seen to be larger in studies that measured intention and behavior within a 1-month period compared to the studies with a time interval greater than 1 month. It seems prudent to suggest that to improve the predictive utility of the intention-behavior association, intention assessment must be measured as close as possible to the commencement of required behaviour.

Secondly, in their meta-analysis, Hagger et al. [23] found that studies with older participants (26 and over) had a stronger intention-behavior association compared to studies with younger participants (25 and under). Without doubt intentions between children and older individuals may differ and this seems to have been overlooked in previous research. When we consider other subject characteristics such as ethnicity and gender it is apparent that these considerations may have been overlooked by previous authors. For those reasons it is crucial that further research determines whether these subject characteristics moderate the effect sizes of the TRA and TPB constructs.

It has been shown that the application of both the TRA/TPB has strong support in the literature and has aided the understanding of the intention behavior relationship. However because of the disparity in the implementation of the theory and the methodological and conceptual critiques proposed, we are left with many unanswered questions. While this theory could be used to guide future interventions, greater care is warranted regarding measurement of its constructs. Nevertheless, it appears that because of the high amount of unexplained variance between intention and behavior associated with the TPB, researchers have tended to rely on other theories when developing PA interventions. As research is ongoing to enhance the predictive validity of the TPB, it is questionable given its ambiguity whether researchers should rely solely upon this theory when constructing future PA interventions.

5.1. Self-Determination Theory. While some individuals participate in regular PA simply for the enjoyment of exercising, others appear to exercise to attain intrinsic or extrinsic rewards such as losing weight, being more attractive, or obtaining recognition from significant others [27]. Previous research has shown that individuals who exercise out of enjoyment rather than being motivated by intrinsic or external rewards are more likely to adhere to a specified exercise programme [28]. Since the goal of health professionals is to promote a continued active lifestyle in individuals

not currently meeting the current PA recommendations, studying the cognitions that are related to motivation has recently been at the centre of much investigation into understanding how to promote long-term behaviour change. One theory of human motivation that has been applied extensively to the understanding of exercise behaviour is the self-determination theory (SDT) [29].

Although there are many approaches to initiating behaviour change, research has shown that, without successful behavioural intervention, approximately 50% of individuals who start a PA program will, on average, drop out within the first six months [30]. The SDT, in contrast, focuses on the processes through which a person acquires the motivation for initiating new health-related behaviours and maintaining them over time. The theory assumes that individuals by nature are active, interested, curious, self-motivated, and eager to succeed. What it also recognises though is that individuals can be alienated or passive and disaffected and accounts for these differences in terms of the types of motivation, which stems from the interaction between individuals inherent active nature and the social environments that either support or thwart that nature [27].

Specifically, the SDT proposes that behavioural regulation towards an activity varies in the extent to which it is autonomous (self-determined), which involves behaving with a full sense of volition and choice, or controlling, which involves behaving with the experience of pressure and demand toward specific outcomes that comes from forces perceived to be external to the self [28]. Furthermore, the theory proposes that individuals have three basic psychological needs, autonomy, competence and relatedness. Autonomy refers to being the perceived origin or source of ones own behaviour, competence, refers to feeling effective in ones ongoing interactions with the social environment and experiencing opportunities of fulfillment, while relatedness refers to feeling connected to others and to have a feeling of belongingness with individuals and the community [27]. The existence of these needs has been proven empirically [31] and is perceived to be essential to all individuals as they can act in an intrinsically motivated fashion towards behaviour because they perceive it as being important in satisfying these psychological needs.

So when these three basic psychological needs are satisfied, an individual's inherent activity will be supported, optimal motivation will be promoted, and positive psychological, developmental, and behavioural outcomes will be produced [27]. Conversely, social environments that thwart satisfaction of these needs yield less optimal forms of motivation and have deleterious effects on a wide variety of well-being outcomes. To conclude, it is evident that the SDT is a dialectic theory which views the environment as nurturing need-satisfaction and motivation.

5.2. Components of the SDT. As an explanation into the motives behind individuals partaking in, and maintaining, an active lifestyle through changes in their behaviour, the SDT has demonstrated exceptional longevity since its initial conception more than three decades ago. Beginning with the basic premise that the most useful theories of motivation would be broad in scope, encompassing a wide range of phenomena, use concepts that have phenomenological or personal meaning for people, be derived using empirical methods and have principles that can be applied across life's domains, [28] the SDT has evolved in the form of mini-theories. So in a sense the SDT is actually a meta-theory comprised of subtheories that seek to explain human motivation and behaviour based on individual differences. Rather than being stand-alone theories, the minitheories are readily integrateable with one another in that they all share organismic and dialectical assumptions and all involve the concept of basic psychological needs [27]. Thus, together they constitute the SDT and, when coordinated, cover all types of human behaviour in all domains. We will now briefly discuss the three constituent theories of the SDT.

5.3. Cognitive Evaluation Theory. The cognitive evaluation theory (CET) was the first subtheory to be developed to explain the effects of intrinsic motivation on behaviours and how social contexts affect intrinsic motivation. The theory was formulated to account for reward effects on intrinsic motivation and suggests that autonomy and competence are integral constructs of intrinsic motivation and that contextual events, such as rewards, positive feedback or the imposition of a deadline, are likely to have an affect on an individuals intrinsic motivation towards a behaviour or activity [29].

Research examining the undermining effect and the informational function of the reward in the CET has been extensive [32] although very few have actually been carried out in the domain of exercise and health. A possible explanation for this is that exercise behaviour is unlikely to be viewed as an interesting endeavour and performed solely for extrinsic rewards. This seems plausible as it should be remembered that the CET when formulated was only proposed to apply to behaviours and tasks that are highly interesting rather than to mundane tasks that could be viewed as monotonous and boring and unlikely to be intrinsically motivated [29]. Consequently, the CET cannot explain how uninteresting behaviours can be prompted or more importantly how to promote self-regulation of these behaviours so that individuals will persist over a prolonged period of time. As initial research utilising the CET focused on the intrinsic-extrinsic distinction, it seems that other forms of motivation may be apparent in the control of behaviour in uninteresting behaviours and explains why so few studies have been carried out using the CET in the exercise and health domain.

A further limitation of the CET is that although being identified as an important psychological need, relatedness is not accounted for within the theory [29, 31]. Research has shown that extrinsic rewards often undermine intrinsic motivation, although it is also the case that individuals can feel autonomous while being motivated. In an attempt to explain this and incorporate the basic psychological need of relatedness within the SDT, a second subtheory was proposed.

5.4. Organismic Integration Theory. The Organismic Integration Theory (OIT) extends the essential distinction between intrinsic and extrinsic motivation in the CET and seeks to explain the motives behind individuals engaging in nonintrinsically motivated behaviours. Based on the basic psychological need of relatedness, it is proposed that individuals will seek satisfactory relationships with others and engage in non-intrinsically motivated behaviours to satisfy relatedness and function effectively in the social world [27]. Accordingly motivation for the behaviour can vary depending on the degree to which the value and regulation of the requested behaviour have been internalized and integrated [27].

Numerous experimental and field studies have examined the correlates and consequences of autonomous and controlled motivation and have consistently demonstrated that autonomous regulation is associated with greater persistence; more positive affect; enhanced performance, especially on heuristic activities; and greater psychological well-being [28]. There have also been studies that have examined the utility of self-determined forms of motivation within an exercise context, demonstrating that autonomous motivation is associated with exercise behavioural engagement and adherence over time [33], exercise intentions [34], and perceived competence [35]. These findings have been supported through a recent meta-analysis of 21 studies which confirmed the simplex-ordered structure of relations among the regulation styles and the effects of these on exercise behaviours and outcomes [36].

5.5. Basic Needs Theory. The final subtheory within the SDT refers to the basic needs theory. This last theory was only recently developed in an attempt by Deci and Ryan, [27] to clarify the somewhat often misunderstood meaning of the basic psychological needs of individuals and their relationship to mental health and well-being. As highlighted previously the three basic needs refer to autonomy, competence, and relatedness. The basic needs theory proposes that when individuals feel as though these three needs are supported, both intrinsic motivation and internalization are supported. Conversely, if the social context inhibits or neglects one of these needs then intrinsic motivation and internalization will be reduced. So, within an exercise-related context, if individuals feel as if a particular behaviour has the potential to fulfil valued goals then participation in that behaviour will increase. With such endeavours the authors propose that the behaviours will become internalised, finally becoming integrated into an individuals set of behaviours that will satisfy the three basic psychological needs.

Understanding the conditions that foster, rather than undermine, these psychological needs has enormous potential for the development of social environments that will promote self-determined motivation, personal development, and well-being. Although it is well documented that the satisfaction of the needs for autonomy, competence, and relatedness will predict health and well-being [27, 28], surprisingly little research has been carried out on the measurement of perceived competence, autonomy, and relatedness in exercise contexts [37]. Given that optimising participant motivation is a central issue in PA interventions and that the satisfaction of the three basic needs is seen as fundamental to individuals approaching behaviours in an intrinsically motivated fashion, it is perplexing to consider why this component within the SDT has been poorly examined in a PA behavioural context.

5.6. Evaluation and Critique of the Self-Determination Theory within Physical Activity. Until recently the vast body of research that has adopted tenants of the SDT within an exercise domain has not been without its limitations. Much of the research that has been carried out in the exercise domain has been methodologically flawed. In their recent meta-analysis Chatzisarantis et al. [36] identified 21 published articles that adopted the Perceived Locus Of Control (PLOC) in the exercise domain and found that, on the whole, findings supported the existence of a self-determination continuum. Nevertheless, the authors did question this assumption due to the small number of studies within the meta-analysis and the distinct lack of consistency in the methodological approach used within the studies. Much of the studies seemed to adopt correlational designs rather than experimental designs. Given that researchers can only infer causality when adopting correlational designs it is reasonable to agree with the tentative findings of Chatzisarantis et al. [36] specifically with regards to the process of internalization.

While experimental methods and intervention studies have been extensively adopted by researchers in the sporting domain, until recently very little research had adopted these approaches within an exercise behavioural context. Edmunds et al. [38] though have shown that interventions designed to change motivational regulations in individuals can produce increases in exercise behaviour. Specifically, the researchers examined whether an exercise instructor's teaching style could be manipulated so that it is was perceived by individuals as providing more autonomy support, structure, and interpersonal involvement. In addition the authors also examined the impact of the delivery of the exercise class on the basic psychological needs, autonomous motivation, and behavioural outcomes. Of the two groups that participated in the study, one group acted as a control group whereas in the second group, the treatment group, the instructor focused upon promoting autonomy support by taking the perspective of the exercise class participants into account, acknowledging their feelings and providing them with pertinent information and opportunities for choice.

In comparison to the control group, the individuals within the treatment group reported significantly greater increases in relatedness and competence need satisfaction, positive affect, structure, and interpersonal involvement which corresponded to increased participation and retention rates. The authors concluded that interventions grounded in the SDT could positively influence exercise class participants' behavioural, cognitive, and affective responses to exercise and should be considered when designing future interventions studies. Unfortunately, and as the authors state, this

study was not without its limitations. Firstly, the investigation only lasted 10 weeks and failed to consider whether this approach would lead to long-term participation. Secondly, a lack of generalizability of the findings is present since only female participants aging between 18 and 53 years were recruited.

Although numerous motivational theories exist, researchers seeking to understand the social conditions that support need satisfaction and subsequent motivation have shown a keen interest in the application of the SDT within health-related exercise contexts. The theoretical framework proposed has been well supported within a variety of contexts, including PA, and is increasingly being used and recommended to guide future intervention and experimental studies. While recent research has supported the application of interventions grounded in SDT [38], it is evident from this discussion that further research is needed within the field of exercise-related behaviour change. The theory has much to offer in terms of predicting behaviour, understanding behavioural mechanisms, and designing appropriate interventions that increase PA participation and adherence. Encouraging individuals to self-regulate and continually form intentions to exercise seem to be the best option to promote adherence to a physically active lifestyle.

6. The Transtheoretical Model within Physical Activity

In an attempt to overcome the limitations of social cognitive models, researchers have considered the use of stage-based approaches in behavior change interventions. The most popular stage model applied with a PA context is the TTM [39]. Within the TTM health behavior adoption and maintenance is described as a cyclic process whereby individuals pass through a series of specific stages, each characterised by a particular pattern of psychosocial and behavioral changes. As such, within the TTM, individuals are classified by their readiness to change into one of five stages: precontemplation, contemplation, preparation, action, and maintenance [40]. Though several attempts at change are likely before maintenance is reached, the progression through the process may in fact strengthen behavior change as individuals learn from past regressions [41].

Designing interventions that meet the requirements of individuals based on their stage of change is considered to not only enhance participation and retentions rates but also reduce the resistance of individuals to initiate difficult behaviors [42]. Consequently, much of the PA research that has utilised the TTM in interventions has been delivered in accordance to an individual's stage of change and have found that individuals progress more towards the action and maintenance stages than control participants [43]. Another valuable feature of the TTM is that not only can it provide a framework to categorise individuals into a particular stage of change, but it also indicates how to encourage individuals to change their behaviour and progress through the different stages. Specifically, Prochaska and Marcus [42] propose that each stage is characterised by particular cognitive and psychodynamic variables, which, if targeted, can move individuals into subsequent stages of behavior. The processes of change included in the TTM represents the behavioral or experiential changes used by an individual to modify their experiences.

The body of evidence regarding the effectiveness of TTM based interventions is mixed. In relation to PA, van Sluijs et al. [44] carried out a systematic review of the literature concerning the effect of stages of change-based interventions and its effects on smoking, PA, and dietary behavior. In relation to PA the authors identified 13 randomised control trials (RCTs) that included stage of change-based and behavioral outcomes and found no evidence of an advantageous effect of stage-based interventions as opposed to alternative approaches. This reflects the findings of previous systematic reviews [45].

Here the authors systematically assessed the effectiveness of PA promotional activities that used a stage-based approach in bringing about changes in health-related behavior. Their inclusion criteria of only using RCTs identified seven trials of activity promotion interventions based on the constructs of the TTM. Four of these seven studies found no significant changes in behavioral outcomes, two studies showed mixed results, while only one study showed significant effects in favour of stage-based interventions. The authors did however raise issue with the methodological quality of the studies used highlighting the lack of consistency between interventions and poor appreciation of participant stage classification. The authors deemed the TTM an unsuitable approach for bringing about positive changes in health behavior though they did suggest the need for further research.

Finally, Adams and White [46] reviewed the effectiveness of 16 TTM informed interventions and found that 73 per cent of short-term (<6 month) studies reported a positive effect of TTM studies over "control conditions." The equivalent long-term (>6 months) proportion was 29 per cent. From these findings it could be suggested that stage-based interventions are no more effective than control conditions in promoting long-term adherence to PA. However, Marshall and Biddle [47] in their meta-analysis included 71 published reports that presented empirical data on at least one core construct of the TTM applied to exercise and PA. From their analysis they were able to support the application of the TTM suggesting that the core constructs of the TTM differ across stages with most in the direction predicted by the theory.

There may be numerous reasons why stage-based interventions may sometimes lack effectiveness though three dominant explanations have been suggested. First, a range of evidence has been used not only to evaluate the model but also to develop arguments in the literature [48]. For instance, there seems to be no evidence-based consensus on which criteria should be used for assessing the methodological quality of studies. Whilst some research has utilized an RCT design, others have no control group with much being cross-sectional in nature [49]. Consequently, the items included are, to some extent, arbitrarily chosen. Deciding upon which studies are included and excluded in systematic reviews

therefore can significantly influence the evidence gathered and thus the consensus given.

Secondly, since there are fundamental differences between some health behaviours and the addictive behaviors upon which the model was originally formulated, a lack of evidence may be due to the fact that some behaviors are simply more suitable to stage-based interventions [48]. Given that PA is a multifaceted complex phenomenon, practitioners who are reliant upon models that focus upon just the individual may be underestimating the true complexity of influences upon the individual. There is a wealth of evidence that has shown that other external and social factors, such as age, gender, and socioeconomic status, influence complex behaviors, which the TTM fails to consider [6, 8, 50]. It seems that the reliance upon the TTM by practitioners helps conceal the multifaceted complexities involved in changing complex behaviors.

7. Emerging Practice: An Ecological Approach

Within this paper, only a small selection of behavior theories has been discussed. The inclusion of the models in this paper is based on their popularity and application in intervention studies within the PA domain. While all four models have various contrasting features, they also share some core principles. First, all of the models relate predominantly on changing the behavior of the individual and focus less on the environment. Second, the models exist within a positivist and cognitive-rational paradigm where the main focus is to predict and control. As such, the models consider the determinants of specific behaviors as linear and maybe even more importantly phase staged. Meanwhile, Adams and White [51] state that individualized stage-based interventions are not effective in promoting long-term adherence to PA as they oversimplify the individual's ability to make positive changes to their behavior.

Overall, traditional health behavior models leave a suggestion that interventions, programs, activities, and policies can be fully planned and controlled, with predictable outcomes. This clearly does not reflect the real world of health behavior and PA seen from the developments in obesity and overweight rates throughout the world. What has now become apparent within the last twenty years is that changing health behavior is a complex and multifaceted phenomenon that has multiple levels of influences [8, 52]. With the reliance upon individual psychosocial models it is now clear that such approaches do little to effect change beyond the individual. Since social ecological models of health behavior [8] focus on individual influences as well as social, policy, and environmental factors that may facilitate or inhibit individual behaviour, researchers have now embraced the use of such frameworks to inform their interventions.

8. Ecological Models of Physical Activity Promotion

Ecological models profess that individual, interpersonal, organizational, societal, and community factors should be considered when planning and implementing health promotion interventions [8]. When adopting such an approach it is acknowledged that behavior is influenced by multiple levels and, in order to ensure lasting change, appreciation of this is necessary. The use of multilevel ecological approaches is widely accepted to guide public health policy in the United States (US) [53]. Though the use of ecological approaches within health promotion is relatively recent, its application for understanding behavior is not new. The role of the primary contributors to ecological perspectives and its subsequent utility within health research has been identified and discussed previously [8, 54, 55] and will not be revisited here. Rather, we will identify the challenges of researchers embracing an ecological perspective to inform interventions within the domain of PA behavior.

Though ecological-based multilevel interventions hold great potential for influencing PA, certain issues associated with such an approach need to be acknowledged. For instance, guiding frameworks such as the Social Ecological Theory [8] and the Ecological Model of Health Behavior [50] are useful for considering the behavioral determinants of health broadly. However, these models were devised to provide an overarching framework to guide interventions and their role in advancing the application of ecological perspectives within health behavior should be commended. Nevertheless, these frameworks fail to provide specific mechanisms through which particular influences may interact and influence specific behaviors. Indeed, the lack of specificity and instruction given presents methodological and conceptual challenges that are not apparent when utilising cognitive based models.

Understandably, it could be for this very reason that researchers within the PA domain are still heavily reliant upon cognitive-based theories which provide applicable measures that can be implemented across numerous domains and setting, particularly when one considers the positivist reductionist approach which seems to govern funding bodies and public health policy which advocates the need for identifying causal pathways in health research. When one considers further the traditional desire of inferring causality and solving problems through rational deduction it is unsurprising that there is still reliance from researchers upon traditional linear cognitive paradigms to inform interventions.

With such an approach there is a belief that behavior can be explained as a linear process whereby decisions are planned and actions instinctively ensue. It is apparent that complex behaviors such as PA do not occur in such a way. Instead, behavior is influenced by multiple levels of factors that interact with one another influencing individuals and subsequent behavior. As such it is now becoming accepted that behavior cannot be understood by measuring individual factors alone but rather behavior emerges due to the complex interactions between multiple levels of influences [55–57].

Increasing acceptance of the complexities involved in human behavior renders the current linear phase stage approach to understanding PA behaviors incongruous. From a PA perspective, the complexities involved in understanding behavior can be viewed as a collection of numerous

determinants whose actions, though unpredictable, impact upon other determinants [6]. Since these determinants of behavior are often nested within numerous levels of influences as outlined by the ecological framework [8], to fully comprehend the impact of individual determinants upon behavior there must be an acceptance of the mediating role of all determinants. Another important premise to acknowledge is that influence of determinants may change over time with a direct influence upon behavior [58]. This is an important constituent to the study of human behavior which is not embraced within the framework of the four main theoretical models most widely utilized within the PA domain.

Rather, the main determinants are believed to influence individuals whereby behavior change occurs in a linear manner [59]. For instance, traditional research paradigms propose that the measurement, and increases, of cognitions such as attitudes, efficacy, beliefs and intentions over time will determine how effective an intervention is for enhancing behavior. This approach however seems flawed as it fails to appreciate the complexities involved in human behavior whereby change often occurs in a nonlinear manner [59, 60].

9. Chaos and Complexity

Nonlinear dynamical approaches, such as complexity theory and chaos theory, to the study of health behaviours have recently emerged in the health domain literature [57, 59–61]. As these authors contend, this new approach to understanding behavior has stemmed from the limitations inherent in current approaches that are reliant solely upon traditional cognitive rationale paradigms to explain complex behaviours. With such an approach there is a belief that behaviour can be explained as a linear process whereby decisions are planned and actions instinctively ensue. From the previous discussion however, it is apparent that complex behaviours such as PA do not occur in such a way. Instead, behavior is influenced by multiple levels of factors that interact with one another influencing individuals and subsequent behaviour, hence the term, complex behaviours. As such it is now becoming accepted that behavior cannot be understood by measuring individual factors alone but rather behavior emerges due to the complex interactions between multiple levels of influences which is often spontaneous, uncontrolled, and uncertain [56], hence the term chaotic.

Increasing acceptance of the complexities involved in human behavior, for instance, the initiation and/or maintenance of PA, renders the current linear phase stage approach to understanding PA incongruous. The proposed application of the new science of complex adaptive systems with the PA domain [59, 60] may however provide a means to better understand the complexities involved in human behavior. Thus, within a complex adaptive system approach human beings can be viewed as being composed of, and operating within, multiple interacting and self-adjusting systems including individual, interpersonal, organizational, societal, and community systems [8, 50, 57]. From a PA perspective, this complex adaptive system can be viewed as a collection of numerous determinants whose actions, though unpredictable, impact upon other determinants. Since these determinants of behaviour are often nested within numerous levels of influences as outlined by the ecological framework, to fully comprehend the impact of individual determinants upon behavior there must be an acceptance of the mediating role of all determinants [62].

Despite gathering consensus that multilevel approaches are required to ensure long-lasting change in behaviour, the field is limited at present due to the dependence upon cross-sectional evidence [63]. Of course this new approach to the study of health behavior is in its infancy and as one would expect there is still a great deal to understand regarding the key determinants of behavior worthy of intervening upon. Nevertheless, the PA domain has begun to embrace the need for ecologically informed PA interventions [64–66]. It could be that we are at the embryonic stage of another paradigm shift with the acceptance that behavior change does not occur in a deterministic and linear fashion, but more so through complex interactions between numerous determinants interacting in a nonlinear manner [59, 61].

This principle effectively precludes the inference of causality derived from cross sectional analysis. This premise though is not new given that Bronfenbrenner [67] identified these issues more than 60 years ago stating "piecemeal analysis, fixed in time and space, of isolated aspects and attributes is insufficient and even misleading" [67]. Nonlinear dynamical approaches, such as complexity and chaos theory, to the study of health behaviors have recently emerged in the health domain literature [57, 59–61]. The proposed application of the new science of complex adaptive systems within the PA domain may however provide a means to better understand the complexities involved in human behavior. Within a complex adaptive system approach human beings can be viewed as being composed of, and operating within, multiple interacting and self adjusting systems including individual, interpersonal, organizational, societal, and community systems [60]. From a PA perspective, this complex adaptive system can be viewed as a collection of numerous determinants whose actions, though unpredictable, impact upon other determinants. Since these determinants of behaviour are often nested within numerous levels of influences as outlined by the ecological framework, to fully comprehend the impact of individual determinants upon behavior there must be an acceptance of the mediating role of all determinants [62].

Another important premise of complex adaptive systems is that determinants can change which can affect the behavior of individuals over time [57]. This is an important constituent to the study of human behavior and highlights the limitations of current research practices within the PA domain. For instance, despite gathering consensus that multilevel approaches to health behavior consistent with social ecological frameworks are required to ensure substantial changes in health behaviors, the field is limited at present due to the dependence upon cross sectional evidence [63]. In complex systems, behavior is said to emerge from the interaction over time of numerous determinants influencing said behavior in a non linear manner [61]. Traditional

research paradigms propose that the measurement, and increases, of cognitions such as attitudes, efficacy, beliefs, and intentions over time will determine how effective an intervention is for enhancing health behaviors. This approach however seems flawed as it fails to appreciate the complexities involved in human behavior whereby change often occurs in a nonlinear manner, rather than the linear, deterministic manner proposed by traditional cognitive paradigms [60].

The seminal paper by Resnicow and Vaughan [59] has ignited debate in the literature [68] regarding the usefulness of the prevailing health behavior theories in understanding PA behavior which warrants further comment. Despite disagreements between authors, both contend that there is a need for further research that incorporates nonlinear concepts into future interventions. While this sentiment is shared there is at present a lack of guidance upon how to implement such approaches within a PA context. Nevertheless, previous and future reviews based upon cross sectional research designs can help inform interventions and generate hypotheses and their importance should not be underestimated.

10. Summary

Excellent reviews have already taken place which has enhanced our understanding of the key determinants of specific behaviors, within specific contexts [52, 69–72]. Nevertheless, researchers are faced with the difficult task of developing site- and behavior-specific ecological models. Though daunting the study of human behavior through ecological and complexity theories affords the generation of hypothesis informed through cross sectional evidence. Identifying the key determinants of behavior relative to individual characteristics, contexts, and activities is the first step in devising appropriate interventions. The challenge thereafter is to consider how to monitor the complex interactions that will occur over time within the multiple levels of influence. As such, a unified model of research and practice which integrates both ecological and complexity theories is very much needed. Only then can we begin to understand the role of the multiple influences upon behavior and begin to translate this evidence into future health-enhancing interventions.

11. Conclusion

It is now well established that theoretically informed interventions are imperative for successful physical activity promotion. Though only a small selection of behavior theories have been discussed in this paper it is apparent that two major approaches to PA promotion have dominated the literature, one founded on a stage-based model and the other founded on social cognitive principles. While these approaches have greatly enhanced our understanding of the key determinants of PA behavior it is now apparent that behavior is influenced not only through individual level cognitions. It seems that the increasing acceptance of the complexities involved in human behavior renders the current linear phase stage approach to understanding PA behaviours incongruous. What has now become apparent within the last twenty years is that changing health behavior is a complex and multifaceted phenomenon that has multiple levels of influences [8, 52]. Since ecological approaches towards health behavior focus on individual influences as well as social, policy researchers have now embraced the use of such frameworks to inform their interventions. However, there is a lack of models available that provide specific mechanisms through which particular influences may interact and influence behavior. Researchers are now faced with the daunting task of relying upon detailed cross sectional evidence to develop and test hypothesis in order to enhance further our understanding of the determinants of PA. It seems that the field of PA research is at the embryonic stage of a paradigm shift towards improving our understanding of complex behaviours through the application of complex ecological interventions. Recently the health domain has embraced the use of nonlinear dynamical approaches, such as complexity theory to the study of complex behaviors. In the PA domain, there is no unified model of research and practice which integrates both ecological and complexity theories. Forthcoming PA models should begin to consider the advantages of incorporating the principles of complexity theories into future intervention programmes. This domain of future work promises to be a worthwhile endeavour in tackling current obesity and inactivity levels and should help generate further understanding of the complexities involved in PA behavior.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 803769, 10 pages
doi:10.1155/2012/803769

Research Article

Weight Gain Prevention for College Freshmen: Comparing Two Social Cognitive Theory-Based Interventions with and without Explicit Self-Regulation Training

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Received 29 November 2011; Revised 7 March 2012; Accepted 2 April 2012

Academic Editor: Amy A. Gorin

The college transition represents a critical period for maintaining a healthy weight, yet intervention participation and retention represent significant challenges. The objective of this investigation was to evaluate the preliminary efficacy and acceptability of two interventions to prevent freshman weight gain. One intervention provided opportunities to improve outcome expectations and self-efficacy within a social cognitive theory framework (SCT), while the other targeted the same variables but focused on explicit training in self-regulation skills (SCTSR). *Methods.* Freshmen ($n = 45$) aged >18 years were randomized to a 14-week intervention, SCT or SCTSR; both included online modules and in-class meetings. Of the 45 students randomized, 5 withdrew before the classes began and 39 completed pre- and posttesting. Primary outcomes included body weight/composition, health behaviors, and program acceptability. Analyses included independent sample t-tests, repeated measures ANOVA, and bivariate correlational analyses. *Results.* Body weight increased over the 14-week period, but there was no group difference. Percent body fat increased in SCTSR but not SCT (mean difference: SCTSR, $+1.63 \pm 0.52\%$; SCT, $-0.25 \pm 0.45\%$; $P = 0.01$). Class attendance was 100% (SCTSR) and 98% (SCT); SCTSR students (>50%) remarked that the online tracking required "too much time." *Conclusions.* The intervention was well received, although there were no improvements in weight outcomes.

1. Introduction

It has been estimated that the average American adult gains ~0.9 kg annually [1]. Young adults attending college demonstrate an even greater trajectory of weight gain (i.e., 1.8–4.1 kg) [2–5]. Importantly, weight gain, rather than initial weight status, leads to adverse changes in cardiovascular disease risk factors and the metabolic syndrome among young adults [6]. Given the large number of young adults attending college or university each year and the health implications of weight gain in this population, the early college years appear to be a critical period for promoting weight management.

Prior research in college students using qualitative interviews and focus groups indicated that, during high school, healthy meals and regular exercise were part of a student's routine, but these positive health behaviors appear to decline during the transition to college [7]. Thus, weight gain prevention efforts targeting this population should not only provide education on healthy diet and physical activity behaviors, but also instill skills in goal setting, planning, and self-monitoring, while incorporating social and environmental support to facilitate adherence and maintenance of healthy behaviors [7]. In the young adult population, low-intensity (i.e., limited or no intervention contact such as monthly phone calls or newsletters) and knowledge-only approaches that do not include recommendations for energy intake reduction do not appear to be effective in preventing weight gain [8–10]. High-intensity (i.e., frequent contact: 5 sessions/week for 16 months [11]; twice weekly for 15 weeks [12]; twice per month for two months, monthly thereafter for two years [13]) interventions that include regular group sessions or supervised exercise have been successful in producing weight maintenance in this population; however, high-intensity approaches require

significant time for both participants and program staff, and extensive program resources. Previous interventions in this area have also focused on daily weighing without nutrition or physical activity education [14], increasing physical activity without including a dietary component (Project GRAD) [8], and short-term (6-week) social cognitive theory-based internet-based education and feedback addressing healthy eating and exercise [15]. Gow et al. [15] reported that an internet behavioral intervention combined with weight and caloric feedback was successful in maintaining body mass index (BMI) in college freshmen; however, this study was conducted over a short-time period and had overall retention rates of 68.6%. Longer-term effects of the intervention on weight gain were not evaluated. Internet-based interventions promoting weight gain prevention that include social cognitive determinants have been successful in other populations such as high-school females [16] and middle-aged adults [16, 17]. However, specific challenges that must be addressed in developing weight management interventions for the young adult population include program participation and retention [18, 19]. Formative work in this population revealed that academic course credit and monetary incentives would increase student's interest in an intervention program [7]. Previous investigations that have offered course credit as an incentive have differed in course content and intervention protocol. Matvienko et al. [10] enrolled female college freshmen into one of two groups: a nutrition science course or a control group (no course). Neither group experienced weight changes throughout the 16-month study so weight outcomes could not be attributed to the intervention alone. Sallis et al. [20] enrolled university seniors in one of two courses for credit: a physical activity intervention focusing on methods of behavioral self-management or a knowledge-oriented control course. This intervention focused primarily on physical activity measures alone without a nutritional component, and weight management outcomes were not assessed. These studies suggest that course credit offered as an incentive may increase initial participation rates within this population, but the effect on weight outcomes is unknown. While monetary incentives may improve participation rates [21] and weight management outcomes in the general adult population [22], this intervention component has not been evaluated in college-aged adults.

A number of studies described above used a social cognitive theory-based intervention that focused on promoting positive outcome expectations and self-efficacy, to varying results [8, 13, 15]. To our knowledge, an intervention targeting weight gain prevention among college freshman, which includes strategies aimed at instilling individual self-regulation (e.g., self-monitoring, goal setting, modest financial incentives as feedback), as well as physical and social environmental support for healthy lifestyle behaviors, has not been conducted. Further, these self-regulation strategies when combined with intervention content that targets outcome expectations and self-efficacy could possibly be the key to intervention success [23, 24]. Therefore, the purpose of this investigation was to evaluate the feasibility, acceptability, and preliminary efficacy of a moderate-intensity, social cognitive theory-based intervention utilizing the internet and in-class sessions that would incorporate these self-regulation components to prevent weight gain in college freshmen and to compare this intervention approach to a social cognitive theory-based approach with a similar amount of contact, but without an explicit focus on self-regulation skills.

2. Methods

2.1. Subject Characteristics. Normal weight, overweight, or obese (body mass index [BMI] 18–40 kg/m^2) first-time freshmen living on campus were recruited from three dormitories on the university campus. Recruitment took place during freshman "Move-In" (i.e., the week prior to the onset of Fall semester classes). Both active and passive recruitment methods were used. Active methods included enlisting resident advisors (RAs) from each dormitory to personally invite residents to attend a group information recruitment session led by the study coordinators (ED, KP). RAs were enlisted using email advertisements sent to dormitory supervisors, and RA recruitment incentives were used to both recruit and retain study participants. Those successful in recruiting residents who completed baseline and posttesting were compensated $10 per resident. Passive recruitment methods included posting study fliers in dormitories and word-of-mouth.

Individuals were excluded if they were <18 years of age or if they reported a history of eating disorders or major chronic disease (diabetes, hypertension, heart, lung, or kidney disease). There was no upper age limit for participation, although students were required to be first-time college freshmen who had recently graduated from high school. Students with extreme obesity (BMI > 40 kg/m^2) were ineligible due to the weight and size limit of the dual-energy X-ray absorptiometer (DXA) table and due to clinical obesity treatment guidelines which recommend substantial weight loss [25]. The study protocol was approved by the university's Institutional Review Board, and all participants provided written informed consent prior to study enrollment. Students were informed that the purpose of the study was to determine the effectiveness of two weight control programs developed for college freshmen.

2.2. Protocol

2.2.1. Initial Screening Procedures and Baseline Assessments. An overview of the study protocol is provided in Figure 1. Individuals meeting enrollment criteria completed baseline laboratory assessments, which included measurement of height, weight, body composition, and habitual dietary intake and physical activity level. Height was measured in centimeters without shoes using a wall-mounted stadiometer, and body weight was measured to the nearest 0.1 kg using a digital scale with participants wearing light clothing (shorts, t-shirt) and no shoes (Scale-Tronic model 5002, Wheaton, IL). Percentage body fat, absolute fat mass, and fat-free mass were measured using DXA (GE Lunar Prodigy; GE Healthcare, Madison, WI); this unit is able to precisely

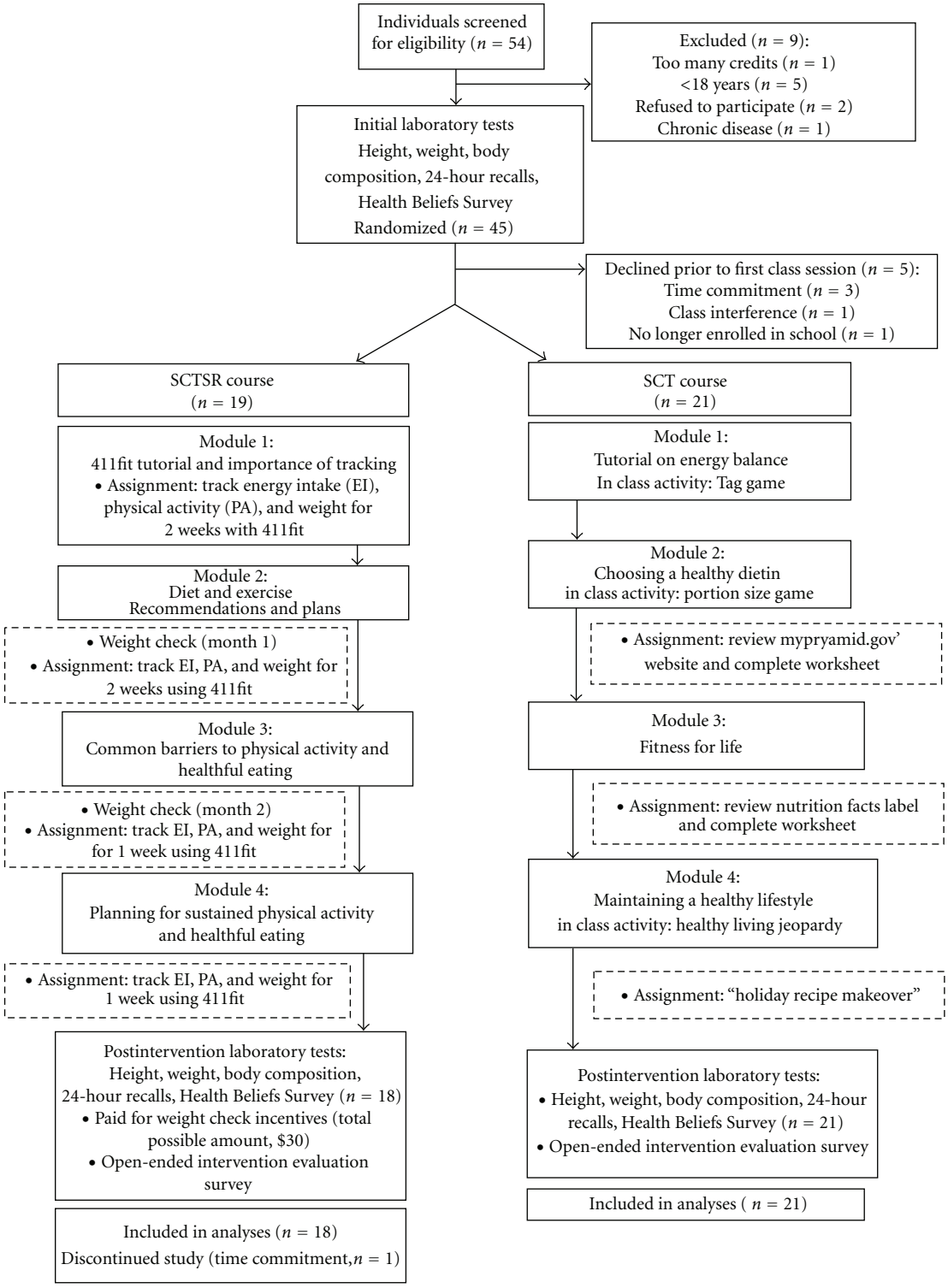

Figure 1: Overview: weight gain prevention in college freshmen.

determine lean body mass (root mean squared error value of 0.24 kg) [26]. Habitual dietary intake was assessed using the average of three multiple pass 24-hour recalls; the multiple pass recall method is able to determine energy intake to within 8–10% of actual energy intake in both men and women [27, 28]. The first recall was done in person at the laboratory session, and the second and third were done via telephone; recalls were collected within a two-week period by a trained research assistant. Participants were provided with two-dimensional food models to assist in portion size determination. Recalls were analyzed using dietary analysis software (NDS-R 4.05; University of Minnesota, Minneapolis, MN). Habitual physical activity was measured in minutes per week of mild, moderate, and strenuous activity, as well as

hours per weekday/weekend day of sedentary activity using a measure that has demonstrated validity, reliability, and sensitivity to change when compared to objective measures [29]. Participants also completed a Health Beliefs Survey; this questionnaire assesses social cognitive theory determinants of diet and physical activity behaviors and has adequate to high internal consistencies (Cronbach's $\alpha = 0.68$–0.90) [17].

2.2.2. Intervention Period. Following completion of baseline assessments, students were randomly assigned to either a social cognitive theory-based (SCT) or a social cognitive theory plus self-regulation skills training-based (SCTSR) 1-credit Pass/Fail course and were enrolled during the fall semester of 2009. Of the 45 students randomized to the courses, only 2 students knew each other (they were randomly assigned to separate groups). Both courses provided an equal number of online modules and biweekly in-class sessions (50 min/session) with an instructor (M.S. or Ph.D.-level graduate student in nutrition/exercise science), which lasted throughout the 14-week semester. Students in each course received equal amounts of in-person contact with the course instructor. Each module was followed by completion of a required in-class quiz. The SCT course modules (Figure 1) focused on outcome expectations by providing knowledge about healthy eating, physical activity, and their benefits; in-class sessions reinforced outcome expectations and focused self-efficacy through physical activity and nutrition lessons and experiential activities. The SCTSR course modules provided information about healthy eating and benefits of physical activity (Figure 1) but included self-regulation features. Our approach to self-regulation was based the conceptualization that it includes three general categories—self-monitoring (and the social and cognitive conditions under which one engages in self-monitoring), goal setting, and enlisting self-motivating supports and incentives to sustain health behaviors [30]. Specifically, course content and modules included information to assist students with planning and tracking, sample meal plans using foods available at university dining facilities as well as off-campus fast food restaurants, sample workout plans that could be followed at on-campus fitness facilities, and weekly emails that provided information on focused on self-regulation strategies related to diet and physical activity behaviors. For example, email content focused on self-regulatory skills related to portion control, tracking eating behaviors such as fruit/vegetable consumption, and self-monitoring of physical activity. The SCTSR course utilized an online Internet-based tracking program entitled "411Fit" (411Fit, UNC Charlotte, Charlotte, NC) to log daily diet/activity behaviors. To receive a passing grade for the self-regulation component of the course (15% of total grade), SCTSR students were required to complete online diet and physical activity tracking for at least 70% of total number of assigned days, as follows: two weeks in month 1, one week per month in months 2–4 (i.e., 25 of 35 assigned days). In addition to encouraging the development of planning and tracking skills, in-class sessions included content on goal setting and overcoming barriers to healthy eating and performing physical activity. During the class sessions and following each of the assignments that encouraged self-regulation skills, participants were provided with feedback on their progress and encouraged to make appropriate changes to their goals and planning strategies based on degree of successful attainment. Participants in the SCTSR course were also offered monetary incentives for maintaining their body weight (or for maintaining body fat, if weight increased due to lean mass gains) throughout the semester. This incentive was used as a reflection of self-motivating incentives based upon our preliminary qualitative work where college students indicated that financial incentives would be motivational [7]. It could also be argued that incentives align with outcome expectations and may have been an appropriate component for the SCT intervention arm. However, the alignment of incentives with goal setting and feedback (clear self-regulatory strategies) would have resulted in SCT participants explicitly setting goals thereby minimizing the difference between conditions. SCTSR participants were weighed monthly during a brief, 10-minute laboratory session (Figure 1) and offered \$5, \$10, and \$15 for weight maintenance at months 1, 2, and 3, respectively, for a total of \$30 if individuals maintained weight during the entire semester and attended each monthly weigh-in. These modest incentives were intended to align with the goal of weight gain prevention as a method to provide timely feedback and encourage continued attention to the goal.

2.2.3. Posttesting. Following the intervention at the end of the semester, participants repeated baseline measurements (body weight and composition, three 24-hour food intake recalls, self-reported physical activity level, Health Beliefs Survey). All participants were compensated \$20 if they completed both pre- and posttesting measurements. Participants were also asked to disclose friends or other known acquaintances prior to starting the intervention who were in a different group to assess possible contamination, and they completed an online open-ended survey at the end of the semester to evaluate the acceptability of intervention features and overall course experience.

2.3. Statistical Analyses. Baseline group demographic characteristics were assessed using independent sample t-tests for continuous variables and chi-square tests for frequency variables (gender) (SPSS versus 12.0 for windows, SPSS Inc, Chicago, IL). Repeated measures ANOVA were used to assess group and time differences for subjects completing the intervention. Associations among variables were assessed by simple bivariate correlational analyses (Pearson's r). Due to the sample size and exploratory nature of the trial, we set an a priori level of significance at $P < 0.10$.

3. Results

3.1. Baseline Characteristics. A total of 45 students were enrolled in the study, completed baseline testing, and were randomized into one of the two intervention groups. Of those, 5 students withdrew from the course prior to the

Table 1: Baseline demographic characteristics of college freshmen enrolled in a 14-week weight gain prevention intervention*.

	Full sample ($n = 45$)	Social cognitive theory self-regulation group (SCTSR; $n = 24$)			Social cognitive theory group (SCT; $n = 21$)		
		Male	Female	Total	Male	Female	Total
Gender, n	60% Male 40% Female	16	8	24	11	10	21
Age, yrs	18.1 ± 0.1	18.1 ± 0.1	18.1 ± 0.1	18.1 ± 0.1	18.2 ± 0.2	18.1 ± 0.1	18.1 ± 0.1
Height, m	1.72 ± 0.01	1.76 ± 0.02	1.66 ± 0.02	1.73 ± 0.02	1.8 ± 0.01	1.6 ± 0.01	1.71 ± 0.02
Weight, kg	69.5 ± 1.9	70.7 ± 3.3	70.4 ± 6.5	70.6 ± 3.0	76.8 ± 1.4	58.7 ± 1.8	68.2 ± 2.3
BMI, kg/m^2	23.4 ± 0.6	22.8 ± 1.1	25.6 ± 2.6	23.7 ± 1.1	23.9 ± 0.4	21.7 ± 0.7	22.9 ± 0.4
Body fat %	24.0 ± 1.8	16.0 ± 2.8	35.3 ± 3.5	22.5 ± 2.9	20.5 ± 1.8	31.7 ± 2.9	25.9 ± 2.0
Fat mass, kg	16.8 ± 1.5	12.0 ± 2.9	23.2 ± 4.5	15.7 ± 2.6	15.1 ± 1.4	18.1 ± 2.2	16.5 ± 1.3
Fat-free mass, kg	49.5 ± 1.5	55.7 ± 1.4	39.4 ± 2.0	50.3 ± 2.0	58.2 ± 1.3	37.8 ± 1.0	48.5 ± 2.4

* Data are presented as mean ± SEM. No baseline group differences in these variables were detected.

first class meeting causing them to be ineligible for the study. At the end of the semester, 39 students had completed the intervention and all pre- and posttesting measurements (Figure 1). Baseline sample and group demographics are shown in Table 1. The majority of participants were white (77%), and remaining participants were Asian or Pacific Islander ($n = 4$) and "other" ($n = 6$). Groups were not different with respect to gender ($\chi^2 = 0.95$, $df = 1$, $P = 0.33$); the only baseline group difference was in minutes/week of strenuous physical activity (Table 2) and positive physical activity outcome expectations (Table 3).

3.2. Intervention. Body composition, dietary energy intake, and physical activity variables across groups at baseline and week 14 are presented in Table 2. Weight increased in both groups, but there was no group difference in body weight over the intervention period (mean difference: SCTSR, +1.75 ± 0.40 kg; SCT, +0.95 ± 0.43 kg; $P = 0.18$). Percent body fat increased in the SCTSR group but not in the SCT group (mean difference: SCTSR, +1.63 ± 0.52%; SCT, −0.25 ± 0.45%; $P = 0.01$); however, there were no group differences over time in BMI change (SCTSR, +0.58 ± 0.13 kg/m^2; SCT, +0.31 ± 0.15 kg/m^2; $P = 0.18$) and absolute fat mass change (SCTSR: −0.57 ± 1.78 kg; SCT: −0.01 ± 0.40 kg; $P = 0.74$). For the online tracking, 100% of the SCTSR participants were successful in tracking diet and physical activity behaviors at least 70% of the assigned days (25 of 35 assigned days). With regard to incentives for weight (or body fat) maintenance, five of the 18 SCTSR (∼28%) participants received monetary incentives after the 14-week intervention. All who received monetary incentives were male.

There were no changes over time or between groups in total dietary energy intake, macronutrients, or total dietary energy density (Table 2). Moderate and strenuous physical activity significantly declined over time; this decline was greater in the SCTSR than SCT group (Table 2). There were no changes in level of sedentary activity.

Questionnaire scores for social cognitive theory determinants of eating and physical activity behaviors are provided in Table 3. At baseline, students seldom (score of 2 = seldom) used dietary strategies to regulate their energy and fat intake or plan/track their food intake, but following the intervention occasionally (score of 3 = occasionally) used dietary strategies to regulate their energy and fat intake or plan/track their food intake. As expected, increases were noted in positive diet and physical activity outcome expectations, but there were no group differences. Changes in clinical laboratory measures of body composition, habitual dietary intake, and physical activity were associated (all $P < 0.05$) with changes in respective SCT determinants of eating and physical activity behaviors. Specifically, changes in positive dietary outcome expectations were correlated with changes in body fat mass (kg) ($r = -0.57$). Changes in the dietary strategy of regulating energy intake and fat were correlated with changes in dietary energy intake ($r = -0.50$) and dietary energy density ($r = -0.46$). Change in physical activity self-regulation strategies was associated with percent body fat and changes in strenuous physical activity ($r = -0.34$ and $r = 0.35$, resp.). Finally, the change in self-efficacy for overcoming barriers to physical activity was correlated with changes in strenuous physical activity and the combination of moderate and strenuous physical activity ($r = 0.41$ and $r = 0.44$, resp.).

Overall class attendance for the SCTSR course and the SCT course was 100% and 98%, respectively, and overall module quiz grades were 92% and 87%, respectively. Course instructor evaluations (rated on a scale of 1–4; 1 = poor, 4 = excellent) for each course were a mean of 3.3 and 3.7 for SCTSR and SCT courses, respectively. The results of the open-ended intervention evaluation survey, which addressed intervention acceptability, are presented in Table 4. General responses suggested that the majority of students enjoyed each course and that students would have preferred to meet more frequently throughout the semester. However, during in-class sessions, >50% of students in the SCTSR class remarked to the instructor that the required online tracking (411fit) was excessive in terms of time required.

4. Discussion

Among young adults (aged 18–25 years), the college transition represents a critical period for establishing and maintaining a healthy weight [19]. Yet the challenges of

Table 2: Body composition and other clinical characteristics of college freshmen before and after a 14-week weight gain prevention intervention: social cognitive theory with (SCTSR) and without (SCT) explicit self-regulation training[a].

	SCTSR (n = 18)		SCT (n = 21)		P value, time × group
	Baseline	Week 14	Baseline	Week 14	
Body weight and composition					
Weight, kg[b]	67.7 ± 2.8	69.4 ± 2.7	68.2 ± 2.6	69.1 ± 2.5	0.18
BMI, kg/m^2[b]	22.4 ± 1.0	22.9 ± 0.9	22.9 ± 0.4	23.2 ± 0.5	0.18
% Body fat[b]	19.1 ± 2.5	20.7 ± 2.4	25.9 ± 2.3	25.6 ± 2.2	0.01
Total fat mass, kg	14.9 ± 2.2	14.4 ± 1.9	16.5 ± 1.9	16.5 ± 1.8	0.74
Total fat-free mass, kg[b]	51.6 ± 2.3	52.0 ± 2.4	48.5 ± 2.1	49.4 ± 2.2	0.22
Dietary intake					
Energy, kcal/d	2274 ± 203	2199 ± 213	2093 ± 188	2096 ± 198	0.68
Carbohydrate (% energy)	50.5 ± 1.7	50.9 ± 1.6	50.9 ± 1.5	49.7 ± 1.5	0.56
Protein (% energy)	14.3 ± 0.7	15.1 ± 0.9	15.7 ± 0.7	16.1 ± 0.8	0.74
Fat (% energy)	34.5 ± 1.5	34.1 ± 1.3	33.8 ± 1.3	34.2 ± 1.2	0.73
Energy density, kcal/g[c]	0.76 ± 0.05	0.87 ± 0.05	0.75 ± 0.05	0.82 ± 0.05	0.43
Physical activity					
Mild physical activity, min/wk	224 ± 52	264 ± 44	198 ± 48	157 ± 41	0.40
Moderate physical activity, min/wk[b]	244 ± 55	83 ± 15	123 ± 51	92 ± 14	0.10
Strenuous physical activity, min/wk[bd]	338 ± 66	142 ± 35	160 ± 59	175 ± 31	0.007
Strength training physical activity, min/wk	93 ± 24	72 ± 24	86 ± 22	91 ± 22	0.40
Weekday sedentary activity, hours/day	8.2 ± 1.1	7.5 ± 0.7	6.6 ± 1.1	7.2 ± 0.7	0.53
Weekend sedentary activity, hours/day	5.8 ± 0.9	6.7 ± 0.6	5.8 ± 0.8	6.9 ± 0.6	0.83

[a]Data are presented as mean ± SEM.
[b]Main effect of time, $P < 0.10$.
[c]Calculated with all foods and beverages, including water.
[d]Group difference at baseline, $P < 0.10$.

recruiting young adults to participate in weight management interventions and in retention rates have been recognized [18, 19]. The purpose of this investigation was to evaluate the feasibility, acceptability, and preliminary efficacy of two moderate-intensity interventions created to prevent weight gain in college freshmen. An additional purpose was to compare this SCTSR intervention to an SCT program that lacked an explicit focus on self-regulation skills. Although recruitment and retention did not represent significant problems in this investigation, the intervention was unsuccessful in preventing weight gain over the 14-week period. Previous studies have demonstrated yearly average weight gains of 1.8–4.1 kg [2–4, 31], and if students in this investigation continued to gain weight at the same rate, they would be within that range by the end of their first year in college. Although there was no group difference in weight gain over the 14-week period, the SCT intervention group maintained relative (i.e., %) and absolute fat mass as compared to the SCTSR group. Students enrolled in the SCTSR course expressed to instructors that they believed the course required more time and effort than would be expected for a one-credit course, which may have contributed to the lack of positive weight-related outcomes. Consistent with this possibility, one student in the SCTSR course discontinued the study because of the time commitment required. In contrast, the students in the SCT course reported that they associated the class with "having fun" and requested items such as daily meal plans to help them reach their goals. In addition, the open-ended survey results suggested that students would have benefited from additional in-class sessions. This intervention did not include pre- and postintervention nutrition and physical activity knowledge tests. Instead, biweekly quizzes were utilized to evaluate compliance with completing online class modules. As this was part of a for-credit course, students may have focused more on completing course requirements and tracking/homework assignments instead of utilizing the weight gain prevention skills for their own benefit and health.

Overall, both approaches appeared acceptable in that both groups had high class attendance and quiz grades, favorable course and instructor ratings, and very low attrition (i.e., one dropout). Indeed, relative to retention in other similar studies, both SCTSR and SCT were very high [13, 15]. It is unclear whether these high retention rates may be attributed to the incentive of course credit. Students were informed of university policies related to maintaining full-time status prior to enrollment to allow students the opportunity to discontinue the study if they decided to withdraw from the course. If so, this may have limited the initial enrollment numbers. On the other hand, five students were enrolled in the course but discontinued the study prior to the first class session, and subsequent retention rates were high. Previous studies utilizing the incentive of academic credit report varying retention rates. Matvienko et al. reported higher retention rates for the duration of the course but failed to

Table 3: Social cognitive determinants of eating and physical activity behaviors in college freshmen before and after a 14-week weight gain prevention study: social cognitive theory with (SCTSR) and without (SCT) explicit self-regulation training[a].

	SCTSR ($n = 18$)		SCT ($n = 21$)		P value, time × group
	Baseline	Week 14	Baseline	Week 14	
Dietary strategies					
Regulating energy and fat[b]	2.2 ± 0.2	2.9 ± 0.2	2.6 ± 0.2	3.2 ± 0.2	0.67
Planning and tracking[b]	2.3 ± 0.2	2.9 ± 0.2	2.5 ± 0.2	3.1 ± 0.2	0.89
Regulating fruit and vegetables	3.6 ± 0.2	3.7 ± 0.2	3.7 ± 0.2	3.9 ± 0.1	0.85
Dietary Self-regulatory efficacy					
Keeping track	73.6 ± 4.9	71.0 ± 5.0	71.9 ± 4.5	72.1 ± 4.7	0.60
Fruit and vegetables	66.4 ± 4.4	66.1 ± 5.0	72.0 ± 4.0	74.7 ± 4.7	0.56
Dietary outcome expectations					
Positive[b]	3.9 ± 0.1	4.4 ± 0.2	4.3 ± 0.1	4.6 ± 0.1	0.65
Negative	2.4 ± 0.2	2.5 ± 0.2	2.6 ± 0.2	2.6 ± 0.2	0.37
Physical activity (PA)					
Self-regulation	3.2 ± 0.2	3.2 ± 0.2	3.3 ± 0.2	3.6 ± 0.2	0.42
Self-efficacy to integrate PA into daily routine	73.3 ± 4.1	75.0 ± 3.8	78.7 ± 3.8	80.7 ± 3.5	0.96
PA barriers self efficacy	59.8 ± 5.1	60.2 ± 4.5	67.9 ± 4.7	73.4 ± 4.2	0.43
PA outcome expectations					
Positive[bc]	4.0 ± 0.1	4.1 ± 0.1	4.3 ± 0.1	4.5 ± 0.1	0.32
Negative	2.2 ± 0.1	2.2 ± 0.1	2.1 ± 0.1	2.0 ± 0.1	0.81

[a]Data are presented as mean ± SEM.
[b]Main effect of time, $P < 0.10$.
[c]Group difference at baseline, $P < 0.10$.

retain subjects for follow-up testing [10], whereas Sallis et al. experienced a 53% and 25% dropout rate in the first and second semesters, respectively [20].

Identifying effective weight management intervention approaches for this population continues to be a challenge. Short-term interventions (six-16 weeks) aimed at preventing weight gain in young adults have reported positive outcomes using both small- and large-change self-regulation interventions [32] and a theory-based online intervention combined with email feedback [15]. Retention rates were relatively high (∼80%) in the combined intervention group of the latter investigation [15], although the study duration was relatively brief (i.e., six weeks). One longer-duration educational/behavioral intervention study which utilized small-group seminars for first- and second-year college students reported favorable outcomes; compared to the control condition, body weight in the intervention group was 1.3 kg lower after two years [13]. Study retention rate in this investigation was 83%; however, the study population consisted of health science majors, who may not be representative of the general college student population.

Prior work in college students indicated that both monetary incentives and academic course credit would increase student's interest in participating in a program aimed at improving weight-related health behaviors [7]. As a component of interventions aimed at improving health behaviors, monetary incentives appear to have beneficial effects on weight management outcomes in the general adult population over a six- to 18-month-time period [22]. However, the effectiveness of incentives to improve weight management outcomes within special populations groups, such as economically disadvantaged individuals or college-aged adults, is not known. The findings of this investigation do not suggest that a moderate intensity SCTSR intervention which includes monetary and academic (i.e., course credit) incentives will prevent weight gain among college freshmen.

Although our interventions were unsuccessful in preventing weight gain, there are several strengths that should be noted. Measures of both weight and body composition (DXA) were included, as opposed to weight alone or BMI. In young adult males, body composition may be a more appropriate outcome variable than body weight alone as growth may still be taking place; the DXA assesses fat mass and fat-free mass, both of which may contribute to body weight gain. The increase in fat-free mass over time (Table 2) provides support for this point. Inclusion of the open-ended intervention course survey provided valuable (and largely positive) feedback, attendance was high and attrition was minimal in both intervention courses, knowledge gains were demonstrated as suggested by the high quiz grades, and instructor ratings were in the "good" to "excellent" range. A final strength is that the course format was designed and delivered in a way that could be duplicated and disseminated to other universities, through the use of online components/modules and structured in-class sessions.

This study is limited by a small sample size and short study duration. Thus, we are unable to extrapolate the findings beyond our sample or to address the degree to which body composition changes were sustained over a

Table 4: Open-ended exit survey results. Program acceptability and perceptions of social cognitive theory with (SCTSR) and without (SCT) explicit self-regulation training targeting weight gain prevention*.

	SCTSR (n = 18)	SCT (n = 21)
How did this class help you focus on healthy eating and physical activity?		
	Increased awareness of daily food intake (4)	Increased awareness of healthy campus options and food intake (9)
	Helped with daily food intake choices (2)	Improved my physical activity and healthy eating behaviors (4)
	It obsessed over it (1)	I learned different activities for exercise (1)
	Made me realize eating healthy is not that hard (1)	
How would you change the class to make it more meaningful for future freshmen?		
	Make the class sessions more interactive (1)	Increase number of class sessions throughout the semester (4)
	Increase number of class sessions throughout the semester (1)	Include tracking behaviors or sample meal plans and workouts (3)
	Include more detail and emphasis on adverse health risks of obesity and physical inactivity (1)	Make the class sessions more interactive to engage students (3)
	"Teach people to slowly incorporate more and more healthy habits that fit into their schedule. Do not make drastic changes. Do not fill up on high volume, low calorie foods or fake sweeteners like this class tells you to. They fake-out your body and your body will not like it" (1)	Class is adequate the way it is (3)
	Make logging physical activity part of participation (1)	Increase physical activity (1)
Please provide any other general comments:		
	Fun class/enjoyed experience (2)	Great class/enjoyed experience (5)
	Teaches unhealthy/over obsessive eating habits (1)	Liked the class and instructors (2)
	Tracking weight gain was interesting (1)	
	Keep the class organized (1)	

* Number of similar comments indicated in parentheses.

longer period of time. However, the randomization procedure, use of objective measures of body composition, and assessing changes of potential intervention mediators are improvements over previous studies examining weight gain prevention in this population. The latter feature is especially important in that we identified consistent and expected relationships between the changes in social cognitive theory variables and changes in behavioral and weight status outcomes. This suggests that, while the SCTSR and SCT may not have been successful in universal weight gain prevention, the targeted variables are viable for consideration in developing future interventions for this target population.

5. Conclusions

To our knowledge, this is first weight gain prevention intervention trial for college freshman, which includes strategies aimed at instilling individual behavior change skills (e.g., self-regulation, self-monitoring, goal setting, financial incentives), as well as physical and social environmental support for healthy lifestyle behaviors. The intervention programs appeared to be well received and feasible to deliver, although knowledge gains did not lead to improvements in weight-related outcomes. Future studies should address program components such as self-regulation strategies and incentives which are effective for this population, while addressing issues related to student's perceived time constraints, program feasibility, and dissemination potential.

Acknowledgments

This work was funded by NIH K01 DK075424 and the Virginia Tech Fralin Life Science Institute.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 354721, 19 pages
doi:10.1155/2012/354721

Research Article

Physical Activity Advertisements That Feature Daily Well-Being Improve Autonomy and Body Image in Overweight Women but Not Men

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Received 4 November 2011; Revised 31 January 2012; Accepted 26 March 2012

Academic Editor: Pedro J. Teixeira

The reasons for exercising that are featured in health communications brand exercise and socialize individuals about why they should be physically active. Discovering which reasons for exercising are associated with high-quality motivation and behavioral regulation is essential to promoting physical activity and weight control that can be sustained over time. This study investigates whether framing physical activity in advertisements featuring distinct types of goals differentially influences body image and behavioral regulations based on self-determination theory among overweight and obese individuals. Using a three-arm randomized trial, overweight and obese women and men (aged 40–60 yr, $n = 1690$) read one of three ads framing physical activity as a way to achieve (1) better health, (2) weight loss, or (3) daily well-being. Framing effects were estimated in an ANOVA model with pairwise comparisons using the Bonferroni correction. This study showed that there are immediate framing effects on physical activity behavioral regulations and body image from reading a one-page advertisement about physical activity and that gender and BMI moderate these effects. Framing physical activity as a way to enhance daily well-being positively influenced participants' perceptions about the experience of being physically active and enhanced body image among overweight women, but not men. The experiment had less impact among the obese study participants compared to those who were overweight. These findings support a growing body of research suggesting that, compared to weight loss, framing physical activity for daily well-being is a better gain-frame message for overweight women in midlife.

1. Introduction

Sixty-eight percent of the US adult population is overweight or obese [1] and thus at increased risk of developing debilitating and costly illnesses, including, diabetes, cardiovascular disease, and depression. While modest weight loss improves health [2], the vast majority of individuals who lose weight eventually gain it back [3, 4]. Understanding how to best promote weight loss and weight control that can be sustained is a top public health priority. Sustained physical activity participation is a critical component of weight loss maintenance [5]. In addition, regular physical activity reduces the risk of developing cardiovascular disease, diabetes, osteoporosis, and some cancers and improves quality of life [6–11]. Despite

these numerous benefits and over thirty years of behavioral research and messages in the media educating people about physical activity benefits, most individuals do not sustain physically active lives [12]. While most individuals are aware of the many benefits physical activity brings, this knowledge is not sufficient to motivate active lifestyles [13].

For both women and men, the typical messages and communications emphasize physical activity primarily for health and/or weight control benefits [14–16]. Furthermore, exercise is typically prescribed to patients for its weight and health value rather than as a good way to enhance mood or quality of life [17]. When physicians recommend exercise to their patients it is usually within the specific context of the need to diet and lose weight [18]. Thus, the dominant messages in society have framed and branded physical activity primarily as a way to lose weight, prevent disease, and age with good health [19].

How physical activity benefits are framed in health communications and prescribed by clinicians actually socialize individuals about physical activity [20–22]. *They teach people about the goals they should strive to achieve from being physically active (e.g., the reasons why they should participate)*. Goals are the starting point of any behavior [23]. They direct and energize behavior, with some goals energizing behavior better than others [24–27]. Behavioral goals and motives influence the quality of motivation that develops and are central to long-term sustainability [28–31]. Thus, to optimally promote sustainable physical activity, it is crucial to identify *which frames* foster optimal motivational responses toward physical activity and result in goals that are energizing and motivationally potent [19, 29].

Self-determination theory (SDT) has not been previously studied as an explanatory motivation/behavior framework in the exercise/physical activity framing literature as far as we know. Yet, we believe it holds great potential to identify optimal frames for physical activity marketing and promotions. SDT proposes that socialization to a behavior like physical activity occurs within social contexts that either support or undermine autonomy, one of three innate human needs [32]. Feeling autonomous, or self-determined, toward physical activity is important because it helps individuals internalize the value of being physically active so they can integrate it into their selves and lives. Thus, the real objective is for individuals to integrate physical activity regulations *within their sense of self and values* rather than *behavior change, per se* [27].

SDT pays attention to the motives "behind" a behavioral goal—the reasons underlying the decision to become more physically active (or adopt any behavior) [33]. SDT refers to these motives as "regulations" and broadly distinguishes between "controlled" and "autonomous" regulations. Controlled regulations refer to initiating a behavior to fulfill an external demand or a socially constructed contingency (external regulation) and/or also reflect an individual "partially internalizing" the value of being active but not in a deeper sense where it is truly accepted as one's own (introjected regulation). Introjection-based behaviors are done to avoid guilt and shame and to attain feelings of worth. They often feel like a "should" or an obligation [34]. In contrast, autonomous regulations reflect acting with a full sense of volition and choice when initiating an activity. When individuals experience autonomy toward being physically active they value it (identified regulation) and may enjoy and/or receive positive feelings and satisfaction from the act of being physically active (intrinsic regulation).

SDT offers a helpful framework to understand the counterintuitive notion that initiating physical activity with goals related to "losing weight" may, ironically, undermine the ultimate aim to motivate sustainable participation and weight control [33]. Weight loss goals for physical activity embed pressures based on sociocultural norms that encourage women to internalize a sexualized, third-person view of themselves [16, 35–38].

We argue that losing weight as a physical activity goal, in general, is inextricably connected to appearance norms and thinness pressures in our culture, especially for women. Because of that it is difficult to separate out "attractiveness" and "thinness" pressures and goals from a weight loss goal for women. For example, one study validating an exercise motive scale reported that separate "appearance" and "weight loss" items were highly correlated [39]. In addition, we conducted a cross-sectional mixed-method study with 59 midlife women, most of whom were well-educated European Americans (mean age = 45.6 years). They were asked to imagine being physically active for two minutes and then write down the first associations, words, and phrases that came to mind. We coded these data as either "body-shape" or "non-body-shape" according to what words they wrote down [40]. Participants who noted ideas like calories, losing weight, and so forth were categorized as having "body-shape" motives (44%). Those who did not note those types of concepts were placed into the "non-body-shape" motive category (56%). Those who exercised with body-shape motives self-objectified more (e.g., perceiving oneself from a third-person perspective: "How do I look?" instead of "How do I feel?") compared to participants who exercised for non-body-shape goals. Higher self-objectification among participants with weight-related goals indicates that they had more greatly internalized cultural beauty norms and pressures compared to the other participants [35]. The participants with body-shape motives were also 37% less physically active than those with non-body-shape motives ($P < 0.01$).

We later took a random sample of 400 working women (40–60 yr) that resulted in 262 participants [41]. Using a person-centered method of analysis with a cross-sectional study design, cluster analysis identified participants' most important physical activity goals. This sample of overweight women in midlife reported exercising for the following five reasons: (1) sense of well-being; (2) weight loss; (3) health benefits; (4) stress reduction; and (5) weight maintenance/toning. Follow-up analyses on these goals/reasons for exercise suggested that weight-related goals were associated with more external and less intrinsic behavioral regulation compared to goals related to stress reduction and sense of well-being ($P < 0.05$).

Using this five-goal solution we studied participants' exercise participation over one year ($n = 156$). This study

fit a linear mixed model to the data to investigate the fixed effects of physical activity goals on physical activity participation, controlling for BMI and social support. There were significant differences between participants with distinct types of goals on physical activity participation over time (i.e., baseline, one-month, and one-year after baseline), controlling for the effects of BMI and social support. Participants with weight loss goals participated in 34% and 27% less physical activity than those with sense of well-being and stress reduction goals, respectively [24].

Different developmental foci and tasks influence which types of physical activity goals are more or less salient and influential for individuals of distinct ages [20, 42, 43]. Young adults are concerned with establishing intimate relationships [44]. Because of that, appearance/weight-related goals may motivate physical activity because it is in service of a very salient life-stage task [45]. In contrast, women in midlife have family caregiving responsibilities (often children and parents) and jobs and also likely have more goals and priorities competing for time with physical activity compared to younger, college-aged women [24]. Thus, being active in order to lose weight might not make physical activity compelling enough to trump midlife women's other competing daily responsibilities and life tasks [31]. The body of research just presented suggests that being physically active with weight loss goals intersects cultural pressures and is associated with decreased exercise participation, non-optimal regulations, and self-objectification and may also negatively impact body image, especially among overweight women in midlife [24, 30, 32, 40, 41, 46, 47].

Because of these negative effects and lack of sustainable outcomes, some have called to shift the focus and promotion of physical activity from body weight *to health* [48]. Yet, framing and promoting physical activity to achieve better health is more complex than it seems. Some programs of research suggest that "health" as a goal, in general, is *autonomous*; they also consider health goals for exercise to be *intrinsic* [29, 49, 50]. We too had considered health goals for exercise as intrinsic. However, our previous person-centered research suggested that among overweight women in midlife (40–60 yr) who work full time, those who exercised with goals related to health experienced them as more controlling and less intrinsic than participants who had exercise goals related to stress reduction and well-being [41]. Thus, framing physical activity primarily for health benefits, as is typically done, might undermine participation because exercising to improve health may exert pressure, even unconsciously [51].

To better understand this contention, it is helpful to contextualize a "health" goal for physical activity within the American cultural context. Cultural messages about the importance of doing things to "be healthy" dominate the media. Exercising as a way to prevent disease has turned exercise into a moral imperative, something else that we "should" be doing [52, 53]. Furthermore, the manner in which professionals in the health care system characterize a behavior influences how individuals perceive and construe that behavior [54]. Exercise is typically prescribed to patients within the health care system for its medical and health value [17]. Moreover, in medical encounters with patients, practitioners tend to be controlling [55–57]. If practitioners prescribe physical activity to patients as a way to improve health in controlling ways, this creates a context that likely undermines feelings of autonomy toward physical activity and results in patients developing controlled regulations toward this behavior. In recent years, there has even been a movement and branding campaign by leading exercise and medical organizations advocating that clinicians explicitly discuss exercise as "medicine" with their patients [58]. In support of this idea, one study reported that a "health pressures" exercise motive was positively correlated with external behavioral regulation (0.35, $P < 0.01$) [30].

Another reason that health-related goals for physical activity might be controlling and thus nonoptimal for ongoing participation is that efforts to be healthy have been shown to be intertwined with beauty and thinness norms among overweight and obese individuals [59]. One study conducted interviews with 42 overweight and obese participants to investigate how they understood their health and beauty weight loss motives and the relationship between the two. Interviews indicated that participants conflated (e.g., interrelated) beauty and health motives in three ways. The study participants considered depictions of beauty ideals as depictions of health. They used beauty as an indicator of being healthy and also as a motivator for health goals. Another research also found a significant correlation (0.45, $P < 0.001$) between health/fitness and appearance/weight exercise motives among midlife adults who work in the north of England (BMI not reported) supporting the idea that the concepts of health and weight/beauty/attractiveness are interconnected in people's minds [30].

Thus, for overweight and obese individuals it might be especially hard to disentangle health as a goal for exercise from the prevalent beauty and weight/thinness ideals that accompany health content and images in the media—a major form of our socialization [22]. Having health intertwined with weight, in this way, might embed health-related exercise goals with implicit, controlling meanings related to cultural beauty/thinness pressures and result in similar negative emotional and behavioral outcomes from having weight loss goals for exercise as previously discussed above. In fact, our program of research on overweight women, described earlier, does suggest that being physically active to achieve health-related goals is associated with worse outcomes in behavioral regulation, commitment, and longitudinal participation compared to goals related to well-being and quality of life [19, 24, 41]. Furthermore, another investigation we conducted showed that participants with "superordinate-level" goals (e.g., the higher order reason for one's goal) for exercising related to either "current health" or "future healthy aging" participated significantly less compared to participants having superordinate-level goals related to enhancing "quality of life [19]."

We have proposed it would be strategic to rebrand physical activity on a societal level by reframing it as a primary way individuals can enhance their sense of well-being and daily quality of life [19]. Unlike exercising with goals to lose weight and/or improve health, the results from physical

activity aiming to enhance daily well-being are immediately experienced during and/or directly following participation.

A growing body of research shows that smaller, immediate rewards are more motivating than larger, more distant rewards [60, 61]. Other programs of research on women also support our contention that sustainable participation is connected to a desire to improve daily quality of life. One study of overweight women in midlife identified characteristics of female participants who adhered after an exercise intervention ended compared to those who did not adhere [62]. Those who adhered reported being motivated by "an intrinsic desire to improve their quality of life" and de-emphasized body image as their exercise goal. In contrast, those who did not adhere emphasized body image and weight as the goals they aimed to achieve from exercising. This retrospective study and our previous research support the notion that daily well-being goals might better facilitate sustainable physical activity participation among overweight midlife women. Yet to more deeply understand the continuum of processes related to producing sustainable physical activity motivation and behavior, it is important to investigate *the beginning* of this motivation-behavior process—how different frames about the benefits of physical activity immediately influence individuals' feelings about and responses toward being physically active.

Framing research investigates which ways of conveying information about a particular behavior optimally motivates individuals to practice it [54, 63]. In general, much of framing research on physical activity has centered on differences between "gain-framed" and "loss-framed" messages. Gain-framed messages focus on the benefits of adopting physical activity while loss-frame messages target the costs of failing to adopt physical activity. A recent review and meta-analysis of physical activity messages reported that gain-frame messages were more persuasive than loss-framed messages on physical activity participation [63, 64]. SDT may help us understand *which gain-frame messages* support or undermine the development of high-quality motivation necessary to drive physical activity and weight control that can be maintained.

This study aims to expand the framing literature by using SDT as the posited mechanistic framework underlying sustainable physical activity and weight control [27, 65]. This is the first study we know of that uses constructs from SDT to investigate the immediate framing effects from reading distinct "gain-frame" messages promoting physical activity.

The broad objective of this study is to investigate whether a "gain-framed" message featuring daily well-being causes immediate and different effects on behavioral regulations and body image compared to "gain-frame" messages featuring health or weight loss, and whether this differs by gender and BMI among overweight and obese individuals. Based on the body of research just reviewed, we hypothesized that overweight and obese men and women reading the advertisements featuring daily well-being would report decreased controlled regulation and increased autonomous regulation compared to those reading advertisements featuring health or weight loss frames for being physically active. Because women experience much greater pressure to be thin and lose weight [35, 66], we also hypothesized that gender would moderate the framing effects on body image and that women reading the daily well-being advertisement would report better body image compared to those reading weight loss advertisement (but not men).

2. Method

2.1. Study Design. This study used a three-arm randomized design.

2.2. Sample. We recruited a demographically diverse, stratified random sample of midlife men and women aged 40–60 from an Internet research panel administered by Survey Sampling International (SSI) [67]. SSI is a research firm that maintains a panel of more than two million members who have agreed to receive email solicitations for questionnaires of this type. SSI recruits members using multiple opt-in techniques, including Internet banner ads, online recruitment methods, and random digit dialing. All members of SSI research panels complete a screening questionnaire to elicit detailed demographic information. The survey process for all subjects was completely anonymous, so this study received exemption from the University of Michigan Institutional Review Board (#HUM00039282). At the conclusion of the survey, participants were routed back to SSI for payment.

2.3. Protocol. We conducted a web-based experiment of midlife adults aged 40–60 using SSI. To achieve demographic diversity (but not representativeness) we established target response rates roughly matching the prevalence of gender and racial/ethnic groups in the US population. We dynamically adjusted the email invitations for the sample to achieve the desired distribution of participants by demographic variables. Recruitment consisted of an initial email invitation from SSI, followed by 1-2 reminder emails to nonrespondents.

The advertisements were created by gathering messages from health-related organizations that promote exercise on the Internet, such as the American Heart Association [68]. We modeled the structure of our advertisement after typical testimonial-based marketing (e.g., Medifast) [69]. The advertisements were reviewed for face validity by experts in framing, decision making, and marketing as well as medical doctors.

Once the respondents accessed our online survey, they were informed "*In this study we are interested in physical activity communications. We will show you a media message about physical activity and then ask questions following it. We are interested in knowing how you think and feel.*" Participants then were randomly assigned to read one of three advertisements, and then they answered questions about physical activity, the benefits of physical activity, and demographics.

All of the advertisements were created to be "gain-framed" and highlighted three distinct benefits from being physically active. The advertisements were also identical in the following ways: one page long, contained a photo of a middle-aged white couple, and a description of what

"counts" as being physically active. In addition, the frames (e.g., physical activity improves health) were reinforced by having them at the top of every page of the survey. We decided to use the term "physical activity" instead of "exercise" because of the potential controlled regulations and negative meaning that might be specifically associated with the word "exercise," in order to prevent that from confounding our experiment.

The advertisements differed by the frame used to promote being physically active (e.g., the benefit derived from or stated goal for being physically active). The first frame featured "better health." The second frame featured "weight loss." The third frame featured "daily well-being." (Appendix I in Supplementary Material available online at doi:10.1155/2012/354721. shows the three advertisements used in this framing experiment.)

2.4. Measures

2.4.1. SDT Regulation Variables

Controlled Regulation. Controlled regulation reflects having an external locus of causality. *External Regulation* refers to initiating a behavior to fulfill an external demand or a socially constructed contingency. *Introjected Regulation* reflects an individual "partially internalizing" the value of being active but not in a deeper sense where it is truly accepted as one's own. Introjection-based behaviors are done to avoid guilt and shame and to attain feelings of worth. Controlled SDT regulations were measured by adapting two items from the Treatment Self-Regulation Questionnaire (TRSQ) related to diabetes [70, 71]. It was measured by taking the mean of External Regulation plus Introjected Regulation. Participants were informed: "*The following statements list reasons people often give when asked why they are or would become physically active. Whether you currently are physically active or not, please read each statement carefully and indicate whether or not each statement is or would be true for you personally if you decided to be physically active*." Participants responded to two items with a 7-point scale, from 0 (Not at all true) to 6 (Very true). *External regulation* was assessed by the statement: "*I want others to see that I can do it.*" Higher scores indicate higher external regulation. *Introjected Regulation* was assessed by the statement: "*I would feel bad about myself if I didn't try to be physically active.*" Controlled Regulation ranged from 0 to 6. The Controlled Regulation mean (S.E.) score across gender was 3.4 (0.4) (Alpha = 0.59). Higher scores indicate higher Controlled Regulation. The mean score indicates that, on average, participants felt somewhat controlled toward being physically active.

Autonomous Regulation. Autonomous regulation refers to the origin of behavior coming from inside the self. It reflects individuals believing that physical activity is valuable and participating because it feels good or is inherently satisfying. Autonomous SDT regulations were measured by adapting items from the TRSQ related to diabetes [70, 71] and the Behavioral Regulation in Exercise Questionnaire (BREQ) [72]. Participants were informed: "*The following statements list reasons people often give when asked why they are or would become physically active. Whether you currently are physically active or not, please read each statement carefully and indicate whether or not each statement is or would be true for you personally if you decided to be physically active*." Participants responded to two items with a 7-point scale, from 0 (Not at all true) to 6 (Very true). Autonomous regulation was measured by taking the mean of Identified Regulation plus Intrinsic Regulation. *Identified Regulation* refers to personally valuing physical activity participation. It was assessed by the statement: "*I truly feel that being physically active is the best thing for me.*" Higher scores indicate higher Identified Regulation. *Intrinsic Regulation* refers to being physically active as a way to achieve positive emotional experiences and/or satisfaction derived from participating in the behavior per se. It was assessed by the statement: "*It feels good to be physically active*." Higher scores indicate higher Intrinsic Regulation. Autonomous Regulation ranged from 0 to 6. The Autonomous Regulation mean (S.E.) score across gender was 4.3 (0.3) (Alpha = 0.85). Higher scores indicate higher Autonomous Regulation. The mean score indicates that, on average, participants felt somewhat autonomous toward being physically active. The Autonomous Regulation and Controlled Regulation indexes were positively correlated = 0.64 ($P > 0.001$).

2.4.2. Body Image. Body image refers to how individuals perceive and feel about their bodies [73]. We chose the Body Image State Scale (BISS) because of its sensitivity to changes in state body image. The BISS has acceptable internal consistency and is sensitive to reactions in positive and negative situational contexts. Sex differences in body image reflect those that have been seen [74]. The BISS is phrased "*For each of the questions below, select the one statement that best describes how you feel right now, at this very moment*." Participants responded to two items from the BISS that reflected body satisfaction, using a 9-point scale from 0 (extremely dissatisfied) to 8 (extremely satisfied) about (1) *my body size and shape* and (2) *my weight*. Higher scores indicate a more positive body image. The Body Image mean (S.E.) score across gender was 2.4 (0.6) (Alpha = 0.94). The mean scores indicate that, in general, participants reported poor body image.

2.4.3. BMI. BMI was calculated as the ratio of study participants' self-reported weight (kg) to self-reported height squared (m^2) [75].

2.4.4. Gender. Gender was a dichotomous variable. Individuals indicated if they were female or male.

2.5. Analyses. We fit three-way ANOVAs to the continuous outcome variables of interest, checked assumptions of linear models, and found no patterns that required remediation. The predictor variables for these models included the experimental condition (Frame), Gender, and BMI (obese and overweight). The initial model for each dependent

variable included all possible interactions with Frame, Gender, and BMI. We used backward variable selection [76] to discover the most parsimonious models. The Bonferroni correction was used for group comparisons as a conservative method to control for type II errors. SPSS Version 19.0 was used [77]. Data are displayed in graphs with error bars showing the 95th percentile confidence intervals of the mean. Appendix II in Supplementary Material available online at doi:10.1155/2012/354721 shows the adjusted means and standard errors for all variables. We also conducted post hoc analyses on the individual components of controlled and autonomous regulation to understand how the advertisements impacted these individual regulations.

3. Results

A total of 3470 participants accessed the survey, with a 67% completion rate ($n = 2313$). This research question aimed to understand how overweight and obese individuals respond to the typical exercise frames seen in society and health care, with a specific interest in the effects from a "weight loss" frame. Because of that, we only included individuals in the analyses who had BMIs categorizing them as overweight or obese. There were 1690 participants remaining after the underweight and normal weight participants were removed. BMI categories in this study were distributed as follows: 44.9% were "overweight" (BMI $\geq$ 25–29.9 kg/m^2) and 55.1% were "obese" (BMI $\geq$ 30 kg/m^2). Mean (S.E.) BMI of this sample was 32.6 (0.17). Forty percent of female participants were overweight and 60% were obese. Forty-nine percent of men were overweight and 51% were obese. Table 1 shows the study participants' demographics.

Table 1: Baseline demographics of obese and overweight participants ($N = 1690$).

Age (mean, S.E.)	52.5 (1.2)
Sex (%)	
Female	48.6
Male	51.2
Missing	0.2
BMI category (%)	
Overweight	44.9
Obese	55.1
Education (%)	
Some high school/high school graduate	26.5
Some college	33.1
College degree	24.6
Some postgrad	4.7
Master's degree	7.4
Grad/Prof degree	1.7
Missing	2.0
Marital status (%)	
Married	55.1
Domestic partner	6.3
Separated/divorced/widowed	18.7
Single/never married	17.9
Missing	2.0
Household income (%)	
< \$20,000	17.8
\$20,000–\$59,999	45.9
\$60,000–\$99,999	22.0
\$100,000–\$149,999	7.6
\$150,000+	2.4
Missing	4.3
Employment status (%)	
Full time	41.5
Part time	12.9
Not employed	43.6
Missing	2.0
Ethnicity (%)	
African American	15.1
Asian	2.8
European American	68.6
Hispanic	11.1
Other	0.4
Missing	2.0

3.1. Main Dependent Variables

3.1.1. Controlled Regulation. Our final model for Controlled Regulation toward being physically active indicates one significant two-way interaction between Frame and BMI, $F(2, 1667) = 3.4$, $P < 0.05$, $\eta_p^2 = 0.004$. See Figure 1 for the mean scores of Controlled Regulation. The framing effects on Controlled Regulation depend on BMI. For those individuals who were overweight, reading the daily well-being advertisement decreased Controlled Regulation compared to reading the weight loss and health advertisement. In contrast, for obese individuals, those reading the daily well-being advertisement reported higher Controlled Regulation, compared to those reading the health and weight loss advertisement.

Post Hoc Analyses. We conducted post hoc analyses separately on the two components of Controlled Regulation, External Regulation and Introjected Regulation toward being physically active.

External Regulation. The experiment had no framing effects on External Regulation.

Introjected Regulation. The Introjected Regulation model showed a significant two-way interaction between Frame and BMI, $F(2, 1675) = 6.2$, $P < 0.01$, $\eta_p^2 = 0.007$, in the same direction as seen in Controlled Regulation. See Figure 2 for the mean scores of Introjected Regulation.

3.1.2. Autonomous Regulation. Our model for Autonomous Regulation toward being physically active indicates one significant three-way interaction between Frame, Gender,

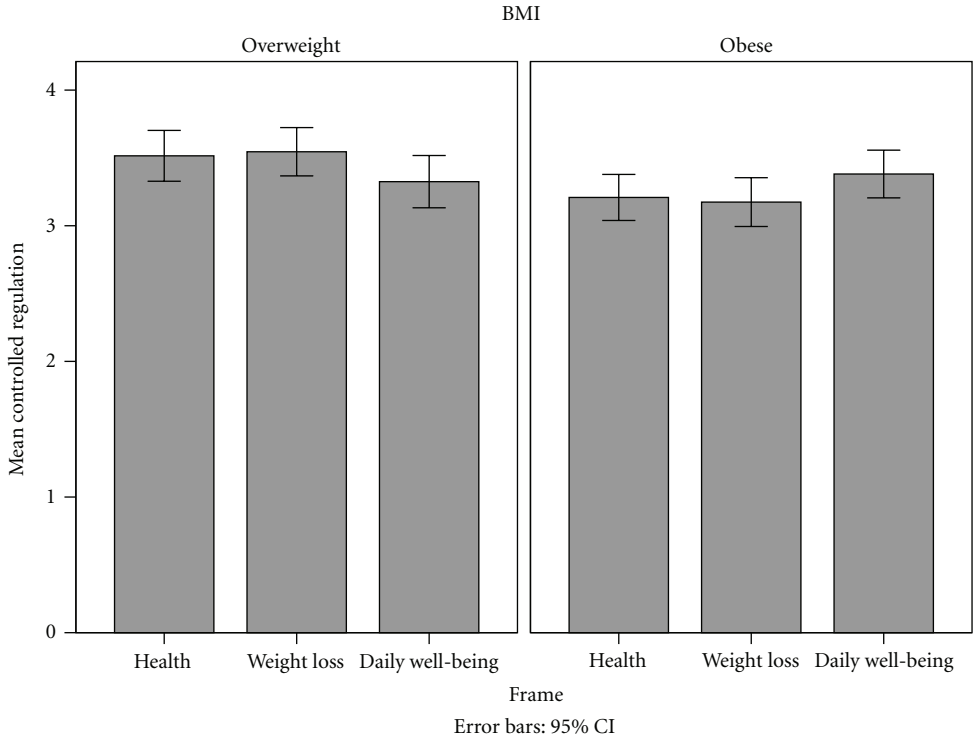

Figure 1: Controlled regulation.

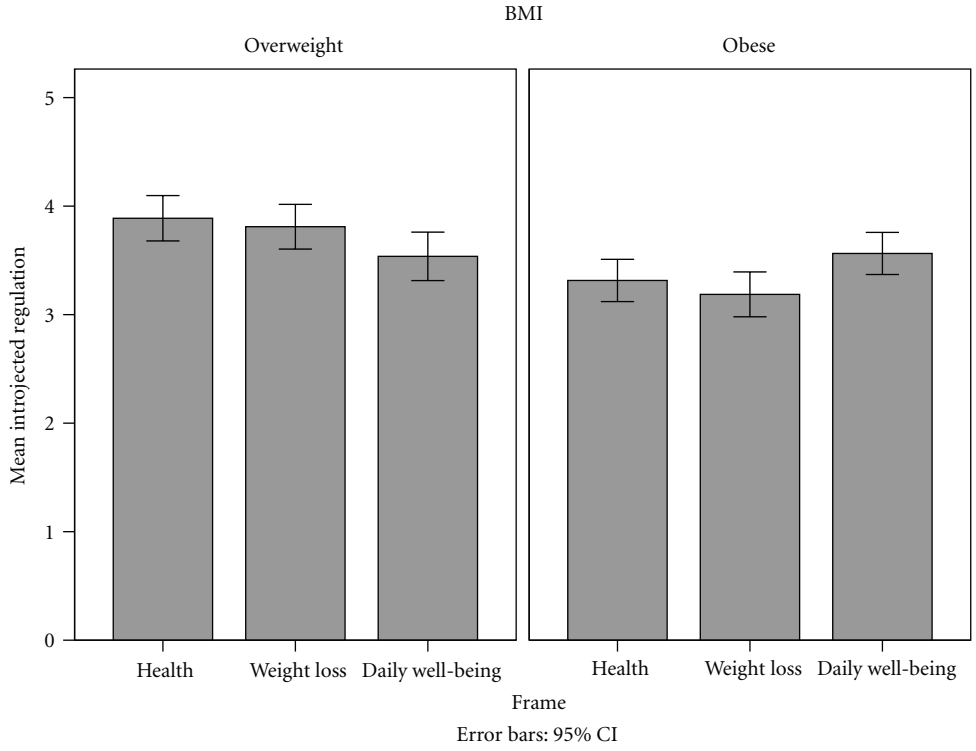

Figure 2: Introjected regulation.

and BMI, $F(2, 1665) = 4.5$, $P < 0.05$, $\eta_p^2 = 0.005$. See Figure 3 for the mean scores of Autonomous Regulation. The framing effects on Autonomous Regulation differed depending on BMI and Gender. Among overweight individuals, men and women responded differently to the daily well-being frame. Overweight women who read the daily well-being advertisement reported greater Autonomous Regulation than those reading the weight loss, but not health, advertisement. In contrast, overweight men who read the daily well-being advertisement reported lower Autonomous Regulation compared to those who read the weight loss and health advertisements.

Post Hoc Analyses. We conducted post hoc analyses separately on the two components of the Autonomous Regulation variable, Identified Regulation and Intrinsic Regulation.

Identified Regulation. Our final model for Identified Regulation toward being physically active indicates a significant Frame-Gender interaction, $F(2, 1666) = 3.1$, $P < 0.05$, $\eta_p^2 = 0.004$, and a significant Frame-BMI interaction, $F(2, 1666) = 3.1$, $P < 0.05$, $\eta_p^2 = 0.004$. See Figure 4 for mean scores of Identified Regulation. Overweight women reading the daily well-being advertisement reported marginally higher Identified Regulation than those reading the weight loss advertisement. In contrast, overweight men reading the daily well-being advertisement reported lower Identified Regulation compared to those reading the weight loss advertisement.

Intrinsic Regulation. Our final model for Intrinsic Regulation toward being physically active indicated a significant three-way interaction between Frame, Gender, and BMI, $F(2, 1665) = 6.7$, $P < 0.01$, $\eta_p^2 = 0.008$. See Figure 5 for mean scores of Intrinsic Regulation. Among overweight individuals, women and men had very different responses. Overweight women reading the daily well-being advertisement reported higher Intrinsic Regulation toward being physically active than those reading the weight loss advertisement. Overweight men, however, had the opposite response. Those who read the daily well-being advertisement reported lower Intrinsic Regulation than those reading the weight loss and health advertisements.

3.2. Body Image. Our final model for Body Image showed a trend toward a three-way interaction between Frame, Gender, and BMI, $F(2, 1236) = 2.8$, $P < 0.10$, $\eta_p^2 = 0.005$. See Figure 6 for mean scores of Body Image. Overweight women who read the daily well-being advertisement reported more favorable Body Image compared to those reading the weight loss advertisement. As hypothesized, this framing effect was not seen among men.

4. Discussion

This study showed that there are immediate framing effects on behavioral regulation and body image from simply reading a one-page advertisement about physical activity and that gender and BMI moderate these effects. The moderation of the framing effects makes interpreting and applying these findings complicated. Overweight women tended to respond positively to the daily well-being frame. This was seen most convincingly in body image and autonomous regulation, with the strongest effect in the intrinsic regulation component of autonomy. Overweight men tended to respond unfavorably toward the daily well-being frame, with generally equal effects on both the identified and intrinsic components of autonomy. None of our hypotheses related to the health frame were supported. This study expands the framing literature by being the first to evaluate *which* gain-frame messages most optimally influence SDT constructs and body image among overweight and obese men and women in midlife.

4.1. Daily Well-Being Frame Compared to Weight Loss Frame

4.1.1. Framing Effects among Midlife Women. Our hypothesis that "daily well-being" would predict greater autonomy toward being physically active compared to "health" or "weight loss" was only partially supported. A trend among overweight (but not obese) women suggested that reading the daily well-being frame predicted higher autonomous regulation toward being physically active compared to reading the weight loss frame. Autonomy refers to feeling as the "causal agent" of one's life and acting in harmony with one's fully integrated self [33]. These data suggest that just the idea of *striving toward well-being through physical activity* may foster autonomous feelings, something that may help women better internalize the value of being physically active and promote ongoing participation. This idea is supported by previous behavioral research showing that overweight women exercising in order to enhance their well-being feel more autonomous and participate in more exercise over time than women exercising to lose weight [24, 41]. Moreover, two other studies investigated differences between active and inactive women related to their reasons for participating. They found that women who are regularly physically active report exercising in order to increase their well-being and quality of life. In contrast, those who are not active report weight loss as their main motive for participating [62, 78]. While it cannot be known whether individuals with weight loss motives aim to "improve appearance" or "benefit health" without also investigating this question specifically [79], the interconnections between losing weight, health, and socialized pressures to be thin and attractive are powerful, often implicit, and might be hard for individuals to untangle [66, 80, 81].

Interestingly, the post hoc analyses showed that the experiment affected "intrinsic" regulation toward being physically active (feeling good from or enjoying the process of being active) more than "identified" regulation (cognitively valuing physical activity). This experiment showed that framing physical activity as a way to achieve daily well-being (compared to weight loss) positively influenced overweight women's perceptions about *the experience of being physically active*. Well-being and feeling good are inherently self-determined. Thus, frames featuring enhanced well-being may implicitly give women permission to create physical

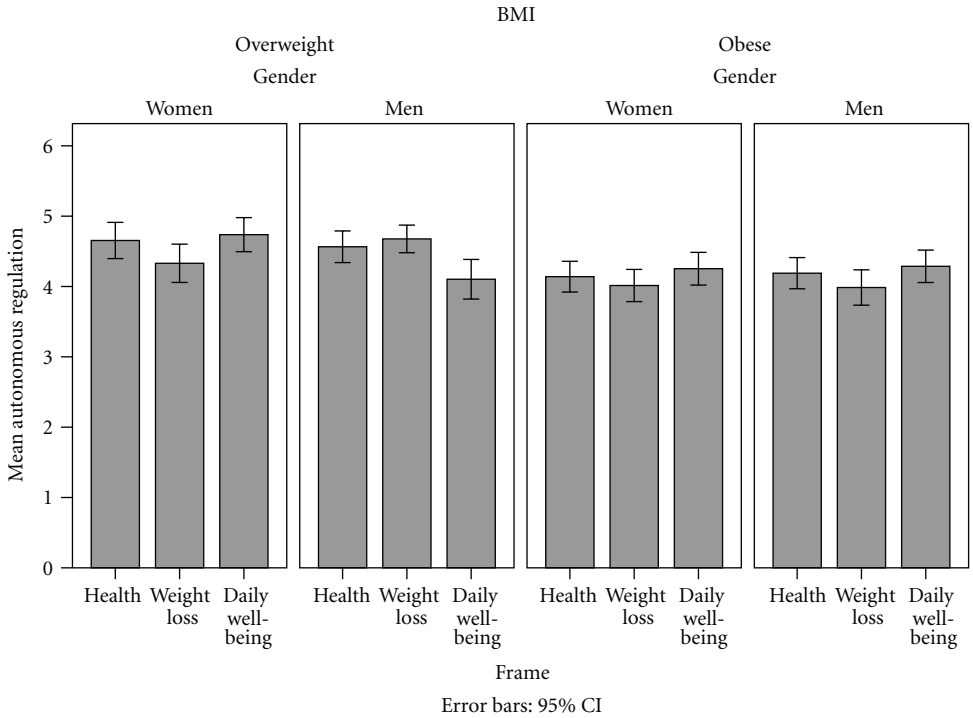

Figure 3: Autonomous regulation.

activity experiences that are congruent with their unique preferences and *intrinsically feel good to them* [82]. If so, this would help women experience physical activity as an *autonomous* activity.

Intrinsic experiences with physical activity, however, may not just influence participation and adherence [83–85]. They also seem to influence weight loss maintenance. Intervention research showed that *increased intrinsic motivation for exercise* was *the strongest predictor* of long-term weight loss among women who participated in a weight reduction program [86]. Furthermore, physical activity messages that emphasize well-being *experiences* instead of women's *bodies* may positively impact women's body image. Women's socialization to physical activity and exercise embeds sociocultural appearance and weight-related pressures [37, 47, 81]. Thus, reframing physical activity as a "positive experience producing" behavior instead of a "body shaping" behavior might improve women's body image. In partial support of this hypothesis, overweight (but not obese) women who read the daily well-being advertisement reported better body image compared to those who read the weight-loss advertisement. Another study, on college-aged women, conducted a framing experiment with similar goals as ours. They found that participants showed an immediate and positive framing effect on body image from reading magazine articles featuring "feel good" messages compared to articles featuring "look good" messages [16]. Having intrinsic goals for exercise has also been shown to enhance self-worth [29]. *This research advances the literature by showing that there are immediate and beneficial framing effects on body image from simply reading an advertisement featuring daily well-being as the primary reason to become physically active, among overweight women in midlife.*

Fostering positive body image may promote sustainable weight control. New research emphasizes the importance of a positive body image for maintaining health behaviors. A 12-month weight management intervention that included a body-image educational component resulted in improvements in body image among participants [87]. The authors further reported that having a more positive body image improved eating self-regulation and behavior. This finding with eating behavior is similar to two separate physical activity interventions that also had program curriculum that addressed the thin ideals and weight-related pressures that women experience. These interventions, conducted with convenience samples, explicitly reframed exercise *away from* weight loss and body shaping goals to self-care and self-worth as key benefits of and new reasons to become more physically active. Both interventions showed increased physical activity from baseline to after the program that was sustained at the long-term study follow-ups [88, 89]. *Having positive feelings about the self, such as from positive body image and self-worth, may be very important to produce sustainable self-regulation and behavior. Thus, our physical activity frames and messages/promotion might improve outcomes if they were crafted to help women feel good instead of bad about themselves and their bodies* [90].

4.1.2. Framing Effects among Midlife Men. Contrary to our hypothesis and the findings among overweight women,

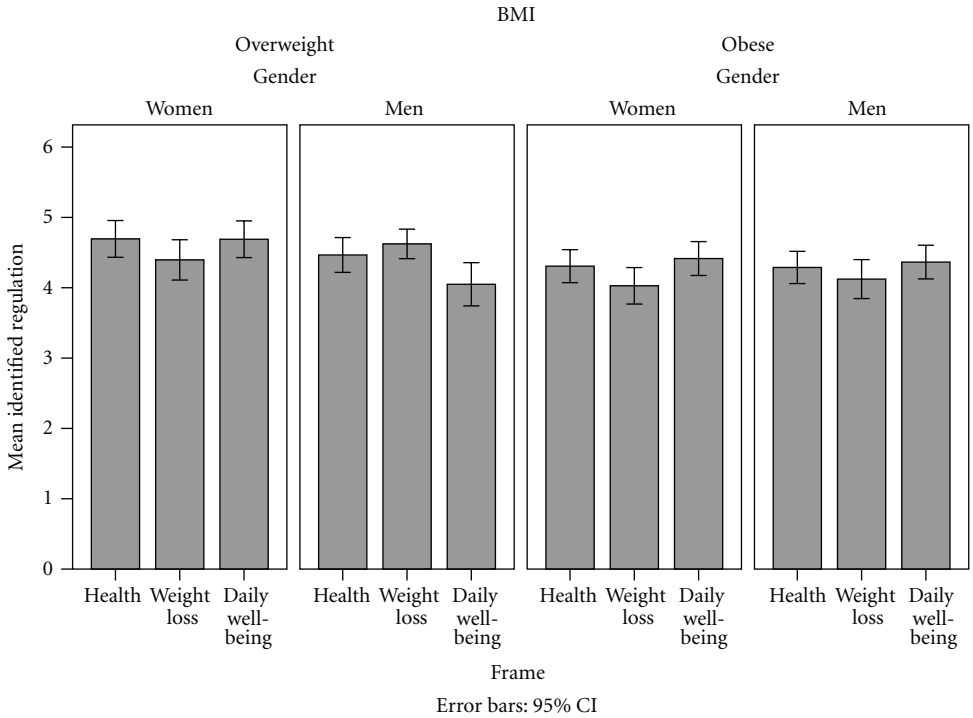

Figure 4: Identified regulation.

overweight men who read the daily well-being advertisement reported *less* autonomy toward physical activity compared to those who read the weight loss advertisement. This finding is curious. Based on SDT and behavioral economics research, we thought that the daily well-being frame would be experienced as the most autonomous by *both women and men*. Despite this, overweight men in our sample experienced the weight loss frame as more autonomous than the well-being frame.

These data might reflect a true gender difference and may indicate that well-being is not relevant or is a nonoptimal physical activity frame for men. The notion that proximal and noticeable well-being benefits from physical activity are not compelling to men, however, conflicts with research across genders suggesting that immediately experienced benefits are more motivating than abstract and distant benefits [91]. In fact, to improve behavioral pursuit, behavioral economists recommend "reward substitution," a strategy to reframe a behavior away from distant benefits (e.g., disease prevention) to rewards that can be experienced immediately (e.g., increased energy) [60, 61].

An alternative explanation for this unexpected finding, based on research focused on men's unique experience with health behavior, may help explain why the daily well-being frame did not foster autonomy among men. The daily well-being advertisement text mentioned benefits like "improved mood" and "stress reduction." It might be that this language was perceived as promoting "mental health" (See the advertisement text in Appendix I in Supplementary Material). Men may be less comfortable with mental health issues [92] and thus may not feel self-determined when confronted with messages about them. In addition, many men define stress as something that is driven by factors that are outside of their control, such as job strain and family responsibilities [93]. Thus, men reading the daily well-being advertisement might have been primed to think about these larger and overwhelming stressors and, as a result, felt less autonomous toward being physically active compared to those reading the weight loss or health advertisements. Moreover, other research compared women's and men's goal hierarchies for losing weight. This study found that while "feeling good" was the central goal (e.g., motive for change) in women's goal hierarchy, *it was not central for men* [94]. This study suggests that men may not value well-being experiences as much as women do [95, 96]. However, more in-depth and gender-specific framing research is needed on men in midlife to better understand which frames and messages are most acceptable and motivating to them [97–99].

4.2. Daily Well-Being Frame Compared to Health Frame

4.2.1. Framing Effects among Midlife Women. Contrary to our hypothesis, women reading the daily well-being and health advertisements reported the same level of autonomy toward being physically active. Given that our past research showed that health goals for exercise resulted in non-optimal behavioral regulation among overweight women in midlife [41], this unexpected finding is important to explore.

We conjecture that this current study finding highlights the conundrum related to promoting physical activity for health (to women). It cannot be denied that health is a central value for individuals [100]. Individuals have clearly

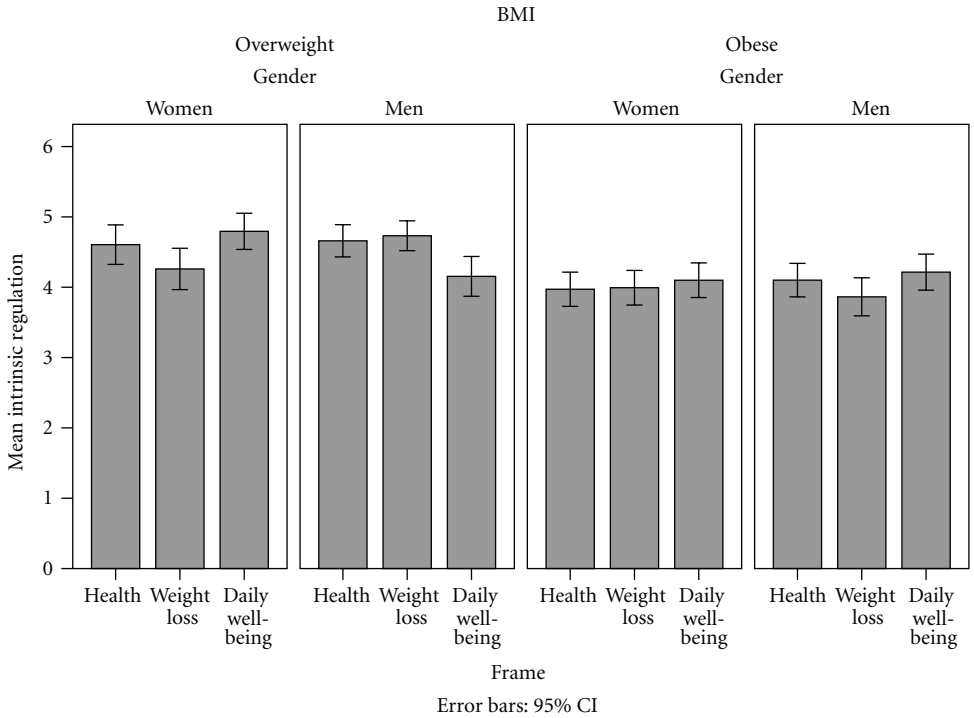

Figure 5: Intrinsic regulation.

been socialized to *value* behaviors like exercise because they improve health and prevent disease [101, 102]. Moreover, other exercise studies show that exercising to pursue good health reflects an intrinsic drive and goal [26, 50]. Valuing exercise for its health benefits is also logical given the frequently communicated link between exercise and health by health organizations and the media [15, 53]. In fact, campaigns even brand exercise explicitly as "medicine" [58]. Placing a high value on health is generally thought to motivate individuals to practice health behaviors [103]. Yet, while the societal branding of exercise for health benefits has been successfully internalized by most, we remain skeptical that health as the primary reason for exercising will optimally promote sustainable participation among women [19].

What an individual espouses as important does not necessarily translate into behavior that is sustained over time. It is easy for individuals to report "exercising for health" as an important value and autonomous aim because, in theory, it is. What individuals find important enough to consistently prioritize within their busy lives, however, may be different than abstract values. For example, in previous mixed-method longitudinal research, midlife women who were overweight evaluated how much they valued their superordinate-level goal for exercising, compared to their other important life goals [19]. The participants in the three largest categories, "current health," "healthy aging," and "quality of life," reported *equally* valuing their goals. Yet, those with "current health" or "healthy aging" exercised significantly *less* than those having exercise goals related to enhancing their quality of life. Research on values and behavior shows that situational forces (e.g., barriers to the behavior) can dramatically reduce behaviors that affirm cherished values [104]. *It is easy to see how exercising in order to benefit health would be highly valued by women. Yet, because women constantly juggle multiple roles and responsibilities [95, 105], it is also easy to see how exercise aiming to improve health could be trumped by the other daily priorities against which it constantly competes* [19, 31, 106]. *Doing behaviors to benefit health, while considered important, may not rank as a top or urgent priority on women's daily "to do" lists.*

Taking medication offers another example to support the notion that despite being valued, health may not be the optimal frame to promote sustainable behavior. The purpose of taking medication is to improve health and prevent disease, not unlike physical activity. Taking pills, however, while not a simple behavior, does not include the same level of logistics and negotiating time that remaining physically active does. Despite this, there are well-documented low adherence rates to prescription medication around the world [107, 108].

4.2.2. Framing Effects among Midlife Men. Overweight men who read the daily well-being advertisement reported *less* autonomy toward physical activity compared to those who read the health advertisements, contrary to our hypotheses and different than the null effects seen among women.

This current study comes out of our program of research that, until now, has been focused on the gender-specific issues faced by midlife, overweight women and is our first time studying these questions among men. We had assumed that daily well-being frames would positively impact men's

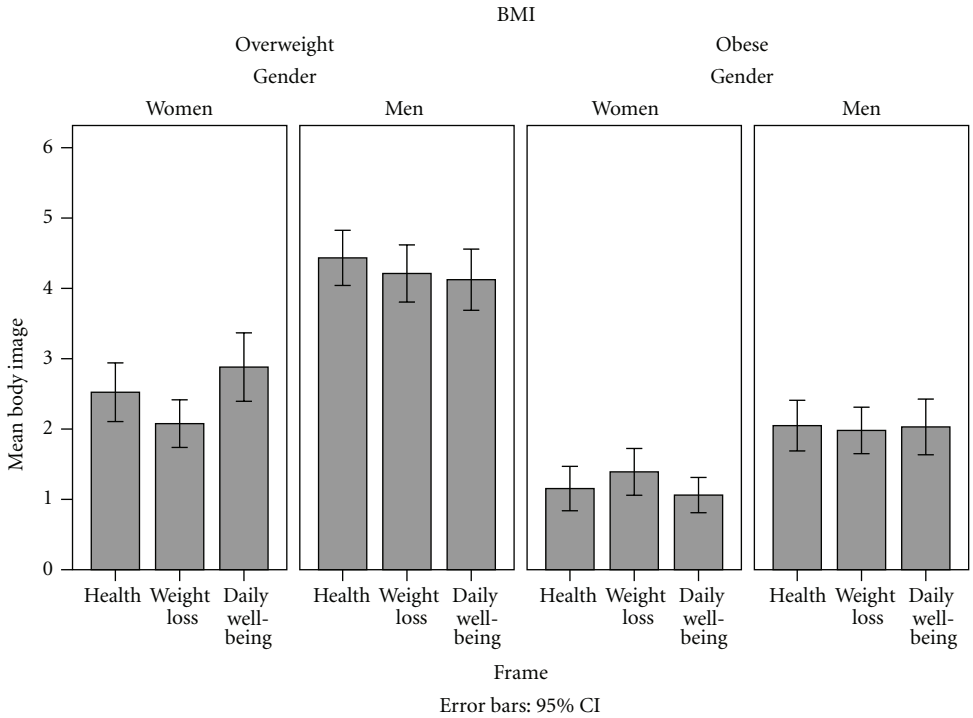

Figure 6: Body image.

behavioral regulations, based on previous investigations on women, SDT, and behavioral economics studies [24, 33, 62, 91, 109]. However, these study data suggest that well-being might not be an optimal exercise frame for men, contrary to our hypothesis. These data suggest that men may feel more autonomous toward a health frame compared to a well-being frame for being physically active.

We believe that to learn how to optimally promote physical activity, it is essential to develop marketing messages that target gender and other specific demographic characteristics, as industry does [19, 110]. For example, a popular commercial weight loss program website (Medifast) shows that they market differently to men than to women. The page promoting Medifast to men started with the following text "When you want to lose weight and get healthy, Medifast makes sense..." [111]. In contrast, the page targeting women says "If you're unhappy or unhealthy because of your weight, Medifast can help you get fast results..." [112]. It is interesting to note that some marketing strategies in industry support the general gender differences identified in this study and our research on women and physical activity [62, 96, 113], such that "losing weight" and "health" are often featured motivators *for men*, while well-being outcomes such as "joy," "hope," "pep," [114] and overcoming "unhappiness" [112] are frequently emphasized for women. However, without more inductive research with men on physical activity per se, it is premature to make conclusions about which frames will be most motivating.

It is important to contextualize this study within a parallel program of research on exercise goals in Europe. There is a growing specialized area within SDT research that investigates the differential contribution of goals and behavioral regulations to physical activity participation that is referred to as the "what" and "why" of goal pursuits. In this specific framework, the "what" of goal pursuits includes participation motives or goal contents (the reason why an individual decides to participate) while behavioral regulations are referred to as the "why" of goal pursuits. In support of the current finding that men experience "health" as a more autonomous goal and frame, much of this other research also finds a positive relationship between "health" goals for exercise, autonomous regulation [26, 29, 115], and physical activity participation [26, 30]. While this European-based research is in line with these unanticipated findings among overweight men, they do not support our previous research showing that women experience health goals for exercising as controlling and predictive of decreased exercise participation over time [24, 41].

We should also consider whether distinct findings among different programs of research might be due to differences in study populations (gender-specific versus mixed gender investigations and analyses, ethnicity, etc.), methodological issues (variable-centered versus person-centered measurement), and life stage (targeting specific life stages versus including individuals in samples across the adult lifespan, etc.). In addition, "health" might have distinct meanings within different cultures that may influence findings in the realms of physical activity motivation, behavior, and weight control. While some research suggests that health goals and frames for exercising benefit motivation [29] and participation [30], research perspectives outside of the physical activity literature suggest that promoting the value

of health as the primary reason for exercise might present challenges to individuals sustaining participation over time [91, 104, 109].

4.3. Controlled Regulation. Controlled regulation was much less influenced by this experiment than autonomous regulation. This was unexpected. Given our previous research, and the extreme cultural pressures to be thin, we were surprised that the weight loss frame was not more greatly associated with controlled regulation, especially among women.

Both the lack of hypothesized effects related to controlled regulation, and the low internal consistency reliability coefficient seen with the Controlled Regulation Index were reported elsewhere [115]. This high mean controlled regulation score suggests that individuals may have been socialized in ways, through the media and within health care, that generally promote controlled regulations toward being physically active. Thus, reading a one-page advertisement may not be sufficient to change this pressuring regulation toward being physically active.

It is interesting, however, to note that the controlled regulation and autonomous regulation indexes were strongly positively correlated. As others have reported, individuals can feel both controlled and autonomous toward being physically active at the same time [116]. This is not surprising given that our general socialization to being physically active includes a strong external focus on body and weight [14] and that individuals do value being healthy and well [103]. Despite this, having concurrent autonomous and controlled regulations toward physical activity may promote ambivalence. Ambivalence toward physical activity is not optimal for sustainable participation. When individuals feel ambivalent toward physical activity they are less likely to prioritize it among the other goals and responsibilities against which it constantly competes [117].

4.4. Different Framing Effects among Overweight and Obese Individuals. The framing experiment, in general, had fewer effects among the obese participants. While not hypothesized, most effects occurred among the overweight participants. The only effect seen among the obese individuals occurred in controlled regulation (specifically in introjected regulation) compared to overweight participants. The overweight individuals reading the daily well-being advertisement compared to those who read the weight loss or health advertisements reported decreased controlled regulation. This suggests that, across genders, overweight individuals may experience a daily well-being frame for physical activity as less controlling than health- or weight-related frames.

The opposite pattern was seen among obese individuals. Obese men and women who read the daily well-being advertisement reported higher controlled regulation compared to those who read the weight loss or health advertisement. Obese individuals experience extreme pressure in society, especially in areas related to their health and weight. We wonder whether their higher controlled response (compared to the overweight participants) to the daily well-being advertisement reflects that the obese participants felt pressured to add one more thing to strive toward on a list that probably already includes losing weight and improving health.

To understand the lack of effects among obese individuals it is important to consider that they experience extreme pressures and prejudices related to their larger size. Obesity is considered one of the most enduring stigmas in society because of the common perception that extra weight is due to controllable personality flaws like laziness, gluttony, or lack of self-discipline. Weight discrimination leads to unfair treatment in employment and health care, among other areas. In addition, the consequences of being overweight and obese worsen as individuals reach heavier weights [118, 119]. Moreover, the health care context uniquely challenges individuals who are obese. There is a heightened focus on and clear disdain of being "obese." Even professionals whose careers emphasize research or the clinical management of obesity show a very strong weight bias. Schwartz and colleagues found that health professionals ($N = 389$) endorsed both implicit and explicit stereotypes that overweight and obese people are lazy, stupid, and worthless [120]. Thus, it is not surprising that obese participants reported lower body image compared to those who were overweight in this study.

Despite frequent dieting, obese individuals frequently do *not* include physical activity as a weight loss strategy. One qualitative study among obese individuals reported that they have many barriers to being physically active, including being embarrassed to exercise in front of people and experiencing exercise as difficult because of their weight and physical health [121]. Another study examined self-reported physical activity barriers and the effects of these barriers on physical activity behavior among 280 previously inactive women enrolled in a physical activity intervention. The authors reported that the obese participants reported significantly greater physical activity barriers compared with those who were overweight ($P < 0.05$) [122]. Obesity is also frequently accompanied by depression [123], and depressed individuals might be even less likely to respond to reading a one-page advertisement about physical activity.

It cannot be overstated that obese individuals face daunting barriers to being physically active. We believe that the lack of effects among the obese participants in this experiment suggest that reading a one-page advertisement is simply not a strong enough intervention for obese individuals, given their negative experiences with and their extreme barriers to exercising. Thus, it may take a much more intense intervention, one with ongoing support, to foster autonomy among obese individuals, as occurred in an intervention study previously conducted with obese women [124]. Much more research is needed to identify how to help obese individuals address their unique barriers so that they can become more physically active in ways they can sustain.

4.5. Why Well-Being for Women? Increasing participation among women in sustainable ways might be a question of improving how we "sell" physical activity and exercise through intensive market research and principles such as branding [19, 110, 125–127]. Instead of promoting the end

points that clinicians, business, and governments endeavor to achieve from promoting exercise to individuals (e.g., "improved health" in service of health care savings), health communications might become more meaningful and persuasive to women if they were based on the exercise benefits that are most compelling to them [41, 62, 94, 96].

Well-being and what "feels good" is inherently subjective. Individuals who strive toward achieving well-being goals have to turn inward in order to determine how to achieve well-being experiences *for themselves* [29]. *Thus, striving toward well-being is inherently autonomous and, as such, may foster a key aspect of the basic psychological needs that promote flourishing and optimal motivation, as posited by SDT* [33]. In fact, other research found that intrinsic (relative to extrinsic) exercise goals positively predicted psychological needs satisfaction [29]. Thus, to promote physical activity as a key means to daily well-being capitalizes on its potentially inherent autonomous nature and, because of that, may be ideal to facilitate ongoing physical activity motivation and participation among overweight women.

There is significant research showing the connection between physical activity and well-being [8, 85, 128–130]. But women may not make that connection when deciding whether or not to be physically active because the vast majority of physical activity promotions feature health- and weight-related benefits [14, 68]. In support of this contention, our previous research showed that only a minority of women reported being physically active to enhance well-being (12%) or quality of life (22%) [19, 41]. *This is concerning because it suggests that women in midlife have not been socialized to consider physical activity for experiential positive mood enhancing and well-being purposes* [41]. This could be reducing the effectiveness of our social marketing and promotion of physical activity to overweight women. Reframing physical activity as a primary way women can feel better every day (like the American Heart Association has started doing: "*You'll feel better* and your life depends on it" [131]) and the downstream effects from feeling better on meaningful areas of life (more patient parenting, enjoyment and productivity at work, etc.) may better promote sustainable physical activity and, hence, may result in better weight control among overweight women.

4.6. Limitations. There are significant limitations to this study. The effects from this experiment are very small, but that was to be expected from this weak intervention. The purpose of this experiment was a "proof of concept" study to see whether this line of research, investigating whether distinct "gain-frame" messages can immediately impact individuals' regulations and body image, was worth pursuing. We believe the findings suggest this line of questioning merits further research, with an emphasized need for more inductive work to illuminate what physical activity frames will be most motivating and compelling to overweight men as well as obese individuals in general. While we proposed that there might be long-term behavioral implications from promoting physical activity with these different frames, these experimental data do not address nor support a causal connection. Another limitation is our sample. Participants who sign up with companies to regularly take surveys for payment represent a specific population that are likely very different from the general population and may affect how they responded to the questions. For example, our study participants reported extremely high levels of unemployment. While this may impact the generalizability of the findings, the randomized design supports the internal validity of this study. Finally, while this sample was selected by the survey research firm to approximate the US population, it still contained a vast majority of European Americans and thus potentially different framing effects by ethnicity are not known.

4.7. Strengths. This study has many strengths. We used a randomized design to evaluate the immediate framing effects on physical activity behavioral regulations and body image among a large sample of midlife adults who were overweight and obese. Having research that focuses on a specific life stage and population is an important strength because individuals in different life stages have different responsibilities, priorities, and values [43, 44]. Thus, to understand how to optimally promote physical activity to a particular group at risk, it is important to investigate that specific population based on their demographics. In addition, while we kept our focus on investigating adults in midlife, we expanded our targeted program of research on overweight women to include men in order to better understand how gender influences motivational responses to distinct frames for promoting physical activity. *This study advanced the framing literature by investigating and identifying differences in effects by gender, and between participants who are overweight and obese, with a less frequently studied frame (daily well-being) using variables related to SDT and body image. These and other data suggest that how we market and frame physical activity may need to change depending on the demographics: life stage, gender, and BMI status, among other variables* [94, 132].

5. Conclusions

How physical activity benefits are framed in health communications matters. The framing of benefits brands physical activity and influences the specific goals individuals strive to achieve through becoming physically active [41, 43]. Because not all goals are equally motivating [30, 60, 133, 134], *the framing of physical activity has important implications for promoting sustainable physical activity and weight control* [27]. This study showed that there are immediate framing effects on behavioral regulation and body image from simply reading a one-page advertisement about physical activity and that gender and BMI moderate these effects. Overweight women tended to respond positively to the daily well-being frame, especially the intrinsic regulation component of autonomy, while overweight men tended to respond unfavorably toward the daily well-being frame. Research shows that women want their leisure time experiences to reflect freedom of choice and intrinsic experiences [96]. Thus, framing physical activity in ways that are congruent with and reflect women's valued *experiences* might help them internalize the value

of being active, making it more compelling to fit regular physical activity into their busy days [19, 24, 106]. These findings support a growing body of research that suggests that framing physical activity for daily well-being, compared to framing it for weight loss, might enhance autonomy toward physical activity, making it a better gain-frame message for overweight women in midlife [19, 24, 62]. More gender-specific research is needed about how to optimally frame physical activity for overweight men and for obese individuals more generally.

Conflict of Interests

M. L. Segar would like to disclose that she consults with organizations and speaks internationally to behavioral professionals and individuals about creating sustainable exercise motivation and participation (http://michellesegar.com/).

Authors' Contribution

M. L. Segar and C. R. Richardson conceived the study. M. L. Segar, J. A. Updegraff, B. J. Zikmund-Fisher, and C. R. Richardson participated in the study design. M. L. Segar, J. A. Updegraff, and C. R. Richardson participated in the statistical analysis. All authors helped draft, read, and approved the final paper.

Acknowledgments

This research was funded by National Institutes of Health grant UL1RR024986, a grant from the University of Michigan Institute for Research on Women and Gender, and the University of Michigan COPE Fund that supports publishing in open access journals. The authors are grateful to Peter Ubel for his great insights into this framing research question and study design and to Heather Patrick for her analysis suggestions and interpretation of the data on behavioral regulations.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 205393, 9 pages
doi:10.1155/2012/205393

Research Article

Weight Misperceptions and Racial and Ethnic Disparities in Adolescent Female Body Mass Index

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Received 2 December 2011; Revised 6 February 2012; Accepted 17 February 2012

Academic Editor: Simone Lemieux

This paper investigated weight misperceptions as determinants of racial/ethnic disparities in body mass index (BMI) among adolescent females using data from the National Survey of Youth 1997. Compared to their white counterparts, higher proportions of black and Hispanic adolescent females underperceived their weight status; that is, they misperceived themselves to have lower weight status compared to their clinically defined weight status. Compared to their black counterparts, higher proportions of white and Hispanic adolescent females misperceived themselves to be heavier than their clinical weight status. Oaxaca-Blinder decomposition analysis showed that accounting for weight misperceptions, in addition to individual and contextual factors, increased the total explained portion of the black-white female BMI gap from 44.7% to 54.3% but only slightly increased the total explained portion of the Hispanic-white gap from 62.8% to 63.1%. Weight misperceptions explained 13.0% of the black-white female BMI gap and 3.3% of the Hispanic-white female BMI gap. The regression estimates showed that weight underperceptions were important determinants of adolescent female BMI, particularly among black and Hispanic adolescents. Education regarding identification and interpretation of weight status may play an important role to help reduce the incidence and racial disparity of female adolescent obesity.

1. Introduction

The prevalence of obesity has reached epidemic proportions in the past few decades. Among adult females, disparities in obesity rates exist between non-Hispanic white women compared with both non-Hispanic black and Hispanic women whose respective obesity prevalence rates were 33.0%, 49.6%, and 43.0% in 2007-2008 [1]. The data show that these disparities are already present in adolescence. In fact, the current racial/ethnic obesity disparity among adolescent girls is striking with the prevalence rate for non-Hispanic black girls of 29.2% being more than twice the rate for non-Hispanic white girls of 14.5% [2]. Hispanic female youths are also heavier than their non-Hispanic white counterparts with an obesity prevalence rate of 17.5%, which is 21% higher than the rate among white female youths. The existing weight disparities at adolescence are of concern and suggest that future disparities may grow even further given that obesity tracks into adulthood [3]. It is important to understand the underlying factors that contribute to these disparities because obesity is associated with a series of negative health outcomes such as diabetes, heart disease, and cancer, and labor market outcomes related to wages and income [4–6].

A number of previous studies tried to explain the racial/ethnic disparities in adolescent weight outcomes by examining racial/ethnic differences in household socioeconomic status (SES) and differences in economic and environmental contexts. The relationship between obesity and SES was found to be complex, and it varied by race/ethnicity. For example, Gordon-Larsen et al. (2003) found an inverse relationship between overweight prevalence and SES for white adolescent females but overweight prevalence did not decrease with increased SES for either black or Hispanic teen girls. Using simulation analyses, the study showed that the racial/ethnic variation in overweight remained even when adolescents had similar SES, which suggests that other factors

beside SES might be responsible for the weight disparities [7]. Consistent with Gordon-Larsen et al. (2003) findings, Wang and Zhang (2006) found a negative relationship between SES and weight for white teens, but no clear relationship was found for black teens [8]. A recent study that examined parental SES along with economic contextual variables found that these factors altogether explained a large portion of the racial/ethnic weight gap for adolescent males but not for females and, in particular, explained the least amount (only 44%) of the racial gap in body mass index (BMI) between black and white adolescent females [9].

Previous studies did not directly account for the importance of social and cultural differences in weight perceptions as potential contributors to racial/ethnic disparities in weight outcomes. Weight misperception, the discrepancy between individual perceptions of weight status and actual weight status based on clinical definitions of weight, is believed to be an important factor in the development of obesity, given that the rising prevalence of obesity was paralleled by a higher incidence of weight misperceptions [10, 11]. Studies showed that between 1988–1994 and 1999–2004 there was an increase in weight misperceptions, particularly among overweight and obese individuals who were more likely to misperceive their weight as clinically normal or healthy [10, 11]. Evidence shows that the inability to correctly diagnose one's clinical weight status as overweight is strongly associated with the increased risk for obesity [10, 12–15]. These findings could play an important role in explaining the higher incidence of obesity among minorities, as well as the overall trends in obesity prevalence [14, 15].

Evidence suggests that there are important racial/ethnic differences in weight perceptions. These differences are related to how permissive one's social and cultural norms are towards excessive weight gain, with black and Hispanic norms concerning weight and weight gain being more permissive than the corresponding white norms [16–18]. A number of recent studies reported that weight misperceptions were more pronounced among black and Hispanic youths who were more likely to underestimate or underperceive their clinical weight status [19–21].

There is a large body of literature investigating racial/ethnic differences in weight perceptions. It was recognized that the predominant Western white culture emphasizes the importance of physical appearance for female success and life satisfaction, with the ultrathin female body being attainable and ideal [22–24]. The sociocultural theoretical model proposed by Stice [22] suggested that racial/ethnic groups with non-Western cultures of origin may not internalize the ultrathin ideal body image embraced by the Western culture and may not place as much value on physical appearance as a means for female success and life satisfaction. As a result, individuals belonging to nonwhite groups may have different weight perceptions when compared to their white counterparts [23–25].

Cultural group attitudes towards weight may influence individual weight status perception through body weight satisfaction, perceived desirability, and perceived attractiveness. There is evidence of racial/ethnic differences in the perception of attractiveness and romantic desirability as a function of body size, with blacks and Hispanics preferring larger body sizes than whites [16, 17, 26]. Barroso and colleagues [16] reported that black and Hispanic adolescent males perceived heavier girls as more desirable than their thinner counterparts. Lower social stigma was associated with being overweight among blacks, with black males also reporting much less stigma than white males when thinking about dating a heavy female [17]. Research indicates that in describing beauty and attractiveness, female black teens placed less emphasis on physical characteristics and more emphasis on psychological traits, whereas white teens were more likely to associate beauty with thinness and were more likely to believe that thinness enhanced their romantic appeal [15, 18, 27–29]. In addition, black women and teens reported substantially higher levels of body shape and size satisfaction compared to their white and Hispanic counterparts [30–33].

The observed racial/ethnic differences in body satisfaction can be partially explained by differences in body ideals, with black and Hispanic youths having heavier body ideals than whites [16, 34]. Rucker and Cash (1992) found that in a sample of 104 black and white college student females there was no racial/ethnic difference in the perception of own weight. However, they found racial/ethnic differences in body size ideals, with black youths preferring larger body size as ideals than whites [35]. Fitzgibbon et al. (2000) examined differences between body image and body ideals and found that body dissatisfaction occurred at lower BMI levels for white women when compared with their black and Hispanic counterparts [36]. White women reported dissatisfaction at BMI levels corresponding to clinically normal weight, whereas black and Hispanic women did not report body dissatisfaction until they were almost clinically obese. Kronenfeld and colleagues (2010) also found that black women chose smaller silhouettes to represent their current size than their white counterparts, and they reported a preference toward larger silhouettes when compared to the ideal silhouettes preferred by white women [34].

This paper contributes to the existing literature by examining the importance of weight misperceptions as a contributor to racial/ethnic weight disparities among adolescent females. We use a decomposition method to assess the importance of weight misperceptions in addition to differences in individual, parental, and contextual factors. Specifically, our study examines whether weight misperceptions are important determinants of BMI for adolescent females and the extent to which racial/ethnic differences in weight misperceptions explain part of the racial/ethnic disparities in BMI for adolescent females.

2. Data

This paper used individual-level data from the National Longitudinal Survey of Youth 1997 (NLSY97). The NLSY97 is administered in the USA by the Bureau of Labor Statistics and follows annually a representative cohort of youths who were aged 12–17 in the first year of the survey, 1997. It contains a large body of information on SES and individual characteristics. This paper used the first four waves of the survey (1997–2000). Our initial sample consisted of

8,822 person-year observations on an unbalanced panel of 3,378 nonpregnant female adolescents who were living at home and were 18 years of age or younger. In order to be able to match our price data to the NLSY97 data, we restricted our sample to female adolescents who lived in the same or contiguous counties for which price matches were available. This reduced our sample to 5,904 person-year observations on an unbalanced panel of 2,615 female adolescents. Finally, the estimation sample was restricted to include only observations with nonmissing information on all of the covariates examined in the study. Our final estimation sample included 5,035 person-year observations on an unbalanced panel of 2,134 female adolescents living in 312 different counties across the USA This study was approved by the Institutional Review Board of the University of Illinois at Chicago.

2.1. Outcome Measures. The outcomes of interest were the ethnic disparities in BMI between non-Hispanic black (hereafter referred to as black) and non-Hispanic white (hereafter referred to as white) adolescent females (black-white) and between Hispanic and white adolescent females (Hispanic-white). BMI was calculated as weight (in kilograms) divided by height squared (in meters) using self-reported weight and height collected in each year of the survey.

2.2. Weight Misperception Measure. Indicators for weight misperceptions were constructed as the difference between the survey respondents' perception of their weight status and their actual weight status based on clinical definitions of weight. Each wave of the survey contained a question that asks "How would you describe your weight?" The response to this question was used to create four perceived weight categories: perceived underweight (equaled 1 if "very underweight" or "slightly underweight," 0 otherwise), perceived normal (equaled 1 if "about normal," 0 otherwise), perceived overweight (equaled 1 if "slightly overweight," 0 otherwise), and perceived obese (equaled 1 if "very overweight," 0 otherwise). Each survey respondent was also classified into one of the four weight categories as defined by the Center for Disease Control and Prevention (CDC) age and gender specific growth charts (underweight if BMI percentile <5th percentile; normal weight if 5th percentile ≤BMI percentile <85th percentile; overweight if 85th percentile ≤BMI percentile <95th percentile; obese if BMI percentile ≥95th percentile). Three categorical variables for the correctness of clinical weight perceptions were then created as the difference between individuals' perceived weight and their clinical weight category: overperceived weight status, correctly perceived weight status, and underperceived weight status. An individual was defined as having overperceived (underperceived) weight status if she perceived her weight status as being heavier (lighter) than her clinical weight category. In other words, individuals with underperceived weight status misperceived themselves to be "thinner" or "skinnier" than their actual clinical weight status whereas the opposite was true for individuals with overperceived weight status.

2.3. Controls Measures. We controlled for standard individual and household characteristics including age, age of menarche, youth's income (including allowance and wages), hours per week worked by youth, living arrangements (living with both or just one parent), and mother's working status (working full-, part-time, or not working), which were obtained from the youth reports. We also controlled for parental income and mothers' education as proxies for household SES. Information on parental income (including wages and salary, investments, child support, and social assistance), in each wave, was collected from the parental questionnaire, and data regarding mother's education (less than high school, high school, some college and more) was obtained from both the parental questionnaire and the youth reports.

In addition, we controlled for a number of contextual factors that may contribute to weight disparities. We included measures of fast food prices and food at home prices obtained from the American Chamber of Commerce Researchers Association (ACCRA). These price data were matched to each wave of the NLSY97 sample based on the closest city match available in the ACCRA data using the county-level geocode identifier. Only observations for which price matches from the same or contiguous county were available were included in our analyses. An additional categorical indicator that controlled for prices matched on the same versus contiguous county was added to all the analyses. We also controlled for the commercial food and activity environment using outlet density measures of available food stores (supermarkets/grocery stores and convenience stores), restaurants (fast food restaurants and full-service restaurants), and commercial physical activity-related outlets obtained from business lists created by Dun & Bradstreet (D&B). The outlet density measures were matched by county and year and were defined as the number of outlets per 10,000 capita. The price and outlet measures are described in greater detail elsewhere [37]. Finally, we also controlled for median county-level household income and for the type of residence: urban, suburban, or rural, based on Census 2000 data merged to the NLSY97 by the county-level geocode identifiers.

3. Empirical Models

A standard Oaxaca-Blinder decomposition analysis [38, 39] was performed to determine the extent to which weight misperceptions explained the racial/ethnic BMI gaps among adolescent females. This methodology decomposes the observed racial/ethnic disparities in BMI into two main components: explained and unexplained portions. The explained portion is calculated as the interaction between the racial/ethnic differences in the endowments of explanatory factors and the average estimated effects. The explained portion is therefore of main interest because it measures how much of the racial/ethnic difference in BMI can be "explained" in terms of the differential endowments of explanatory factors. The unexplained portion is calculated as the interaction between the population endowments and the weighted average of estimated coefficients by race/ethnicity

and therefore can be interpreted as the differential response to the determinants of BMI by each racial/ethnic group. To avoid a well-known index number problem associated with Oaxaca-Blinder decomposition, we implement a widely used alternative proposed by Neumark [40], which uses the estimated coefficients from the pooled regression as the average estimated effects. Several recent studies applied this methodology to studying disparities in public health including gender differences in smoking [41], cross-country differences in obesity between the USA and Canada [42] and Spain and Italy [43], and racial/ethnic differences in BMI between black-white and Hispanic-white adolescents [9]. In addition to the results from the decomposition analysis, we present results from the pooled cross-sectional ordinary least squares (OLS) analyses by racial and ethnic subgroups. The standard errors are robust and two-way clustered at the individual and county level [44].

Our two main hypotheses are that (1) weight misperceptions are important determinants of BMI for adolescent females, and (2) racial/ethnic differences in weight misperceptions explain part of the racial/ethnic BMI gap for adolescent females previously unexplained by standard control measures. A substantial increase in the explained portion due to racial/ethnic differences in weight misperceptions would indicate that policies that reduce the racial/ethnic differences in weight misperceptions may help reduce racial/ethnic differences in health outcomes.

4. Results

4.1. Descriptive Statistics. Table 1 shows the summary statistics by race/ethnicity for BMI, weight misperceptions, individual and household characteristics, parental SES, and economic contextual factors. On average, white adolescent females had lower BMI by 2.2 units and 0.9 units compared to their black and Hispanic counterparts, respectively. These differences are equivalent to 13.2 lbs and 5.4 lbs difference, respectively, for an average 15-year-old female with a height of 5′5″.

On average, compared to white adolescent females, black adolescents were more than twice as likely to underperceive their clinical weight status, perceiving that they were lighter than they actually were and Hispanic adolescents were almost one quarter more likely to do so (12.9% for whites versus 28.6% for blacks and 15.9% for Hispanics). Compared to black adolescents, white and Hispanic adolescent females were more likely to overperceive their clinical weight status thinking that they were heavier than they were (14.1% for blacks versus 24.9% for whites and 22.3% for Hispanic adolescents). The majority of all female adolescents, though to a lesser extent for blacks, correctly perceived their weight status (57.3% for blacks versus 62.2% for whites and 61.8% for Hispanic adolescents).

4.2. Weight Misperceptions by Weight Categories. Table 2 presents descriptive statistics of the weight misperceptions by actual clinical weight categories across the three racial/ethnic groups. Except for the overweight adolescents who correctly identified their personal weight status category, there were no other statistically significant differences between white and Hispanic adolescent girls. In contrast, statistically significant differences between black and white adolescent girls were found for all weight status categories, except for the clinically underweight adolescents and the overweight adolescents who overperceived their weight. For all weight status categories, white adolescents were, on average, less likely to underperceive their actual weight status than their black counterparts. In particular, 15.0% of overweight white adolescents underperceived their weight status compared to 44.9% of overweight black female adolescents and 59.0% of obese white adolescents underperceived their weight compared to 72.7% of obese black female adolescents.

4.3. Decomposition Results. The contribution of weight misperceptions to the "explained" part of the racial/ethnic BMI gaps is shown in Table 3. The base model (Model 1) included the standard individual and household characteristics as well as economic contextual variables. Model 2 added the weight misperception covariates to Model 1.

The base model, Model 1, explained 44.7% of the black-white disparity in adolescent female BMI (column 1) and 62.8% of the Hispanic-white disparity in BMI (column 4). Adding the weight misperception covariates in Model 2 raised the total explained portion of the black-white BMI disparity to 54.3% (column 2) but dropped the portion attributable to individual and environmental contextual characteristics from 44.7% in Model 1 to 41.3% in Model 2. This result suggests that the explanatory power previously assigned to individual and economic contextual factors was in part due to racial differences in weight misperceptions. When the weight misperception covariates were added, the total explained portion of the BMI disparity for Hispanic-white females remained almost unchanged increasing from 62.8% to 63.1%. As shown in Table 3, weight misperceptions explained only 3.3% of the Hispanic-white BMI gap in Model 2. These results suggest that weight misperceptions previously omitted in Model 1 were important and independent determinants of the black-white racial disparity in BMI but less important for the Hispanic-white ethnic disparity in BMI: the portion attributable to weight misperceptions was about 13.0% for the black-white gap compared to 3.3% for the Hispanic-white BMI gap. Weight misperceptions therefore contributed significantly to the total explained portion of the black-white BMI gap making up 23.9% of the total explained portion (13.0% of the total 54.3% total explained) but contributed only modestly to the Hispanic-white total explained BMI gap, making up only 5.2% of Hispanic-white total explained portion (3.3% of the total 63.1% explained).

4.4. Regression Results. To further understand the contribution of weight perceptions to BMI across race/ethnicity, Table 4 shows the results for the pooled cross-sectional OLS results of the determinants of BMI. The excluded category for weight misperceptions was the correctly perceived weight

Table 1: Summary statistics: means (SD) and frequencies.

	White $N = 2{,}697$	Black $N = 1{,}316$	Hispanic $N = 1{,}022$
Outcome measure			
Body mass index	21.56 (3.81)	23.80[a] (5.57)	22.43[a,b] (4.56)
Weight perceptions			
Overperceived weight status	24.90%	14.10%[a]	22.30%[b]
Correct	62.20%	57.30%[a]	61.80%[b]
Underperceived weight status	12.90%	28.60%[a]	15.90%[a,b]
Individual and household characteristics			
Age	15.78 (1.82)	15.81 (1.85)	15.70 (1.94)
Age of menarche	12.22 (1.51)	11.64[a] (1.69)	11.79[a,b] (1.75)
Youth income	794.60 (1,554)	545.80[a] (1,176)	592.60[a] (1,854)
Hours per week worked by youth	12.21 (14.37)	10.82[a] (14.95)	10.19[a] (15.26)
Youth lives with one biological parent	21.00%	50.40%[a]	30.10%[a,b]
Mother does not work	17.50%	21.70%[a]	26.70%[a,b]
Mother works part time	20.40%	11.90%[a]	16.00%[a,b]
Mother works full time	62.10%	66.40%[a]	57.30%[a,b]
Urban residence	70.61%	76.96%[a]	90.00%[a,b]
Suburban residence	9.59%	6.64%[a]	4.51%[a]
Rural residence	19.80%	16.40%[a]	5.49%[a,b]
Parental socioeconomic status			
Parental income ($1982–1984)	39,357 (31,885)	18,922[a] (25,479)	21,450[a,b] (28,114)
Mother not completed high school	8.70%	18.20%[a]	37.80%[a,b]
Mother completed high school	35.90%	42.50%[a]	34.40%[b]
Mother completed more than high school	55.40%	39.30%[a]	27.80%[a,b]
Neighborhood food, physical activity, and socioeconomic contextual factors			
Price of fast food	2.76 (0.16)	2.74[a] (0.20)	2.84[a,b] (0.20)
Price of food at home	1.09 (0.10)	1.09 (0.12)	1.14[a,b] (0.17)
Fast food restaurants (per 10,000 capita)	2.36 (0.82)	2.60[a] (0.86)	2.32[b] (0.63)
Full-service restaurants (per 10,000 capita)	10.54 (2.93)	11.34[a] (4.48)	11.08[a] (3.25)
Grocery stores (per 10,000 capita)	3.00 (1.44)	4.14[a] (2. 55)	3.04[b] (1.78)
Convenience stores (per 10,000 capita)	1.96 (1.14)	2.48[a] (1.71)	1.52[a,b] (0.96)
Physical activity outlets (per 10,000 capita)	3.68 (1.14)	3.24[a] (1.47)	2.97[a,b] (1.20)
County level median household income ($2000)	44,194 (10,417)	39,209[a] (10,020)	43,390[b] (12,001)

Summary statistics are weighted using the NLSY sampling weights.
SD is standard deviation.
[a]Statistically different than whites at $P \leq 0.05$; [b]Statistically different from blacks at $P \leq 0.05$.

status. The results show a significant positive association between underperceived weight status and BMI for all races/ethnicities, and this association was found to be larger for black and Hispanic adolescents. White adolescent females who underperceived their weight status were estimated to have, on average, higher BMI by 1 unit when compared to white adolescents who correctly identified their weight status. Weight underperception by black and Hispanic adolescent females was associated with 3.8 and 2.2 higher BMI units, respectively, when compared to the corresponding adolescent females who correctly identified their weight status. Weight over-perceptions were not associated with BMI for any of the racial/ethnic subgroups.

5. Discussion

In this paper, we investigated racial/ethnic differences in weight misperceptions and their contribution towards racial/ethnic disparities in adolescent female BMI. Overall, more than one-half of female adolescents correctly identified their weight status, with statistically significantly more whites and Hispanics doing so compared to their black counterparts (62.2%, 57.3%, and 61.8% for white, black, and Hispanic adolescent females, resp.). On the one hand, white and Hispanic adolescent females were more likely to over-perceive their weight status compared to black adolescent females, thinking they were heavier than they were clinically

Table 2: Frequencies of weight perceptions by race and ethnicity and by weight categories.

	White			Black			Hispanic		
	Over perceived weight status	Correctly perceived weight status	Under perceived weight status	Over perceived weight status	Correctly perceived weight status	Under perceived weight status	Over perceived weight status	Correctly perceived weight status	Under perceived weight status
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Underweight	44.40%	55.60%	—	64.30%	35.70%	—	41.40%	58.60%	—
Normal Weight	26.70%	62.40%	10.90%	17.30%[a]	68.00%[a]	14.70%[a]	24.70%[b]	64.30%	11.00%[b]
Overweight	12.00%	73.00%	15.00%	8.50%	46.60%[a]	44.90%[a]	16.50%[b]	62.50%[a,b]	21.00%[b]
Obese	—	41.00%	59.00%	—	27.30%[a]	72.70%[a]	—	38.70%	61.30%
N	655	1652	345	183	739	367	222	623	159

Summary statistics are weighted using the NLSY sampling weights.
[a]Statistically different from whites at $P \leq 0.05$; [b]Statistically different from blacks at $P \leq 0.05$.
Underweight: BMI percentile <5; normal weight:85> BMI percentile ≥5; overweight: 95> BMI percentile ≥85; obese: BMI percentile ≥95.

Table 3: Percentage contributions from decomposition model of racial and ethnic disparities in adolescent body mass index.

	Black-white adolescent females (BMI gap = 2.2 units) $N = 4013$		Hispanic-white adolescent females (BMI gap = 0.9 units) $N = 3719$	
(Column)	(1)	(2)	(3)	(4)
Variables	Model 1	Model 2	Model 1	Model 2
Individual, parental, and economic contextual factors	44.72%	41.36%	62.81%	59.83%
Weight misperceptions		12.96%		3.31%
Total percentage explained	44.72%	54.32%	62.81%	63.13%

Variables included in each category correspond to the list shown in Table 1.

(24.9%, 14.1%, and 22.3% for white, black, and Hispanic adolescent females, resp.). On the other hand, compared to white adolescent females, more than twice as many black adolescents and close to one quarter more Hispanic adolescents underperceived their weight status, thinking they were lighter than they were clinically (12.9%, 28.6%, and 15.9% for white, black, and Hispanic adolescent females, resp.). In particular, almost three times more overweight black adolescents and 40% more overweight Hispanic adolescents underperceived their weight status when compared to their overweight white counterparts. In addition, 23% more obese black adolescents underperceived their weight status when compared to their obese white counterparts.

We found that weight misperceptions were particularly important factors in explaining the black-white BMI gap for adolescent girls, increasing the total explained portion of the BMI disparity from 44.7% to 54.3%. When added to the Hispanic-white BMI model, weight misperceptions increased the total explained portion of the BMI disparity just slightly from 62.8% to 63.1%. Weight misperceptions explained 13.0% and 3.3% of the black-white and Hispanic-white BMI gaps, respectively. The large increase in the total explained portion of the black-white BMI gap from the inclusion of weight misperceptions (from 44.7% to 54.3%, an approximate 10 percentage points increase) was close to the same size as the explained portion attributable to the weight misperception variables (13.3%), which suggests that previously omitted weight misperceptions are important determinants of the black-white racial disparity in adolescent female BMI that were not accounted for by the individual, household, and contextual controls.

In addition, weight underperceptions were significantly associated with higher BMI for all adolescent girls but to a greater extent for black and Hispanic adolescents. This suggests that not only do the differences in misperceptions contribute to the explained racial/ethnic BMI gaps, but the differential association of underperceptions with BMI further exacerbates the unexplained part of the disparity.

This paper is subject to a number of limitations. First, height and weight were self-reported. Second, the ACCRA price data had a number of limitations, which included: the data were only collected in a limited number of cities and metropolitan areas; the data were based on establishment samples that reflect a higher standard of living; and ACCRA did not always sample the same cities continuously and hence the data were not fully comparable over time [45] Third, the outlet density count measures were subject to count error and we were limited to using SIC codes which may have classification errors [46]. Fourth, the geographic identifiers in the NLSY97 data only allowed us to control for

Table 4: Regressions estimates of adolescents body mass index, regression coefficients (SE).

Variables	White	Black	Hispanic
Overperceived weight status	0.22	−0.57[b]	0.44
	(0.16)	(0.42)	(0.29)
Underperceived weight status	0.96***	3.75***[a]	2.21***[b]
	(0.34)	(0.52)	(0.70)
N	2,697	1,316	1,022

* Significant at $P \leq 0.10$; ** Significant at $P \leq 0.05$; *** Significant at $P \leq 0.01$.
SE is standard error.
All regressions control for individual and household characteristics, parental socioeconomic status, and neighborhood food, physical activity, and socioeconomic contextual factors.
[a]Estimate is statistically significantly different to the estimate for whites at $P \leq 0.05$.
[b]Estimate is statistically significantly different to the estimate for whites at $P \leq 0.10$.

the economic contextual measures at the county level rather than at more proximate levels. Fifth, smaller sample sizes among the gender-racial/ethnic subgroups may have limited statistical power in our regression analyses that assessed the differential associations with BMI by race and ethnicity. Finally, differences in other social and cultural factors such as immigration generation to the USA, social support, and stress, as well as dietary and physical activity preferences may contribute to the racial/ethnic disparities and deserve further attention in future disparities-related obesity research.

Despite these limitations, several key and interesting results emerged from our analyses. We documented that compared to white adolescents, higher percentages of black and Hispanic adolescent females underperceived their weight status. This disparity was particularly prevalent between black and white overweight adolescent females. These study findings are consistent with a recent study where black and Hispanic adults reported self-perceived health status as higher than their actual clinical health status [47]. Positive attitudes toward health and weight, in particular, among black and Hispanic adults may have a protective effect against certain eating disorders such as anorexia nervosa [23]. At the same time, however, these perceptions may pose a serious problem with respect to increased risk of obesity.

In addition, our estimation results showed that weight underperceptions were significantly associated with adolescent female BMI for all three racial/ethnic groups, particularly for black and Hispanic adolescents for which the estimated association was higher than for whites. These results, although compelling, document only the association between weight underperceptions and female adolescents BMI. Further research is needed to clearly establish potential causality.

Overall, the study results suggest that policies aimed at reducing the obesity epidemic and the racial/ethnic BMI gap should try to address the racial/ethnic differences in weight misperceptions through early education regarding the interpretation and identification of one's weight status. Adjustments in perceptions may help to reduce disparities in weight outcomes, particularly between black and white adolescent females, and help to reduce related health disparities. Given that weight misperceptions are formed at the individual level but are often influenced by cultural norms, there may be an important role for school-based identification of clinical overweight and obesity status to help reduce the incidence of obesity among adolescent females.

Acknowledgments

Support for this research was provided by the National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health (R01DK81335-01A1), and the Robert Wood Johnson Foundation Bridging the Gap ImpacTeen project. The views expressed herein are solely those of the authors and do not reflect the official views or positions of the National Institutes of Health or the Robert Wood Johnson Foundation.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 180176, 9 pages
doi:10.1155/2012/180176

Research Article

Overweight Adolescents' Self-Perceived Weight and Weight Control Behaviour: HBSC Study in Finland 1994–2010

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Received 4 November 2011; Revised 15 February 2012; Accepted 26 March 2012

Academic Editor: Pedro J. Teixeira

Introduction. Overweight and perception of being overweight, may lead adolescent to lose weight. The aim of the present study was to investigate overweight adolescents' self-perceived weight, body dissatisfaction, and weight control behaviour during 1994–2010 in Finland. *Methods*. The country-representative, cross-sectional data of 15-year olds were obtained from the Health Behaviour in School-aged Children (HBSC) study, conducted in 1994 ($N = 1194$; males: 48%), 1998 ($N = 1545$; 49%), 2002 ($N = 1745$; 50%), 2006 ($N = 1670$; 47%), and 2010 ($N = 2082$; 48%). *Results*. The majority of overweight boys (62–69%) and girls (89–100%) assessed themselves as too fat, and their body image was lower than in nonoverweight adolescents. The highest prevalence of current weight controlling was found in 2006 in males (18%) and in 2010 in females (39%). *Conclusion*. The phenomena were current and gender differences notable, but there was no statistically significant difference in overweight adolescents' self-perceived weight, body dissatisfaction, or weight control behaviour between survey years.

1. Introduction

The proportion of overweight and obese adolescents has increased in the Western world and the trend is predicted to continue [1]. Finland is no exception, and depending on the definitions used, approximately 10 to 20% of Finnish adolescents are considered overweight or obese [2]. In a comparative study of 41 countries, the overweight and obesity prevalence in Finnish 15-year-old adolescents was a bit higher than the average of 17% in boys and 10% in girls [3]. Slightly higher percentages than average were also obtained in the proportion of adolescents regarding themselves as a bit or much too fat (males: 22% in Finland versus 21% on average; females: 45% versus 41%). The proportions can be assumed to be even higher among the subgroup of overweight young people, who have been shown to be less content with their bodies than adolescents of normal weight [2, 4, 5].

Likely due to increased levels of obesity and the great value placed on a thin appearance, attempts to lose weight have become more widespread among adolescents [6]. Paradoxically, repeated dieting to lose weight may lead to weight gain via long-term adoption of fasting followed by overeating or decreased breakfast consumption [7]. Extreme dieting has been associated with eating disorders as well as other negative psychological outcomes, such as lower self-esteem in adolescents [6–9].

The prevalence of adolescents' weight control behaviour increases with higher body mass index [10–12]. It has been stated that overweight adolescents may adopt extreme weight control practices because they are further from their ideal weight or have failed to lose weight by means of modest eating or changes in exercise [13]. Obesity, body dissatisfaction, low self-esteem, a feeling of poor life management, and anxiety in young people are connected with weight-reduction behaviour [7, 14, 15]. Overweight and obese children and adolescents have again lower body satisfaction than their nonoverweight peers [16, 17]. However, the perception of overweight rather than the actual weight appears to be the potent force leading to weight-reduction behaviour [4]. According to some studies, acceptance of body size and shape is common amongst overweight teenagers, although some have attempted to lose weight [18].

Factors that protect susceptible adolescents from adopting unhealthy weight-control practices include positive body image [9]. Body image is a multidimensional construct with attitudinal, perceptual, and behavioural components [19]. It

evolves and changes under biological, psychological, social, and cultural influences [20, 21]. The majority of body image disturbances begin during adolescence, although their occurrence has been reported at younger ages [22]. Negative body image predicts weight control behaviour, which may manifest itself in unhealthy actions, for example, fasting, purging, smoking, extreme diets, or training [6, 23, 24]. Body image problems and weight concerns are related to eating disturbances [24, 25], low self-worth [26–28], depressive moods [29, 30], and suicidal ideation [31].

The increasing rate of overweight and obese adolescents has been a public health concern in Finland, and several actions to tackle this problem have been taken. However, less attention has been paid to overweight adolescents' perceptions of their weight and their attempts and practices to control their weight. The purpose of this study was firstly, to monitor overweight 15-year olds' self-perceived weight from 1994 to 2010 and determine the prevalence of body dissatisfaction and secondly, to survey the prevalence of weight control behaviour (i.e., attempts to lose weight and use of specific weight control practices) in the same group during the 2000s in Finland.

2. Materials and Methods

2.1. The Survey. The empirical data for the study were obtained from the Finnish data of the Health Behaviour in School-Aged Children (HBSC) study. The HBSC study comprises cross-national research conducted by an international network of research teams in collaboration with the World Health Organization Regional Office for Europe. The overall goal of the HBSC study is to gain new insights into and increasing the understanding of health behaviour, lifestyles, and their context in young people. The scope of the HBSC study covers the measurements of a comprehensive variety of behaviours, ranging from those that are a risk to health to those that promote health. As well as running the monitoring survey, the HBSC study also seeks to influence the development of programmes and policies in order to promote the health of young people at both national and international levels. The survey questions span a range of health indicators and health-related behaviour as well as the life circumstances of young people. The questions provide information on demographic factors; health behaviour including physical activity; eating and dieting; well-being indicators including body mass index and body image [32].

2.2. Participants. The cross-sectional data were collected through school-based surveys; anonymous, standard questionnaires were issued to a nationally representative sample of 15-year-olds in Finland between March and May in 1994, 1998, 2002, 2006, 2010. The mean age of respondents has been 15 years and 10 months (SD = 4 months) throughout the sampling years of 1994 to 2010. Standard cluster sampling was followed regionally and conducted in accordance with the structure of the national education system. The primary sampling unit was the school, and the participating class from the school was randomly selected.

Table 1: Number of adolescents in the cleaned research data and response rates (%) by gender and survey year.

	1994	1998	2002	2006	2010
	Number of adolescents				
Boys	576	770	870	781	992
Girls	618	775	875	889	1090
Total	1194	1545	1745	1670	2082
	Response rate (%)				
Boys	89	89	87	83	94
Girls	99	99	92	86	97
Total	89	88	88	85	96

The number of the schools involved in the survey was 64 in 1994; 85 in 1998; 100 in 2002; 99 in 2006; and 128 in 2010. The number of pupils in the research data as well as the response rate for each survey year is presented in Table 1. The data cleaning process and data management in detail are presented elsewhere [3, 34].

2.3. Measures. In the HBSC survey, heights and weights, as well as other measures, are based on self-reports. The respondents were asked to indicate their weight in kilograms and height in centimeters. Body mass index was calculated by dividing weight in kilograms by the square of height in meters (kg/m^2) for each respondent. The adolescents' weight statuses were categorised by means of the IOTF age- and gender-specific BMI cut-off points represented by Cole et al. [33]. In the present study, the group of overweight adolescents include obese participants if not otherwise noted. All BMI values under the thresholds for overweight were classified as nonoverweight (i.e., normal and underweight).

Self-reported variables are subject to random error and to systematic reporting bias. However, Strauss [10] reported that over 90% of youth aged 12–16 years were correctly classified as normal-weight or obese based on self-reported heights and weights. More modest results have been obtained in some other studies [35, 36], but the studies by Himes et al. [37] and Haines et al. [38] reported again high correlations between reported and measured BMI in adolescents. To evaluate the reliability of the present survey, the stability of the responses to the questions concerning weigh and height, as well as all measures presented below, was investigated by test-retest correlations. These correlations were based on two similar questionnaires completed within a fortnight by 13- and 15-year-old schoolchildren (N = 194) from the provinces of Eastern and Western Finland in 2005 [34]. Almost all the respondents indicated the same weight on both measurements (Intraclass correlations ICC = .99; 95% Confidence interval CI = .99-.99), whereas the stability in self-reported height was found to be only acceptable (ICC = .63; 95% CI = .54–.70).

To assess perceived weight, the adolescents were asked whether they perceived their body as "much too thin"; "a bit too thin"; "about the right size"; "a bit too fat"; or "much too fat." For the clarity of presentation, we combined the replies of the first two options ("much too thin" and "a bit too

Table 2: Prevalence (%) of overweight with 95% confidence intervals (CI) in 15-year-old Finnish adolescents by survey year.

	1994	1998	2002	2006	2010
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Boys	n = 550	n = 750	n = 849	n = 748	n = 943
Overweight[1]:	12.6 (9.5–16.3)	13.2 (11.0–15.7)	17.9 (15.9–20.1)	19.9 (16.8–23.5)	17.5 (15.0–20.2)
Preobese[2]	11.3 (8.4–14.9)	11.5 (9.3–14.1)	15.0 (13.0–17.1)	16.4 (13.7–19.6)	14.2 (12.0–16.7)
Obese[3]	1.3 (0.5–3.0)	1.7 (1.0–3.0)	2.9 (1.8–4.6)	3.5 (2.2–5.4)	3.3 (2.3–4.6)
Girls	n = 601	n = 754	n = 860	n = 854	n = 1026
Overweight[1]:	4.3 (2.9–6.3)	8.6 (7.0–10.5)	9.4 (7.5–11.7)	12.4 (10.4–14.8)	11.0 (9.1–13.2)
Preobese[2]	3.5 (2.2–5.5)	7.7 (6.2–9.5)	8.0 (6.4–10.0)	10.8 (8.9–13.0)	8.8 (7.2–10.6)
Obese[3]	0.8 (0.4–2.0)	0.9 (0.4–1.9)	1.4 (0.8–2.4)	1.6 (0.9–2.8)	2.2 (1.4–3.6)

n = Number of adolescents who reported their weight and height in the sample.
[1]Criteria for overweight: IOTF [33]. The criteria for overweight include obesity.
[2]Prevalence of adolescents whose BMI exceeded the age and gender specific cut off point for overweight but not for obesity (corresponds to the threshold of 25 kg/m^2 for adult overweigh).
[3]Prevalence of adolescents whose BMI exceeded the age and gender specific cut off point for obesity (corresponds to the threshold of 30 kg/m^2 for adult obesity).

thin"), as well as the last two options ("a bit too fat" or "much too fat"), and these joint replies are shown in the findings. The test-retest stability in self-perceived weight were found to be excellent (ICC = .81; 95% CI = .76–.85) [34].

To identify those adolescents who were trying to lose weight at the time of taking part in the survey, respondents were asked to indicate if they were at present on a diet or doing something else to lose weight. Possible responses were "Yes"; "No, but I should lose some weight"; "No, my weight is fine"; and "No, because I need to put on weight." The additional question, "Have you gone on a diet, changed your eating habits or done something else to control your weight during the last 12 months?," assessed the occurrence and duration of weight control practices. The 12-month period was chosen to cover seasonal variations. Six affirmative answer options for this question were from "Yes, for a few days" to "Yes, for 6 months or more." Those respondents whose answer was "yes" were then asked to indicate which of the listed practices they used to control their weight during the previous 12 months. Listed weight control practices were exercising; skipping meals; fasting (i.e., going without food for 24 or more hours); eating fewer sweets; eating less fat; drinking fewer soft drinks; eating less (smaller amounts); eating more fruits and/or vegetables; drinking more water; restricting diet to one or more food groups (i.e., eat only fruits and vegetables, liquids only, eat only bread, and water); vomiting; using diet pills or laxatives; smoking more; dieting under the supervision of a professional. The test-retest stability of the responses to weight control practices varied from excellent (skipping meals; fasting; restricting diet; vomiting; smoking more) to poor (eating fewer sweets; drinking fewer soft drinks). The stability of responses in attempts to control weight during the previous 12 months was found to be excellent (ICC = .90; 95% CI=.87–.92) [34].

The Body Image Investment (BIS), presented by Orbach and Mikulincer [39], is a measure of emotional investment in the body. The scale consists of four subscales, each composed of six items. The first subscale, which was included in the Finnish survey in 2006 and 2010, refers to feelings and attitudes regarding body image and contains six items: (1) I am frustrated with my physical appearance; (2) I am satisfied with my appearance; (3) I hate my body; (4) I feel comfortable with my body; (5) I feel anger toward my body; (6) I like my appearance in spite of its imperfections. The respondents were instructed as follows: here are some statements about one's feelings of his/her body. There are no right or wrong answers. We would like to know your feelings about your body. Please evaluate how the statements relate to you by checking the degree to which you agree or disagree with each one of statement. Scale scores were obtained by summarising the items (items 1, 3, and 5 were scored in the reverse direction). The scale range was 6–30, the higher score indicating the better body image. The test-retest stability of the responses to the BIS items varied from excellent (item 1: ICC = .77; 95% CI = .70–.82) to acceptable (item 6: ICC = .68; 95% CI = .59–.75) [34].

2.4. Statistical Analysis. The prevalence estimates for data points 1994, 1998, 2002, 2006, and 2010 are presented separately for each gender. For analyses in this paper, PASW Statistics software (version 18) was used. However, more precise variance estimates can be calculated by specifying and using the exact sample design. Therefore, when calculating 95% confidence intervals to determine if the differences in the prevalences were significant, analyses were made by Stata statistical software (version 12). The possible lack of precision in variance estimation due to cluster sampling of this study was thus taken into account by using Stata procedures for complex survey designs [40].

3. Results

3.1. Prevalence of Overweight and Obesity. Within genders, none of the differences in the prevalence of overweight between survey years was statistically significant (Table 2). However, the proportion of overweight boys increased linearly from 13% in 1994 to 20% in 2006. The corresponding

Table 3: Prevalence (%) of self-perceived weight with 95% confidence intervals (CI) among 15-year-old overweight adolescents by survey year.

	1994	1998	2002	2006	2010
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Overweight boys	$n = 69$	$n = 99$	$n = 152$	$n = 149$	$n = 165$
Too thin	2.9 (0.8–10.2)	1.0 (0.1–7.2)	1.8 (0.6–5.4)	2.2 (0.7–6.6)	2.4 (0.9–6.4)
About right	31.4 (20.8–44.5)	29.6 (21.6–39.0)	36.0 (27.7–45.1)	32.4 (24.5–41.4)	33.9 (26.6–42.1)
Too fat	65.7 (54.0–75.8)	69.4 (59.7–77.6)	62.2 (53.4–70.3)	65.5 (56.2–73.7)	63.6 (55.3–71.2)
Overweight girls	$n = 26$	$n = 65$	$n = 81$	$n = 106$	$n = 113$
Too thin		0.0	0.0	1.0 (0.1–7.0)	1.8 (0.4–6.9)
About right		9.4 (4.4–19.0)	1.2 (0.2–8.4)	5.9 (2.7–12.5)	9.7 (5.6–1.6)
Too fat	100.0	90.6 (81.0–95.6)	98.8 (91.6–99.8)	93.1 (86.2–96.6)	88.5 (81.7–93.0)

n = Number of overweight adolescents in the sample.

proportions for girls were 4% and 12%, respectively. Results from the 2010 survey revealed a turning point; linear increase in the proportions of overweight adolescents seemed subsided in both genders. Between genders, boys reported statistically significantly higher levels of overweight than girls throughout the study period.

The prevalence of obesity increased from 1% in 1994 to 4% in 2006 in boys and from 1% in 1994 to 2% in 2010 in girls (Table 2). Nevertheless, none of the differences between years or genders was statistically significant according to the prevalence estimates and their 95% confidence intervals. Due to low number of cases in the obesity group, we combined the preobese and obese cases and refer to them as overweight in the later text.

3.2. Self-Perception of Weight in Overweight Adolescents. There were no statistically significant differences in self-perception of weight among overweight adolescents between survey years of 1994–2010 (Table 3). Two-thirds of overweight boys and some 90% of overweight girls reported perceiving their bodies as too fat. Corresponding prevalences for nonoverweight adolescents varied from 9 to 14% in boys and from 37 to 43% in girls (data not shown). Overweight boys reported that they believe their body is about the right size statistically more often than overweight girls throughout the study period (Table 3).

The mean values of Emotional Investment in the Body (BIS) scores were statistically significantly lower in overweight adolescents than in nonoverweight adolescents in both genders and in both 2006 and 2010 surveys (Table 4). The higher scores of BIS indicate a better body image. The BIS mean values for girls were significantly lower than for boys in both weight status groups (i.e., in overweight and nonoverweight). Within genders or weight status groups, there were no statistically significant differences in the mean values of BIS scores between years 2006 and 2010.

3.3. Weight Control Behaviour in Overweight Adolescents. The proportions of overweight adolescents engaged in weight control behaviour at the time of filling in the survey surged from 3% in 1994 to 18% in 2006 in 15-year-old overweight boys and from 19% in 1994 to 39% in 2010 in 15-year-old overweight girls (Table 5). The prevalences of current weight controlling for nonoverweight adolescents varied from 2 to 4% in boys and from 5 to 14% in girls during 1994–2010 (data not shown).

Table 4: Mean values of the Emotional Investment in the Body (BIS) scores and 95% confidence intervals (CI) in overweight and nonoverweight 15-year-old adolescents in 2006 and 2010.

	BIS mean value[1] (95% CI)	
	2006	2010
	Boys	
Overweight[2]	20.9 (20.1–21.7)	21.2 (20.5–21.9)
Nonoverweight[3]	22.7 (22.3–23.1)	23.6 (23.3–23.9)
	Girls	
Overweight[2]	17.4 (16.4–18.3)	16.7 (15.5–17.9)
Nonoverweight[3]	19.9 (19.5–20.5)	19.9 (19.3–20.1)

[1]Emotional Investment in the Body (BIS) score range from 6 to 30, the higher the better.
[2]Overweight include obesity.
[3]Nonoverweight include normal and underweight.

Based to the prevalence estimates and their 95% confidence intervals presented in Table 5, the difference in the prevalence rates of current weight controlling was statistically significant between years 1994 and 2006 in overweight boys. On the other hand, there was no statistically significant difference between years 2006 and 2010. In contrast to boys, the highest prevalence (39%) in current attempts to lose weight during the study period was observed in 2010 in overweight girls. None of the differences in the prevalences between survey years was statistically significant in overweight girls. Between genders, the difference in the prevalence of current weight controlling was statistically significant in 1998, 2002, and 2010.

There were no statistically significant differences within genders in the proportions of overweight adolescents, who gave an affirmative answer to the question of "Have you gone on a diet, changed their eating habits, or done something else to control your weight during the last 12 months?" between years 2002, 2006, and 2010 (Table 5). Based the

Table 5: Prevalence (%) of attempts to control weight with 95% confidence intervals (CI) among overweight adolescents by survey year.

	Current[1] weight controlling % (95% CI)				
	1994	1998	2002	2006	2010
Overweight boys	2.5 (0.6–9.9)	9.3 (5.1–16.3)	12.3 (7.5–19.6)	17.8 (12.6–24.6)	13.3 (9.0–19.2)
Overweight girls	19.2 (8.3–38.3)	26.2 (16.4–38.9)	33.3 (23.6–44.8)	28.6 (21.2–37.2)	39.3 (31.0–48.2)
	During previous 12 months[2] % (95% CI)				
Overweight boys			26.9 (19.8–35.5)	25.9 (18.8–34.6)	21.5 (15.8–28.5)
Overweight girls			70.9 (60.1–79.8)	56.4 (45.9–66.4)	62.5 (52.3–71.7)

[1] Prevalence of overweight adolescents who were on a diet or did something else to control their weight at the time of filling in the survey form.
[2] Prevalence of overweight adolescents who had gone on a diet, changed their eating habits or done something else to control their weight at some point during the last 12 months leading up to the survey; available from 2002.

prevalence estimates and their 95% confidence intervals, attempts to control weight during the previous 12 months were significantly more common among overweight girls (56–71%) than boys (22–27%) in 2002, 2006 and 2010. The corresponding prevalences for nonoverweight adolescents varied from 5% in 2010 to 8% in 2002 in boys and from 38% in 2010 to 50% in 2002 in girls (data not shown).

There was no statistically significant difference between years 2002, 2006, and 2010 in the prevalence rates of using specific weight control practices among overweight adolescents who had tried to control their weight (Table 6). The most common indicated weight control practices were exercising (>85%), eating fewer sweets (>84%) and less fat (>75%), and drinking fewer soft drinks (>74%). Throughout the study, a higher proportion of overweight girls than boys, who have tried to control their weight, indicated to have used all the specific weight control practices with exception of skipping meals and eating fewer sweets in 2006. However, statistically significant differences between genders were found only in eating smaller portions in 2002 and 2010, and smoking more in 2006.

4. Discussion

The current study monitored the prevalence rates of self-perceived weight and weight control behaviour among overweight adolescents in Finland. There were no significant differences in self-perception of weight between the survey years of 1994, 1998, 2002, 2006, and 2010. It seems that the prevalence of self-perceived overweight has remained stable in the 2000s among the overweight Finnish adolescents after the decrease during 1979–1999 reported in the Adolescents Health and Lifestyle Survey [2]. It also appears that the increased prevalence of obesity in the surrounding society has not greatly influenced the criteria of an ideal body type among adolescents, that is, the reference for "desired weight" has not been made more relaxed. The vast majority of 15-year-old overweight adolescents perceived their bodies as too fat, their body image was lower than in nonoverweight adolescents, and attempts to lose weight were prevalent especially among overweight girls across the study period.

The unhappiness with body weight and engagement in weight control behaviour showed a clear gender difference, as overweight girls reported more often their discontent than the overweight boys. The gender discrepancy in the self-perception of body weight was remarkable: some 90% of overweight 15-year-old females felt that they are either "a bit too fat" or "much too fat," whereas the corresponding proportion for males remained under 70% throughout the study period of 1994–2010. Overweight girls were also more likely to report weight control behaviour compared to boys. The above findings may be a positive indication of girls' better health awareness, or alternatively, the results can be interpreted as a negative indication of more intense appearance pressure to be thin. These indications may also be related to each other: adolescent girls are often focused on appearance and weight loss in describing the aspects of the healthy eating [15, 41].

The prevalence of weight-related teasing has remained stable among both overweight and nonoverweight adolescents in the USA during 1999–2004 [38]. Some studies even claim that the stigmatisation of obesity by children and adolescents has risen [13, 42]. Bullying has been found to have a significant impact on the young people's desire to lose weight [17, 43]. Bullying because of body size has also been found to be associated with dieting and unhealthy weight loss practices, even regardless of adolescents' weight status [43]. This might be one explanation why girls with and without overweight were discontent with their bodies and, more commonly than boys, tried to lose weight. Girls in particular are pointed out as overweight, and they will receive directives to lose weight from both girls and boys more often than boys do [17]. Haines and her coauthors [38] propose that the increase in obesity among youth may have resulted in relaxed body size and shape standards particularly for males, whereas the ideal female weight and shape has remained unchanged. The focus of body-related teasing among males may have moved to muscularity instead of body weight. Results from a study of muscle dissatisfaction in young adult men in Finland [44] also support this presumption.

The prevalence of weight control behaviour at the time of filling in the survey was statistically significantly higher in 2006 compared to 1994 in 15-year-old overweight boys. However, the difference between genders was more notable. Even in 2006, when the highest prevalence (18%) of current dieting in boys was found, considerably higher proportion (26%) of overweight girls was engaged in weight control. In addition, compared to one in four overweight boys, every second of overweight girls answered that they have gone on

Table 6: Prevalence (%) of reported use of specific weight control practices with 95% confidence intervals (CI) among 15-year-old overweight adolescents who have done something to control their weight during the last 12 months by survey year.

	Overweight boys			Overweight girls		
	2002	2006	2010	2002	2006	2010
	Weight control practice % (95% CI)					
Exercise	83.3 (65.1–93.1)	88.9 (74.0–95.7)	88.2 (71.8–95.7)	94.5 (84.2–98.3)	100.0	94.2 (85.5–97.8)
Skipped meals	43.9 (29.2–59.7)	44.4 (29.5–60.4)	32.4 (19.0–49.3)	48.1 (36.1–60.4)	40.4 (28.2–53.8)	52.2 (40.1–64.1)
Fasting	4.9 (1.2–17.5)	8.3 (2.9–21.6)	11.8 (4.3–28.2)	11.1 (5.4–21.6)	14.8 (7.4–27.5)	15.4 (8.0–27.5)
Eat fewer sweets	90.2 (77.2–96.2)	97.2 (83.2–99.6)	85.3 (68.8–93.8)	96.3 (86.1–99.1)	93.0 (82.8–97.3)	100.0
Eat less fat	83.3 (69.2–91.8)	80.6 (66.1–89.8)	79.4 (62.4–90.0)	92.7 (81.9–97.3)	93.0 (82.2–97.4)	80.6 (67.8–89.1)
Drink fewer soft drinks	73.8 (58.1–85.1)	86.1 (70.9–94.0)	88.2 (71.9–95.7)	85.2 (72.5–92.6)	91.1 (80.4–96.2)	82.1 (67.9–90.8)
Eat less/smaller amounts	52.4 (39.3–65.2)	63.9 (49.3–76.3)	55.9 (39.8–70.8)	79.6 (67.3–88.1)	78.9 (65.1–88.3)	86.8 (77.0–92.5)
Eat more fruits/vegetables	70.7 (55.7–82.3)	80.6 (62.0–91.3)	67.6 (49.1–81.9)	83.3 (71.3–91.0)	87.7 (76.1–94.1)	88.2 (76.6–94.5)
Drink more water	73.2 (55.7–85.5)	75.0 (56.4–87.4)	61.8 (44.3–76.6)	89.1 (78.6–94.8)	80.7 (68.0–89.2)	76.5 (64.3–85.5)
Restrict diet	9.5 (3.6–23.1)	30.6 (16.9–48.8)	8.8 (2.8–24.6)	18.9 (10.5–31.5)	19.6 (11.4–31.7)	18.2 (10.6–29.4)
Vomiting	2.4 (0.3–14.8)	2.8 (0.4–17.6)	15.2 (6.5–31.4)	9.3 (4.1–19.5)	17.5 (10.2–28.5)	15.2 (8.2–26.3)
Use pills or laxatives	2.4 (0.4–15.1)	2.8 (0.4–17.6)	2.9 (0.4–18.6)	3.7 (1.0–13.3)	8.8 (3.9–18.6)	1.5 (0.2–10.2)
Smoke more	7.1 (2.4–19.2)	2.8 (0.4–17.7)	5.9 (1.4–21.2)	16.7 (9.2–28.4)	14.0 (25.0–86.0)	9.1 (4.1–19.1)
Diet under supervision	2.4 (0.3–15.2)	2.8 (0.4–17.6)	5.9 (1.5–20.3)	5.6 (1.9–15.4)	5.4 (1.9–14.5)	7.6 (3.3–16.4)

a diet, changed their eating habits, or done something else to control their weight during the 12 months previous of the survey in 2006.

Even though the weight control behaviour was common among overweight adolescents, and especially among girls, the majority of the overweight adolescents' weight control practices could be considered safe: exercising and eating fewer sweets were the most commonly indicated weight control practices. Unhealthy weight control practices have been found to become more common among overweight adolescents in the USA during 1999–2004 [6]. Our findings do not indicate the same development in Finland, even when taking into account the difference in the manner of representation of the results (i.e., overall prevalence versus prevalence within those who have tried to control their weight). However, based on the prevalence of attempts to lose weight among overweight adolescents, and their responses regarding weight control practices in this study, weight control is difficult when you already have overweight even with the knowledge of practices and motivation induced by self-perceived fatness and body dissatisfaction. The current environment is obesogenic and carries conflicting demands for young people. Thinness is idolised and obesity stigmatised and concurrently, meals and snacks high in fat and sugar are encouraged to be eaten, and quick commercial solutions for weight loss are advertised [45].

In Finland, the prevention of childhood and adolescent obesity has received attention both nationally and locally in the 2000s, and the projects appear to be fruitful: there was a slight—but not statistically significant—decrease in the proportion of overweight in adolescents in 2010 compared to the rates in 2006. However, it has been stated that obesity prevention projects may lead to stigmatisation [46] or even to disordered eating and eating disorders, particularly among those with poor body image [47]. There appears to be a false dichotomy between the concerns of adolescent obesity and the body discontent in young people, as these two concerns are tightly interwoven in overweight adolescents' attempts to lose weight.

The findings of our study—overweight adolescents self-perceived overweight, lower body satisfaction, and attempts to lose weight—suggest that in the prevention of adolescent obesity, it is crucial to focus on methods that strengthen the adolescents' self-esteem and do not emphasize body shape and weight. Body satisfaction has been found to protect girls from weight gain even after stabilising the effects of body mass index and sociodemographic factors [48]. It is essential to create favourable conditions for strengthening the factors that provide protection from poor body image—such as good self-esteem, resilience to stress, and faith in self-efficacy—in young people's health promotion. Protective factors reinforce each other, so that the more assets a young person has, the more likely he or she is to engage in health-promoting behaviour [49].

The low prevalence of obesity (1–3%) together with limited sample sizes can be considered to be a limitation of this study; quantitative studies of only a few obese respondents were therefore not practical. Adolescents' self-reported and measured heights and weights have been found to be highly correlated, but generally a bias of underreporting body weight will contribute to an underestimation of the prevalence of overweight [50]. Therefore, the prevalence of overweight in Finnish adolescents may be higher than reported herein.

The HBSC study relies on adolescents' self-report, which raises questions about the reliability of the answers. The stability of the responses was investigated by a test-retest study in 2005 in Finland and was found to be acceptable. In addition, the self-assessment is in some cases the only way to obtain information about a phenomenon. However, adolescents may interpret the concepts of being on a diet and weight control differently than do adults or health professionals [51]. Further research is also needed on how and on what grounds young people assess their body [35], and more versatile indicators of self-perceived weight and weight controlling might produce higher validity of the measurement. Kautiainen [2] concluded that the implications of perceived weight for prevention of obesity and promotion of well-being are complex, because they may differ according to the severity of overweight, the adolescent's maturational, and psychological status as well as gender. It should be noted that while obesity is one of the most powerful predictors of body dissatisfaction, the level of discontent, and its consequences vary.

5. Conclusions

Results of this study demonstrated not only the self-reported overweight in Finnish 15-year olds, but also that the majority of overweight adolescents were aware of their weight status. Findings revealed apparent gender differences in self-perception of weight, body dissatisfaction, and in engagement in weight control behaviour among overweight adolescents. The results emphasise the need for further research into the impact of gender on the attitudes towards own weight and the importance of the size and shape of the body.

Acknowledgments

HBSC is an international study carried out in the collaboration with WHO/EURO. For further details, see http://www.hbsc.org/. The International Coordinator of the HBSC study is Candace Currie. The Principal Investigator for Finland is Jorma Tynjälä.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 601872, 8 pages
doi:10.1155/2012/601872

Research Article

Being Normal Weight but Feeling Overweight in Adolescence May Affect Weight Development into Young Adulthood—An 11-Year Followup: The HUNT Study, Norway

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Received 28 September 2011; Revised 9 February 2012; Accepted 15 March 2012

Academic Editor: Simone Lemieux

Objectives. To explore if self-perceived overweight in normal weight adolescents influence their weight development into young adulthood and if so, whether physical activity moderates this association. *Methods*. A longitudinal study of 1196 normal weight adolescents (13–19 yrs) who were followed up as young adults (24–30 yrs) in the HUNT study. Lifestyle and health issues were assessed employing questionnaires, and standardized anthropometric measurements were taken. Chi square calculations and regression analyses were performed to investigate the associations between self-perceived overweight and change in BMI or waist circumference (WC) adjusted for age, age squared, sex, and other relevant cofactors. *Results*. Adolescents, defined as being normal weight, but who perceived themselves as overweight had a larger weight gain into young adulthood than adolescents who perceived themselves as normal weight (difference in BMI: 0.66 units [CI95%: 0.1, 1.2] and in WC: 3.46 cm [CI95%: 1.8, 5.1]). Level of physical activity was not found to moderate this association. *Conclusions*. This study reveals that self-perceived overweight during adolescence may affect development of weight from adolescence into young adulthood. This highlights the importance of also focusing on body image in public health interventions against obesity, favouring a "healthy" body weight taking into account natural differences in body shapes.

1. Introduction

Overweight and obesity are increasing in many parts of the world and are one of the major risk factors causing health problems [1]. Preventing adolescents from becoming obese adults is important for their future health and may reduce health-care costs [2]. Weight control and ideal body shape have evolved to be a main focus not only in health promotion policies but also in commercial businesses. The public is overwhelmed with advertisements and information, resulting in weight norms which are hard to reach for many people and in slimming pressure [3]. Especially girls' psychological wellbeing might be disadvantaged by weight misperception and the wish to lose weight [4].

Paradoxically, as the social pressure for thinness and the associated stigmatization of obesity have increased [5], so has the prevalence of obesity [6] and thus, the discrepancy between desirable body weight and actual body weight has increased [7]. This may easily cause distress [4, 8] and perceived psychosocial stress has, in turn, been found to increase adiposity [9–11], especially central obesity [12].

Adolescence is a period in life when risk behaviors may be established enhancing the risk for diseases in later adulthood [13]. As youth in modern society are overwhelmed by public health messages and commercial information from media, often negatively focused on obesity, this may affect young people's perception of weight norms, particularly in this vulnerable period of life. Weight misperception, especially

self-perceived overweight and slimming behaviors, seems to be highly prevalent among adolescents [8, 14].

Previous studies have mainly focused on obese subjects when documenting that dieting [15] and worries about weight [9] may have a negative impact on health. In this way, body image has been reported to mediate the relationship between obesity and psychological distress [7] and mortality has been associated with intention to loose weight in overweight adults [15]. In adolescents the feeling of overweight, rather than being overweight has been suggested to be associated with psychological wellbeing [11]. Further, body image dissatisfaction has been reported to contribute to suicidal ideation [10] and depression [16]. In a cross-sectional study Perkins et al. [17] noted that adolescents who misperceived peer weight norms toward overweight had a greater risk for being overweight.

Previous studies have focused on several health outcomes in obese people but have not been concerned with the effect that self-perceived overweight in normal weight adolescents might have on subsequent weight gain into adulthood in a longitudinal design. Lessening the psychosocial pressure by improving the weight perception in youth may be an important focus in prevention strategies for counteracting the development of overweight.

Thus, the aims in this longitudinal study were to investigate whether self-perceived overweight in normal weight adolescents might have an impact on the development of their weight into young adulthood and if so, whether physical activity moderated this association.

2. Methods

2.1. Study Population. HUNT, the Health Study of Nord-Trøndelag, is a large-population-based study carried out three times during the last 25 years in the county of Nord-Trøndelag, Norway (http://www.ntnu.no/hunt/). Nord-Trøndelag County (130 000 inhabitants) has a homogenous population and has a geographical, demographical, and occupational structure fairly representative of the whole of Norway, though lacking large cities [18, 19]. The average income and mean educational level are slightly lower than the national average. The socioeconomic inequality in mortality in the region is at the national level [20].

Young-HUNT is the adolescent part (13–19 years) of HUNT. The Young-HUNT 1 survey was carried out in 1995–97 as part of HUNT2. The follow-up study presented in this paper includes participants in Young-HUNT1 who also participated as young adults (24–30 years) in HUNT 3 carried out in 2006–2008.

All students in junior high and senior high schools were invited to participate in Young-HUNT1, and 8408 (83%) completed both a comprehensive questionnaire about life style, health, and quality of life and underwent a clinical examination including anthropometric measures during school hours. A total of 5616 adolescents had a BMI within the normal range according to the International Obesity Task Force's (IOTF) criteria for adolescents defined by Cole et al. [21] and reported no psychological or physical dysfunctions that affected their daily activities. The 59 participants who reported to be pregnant at followup were excluded. Finally, 1196 adolescents who participated in both Young-HUNT1 (aged 13–19 yrs) and as young adults (24–30 yrs) in HUNT 3 were included in the present study (Figure 1).

In HUNT3, data was also collected by comprehensive self-administered questionnaires which included questions on physical and mental health, somatic complaints, and lifestyle. Anthropometric measures were obtained by specially trained nurses using the same standardized protocols as in Young-HUNT1. In both Young-HUNT1 (baseline) and HUNT3 (followup) height and weight were measured to the nearest centimetre, respectively to the nearest half kilogram with light clothes, without shoes, jacket, or outdoor garments. Waist circumference (WC) was measured to the nearest centimetre, applying a nonstretchable band horizontally at the umbilical level after the participants emptied their lungs or midway between the last rib and the iliac cristae if the latter was largest [19].

Predictors at baseline were used to study weight gain, in BMI units (kg/m^2) and centimetres (WC), at followup.

2.2. Variables at Baseline: Young-HUNT1 (1995–97). Self-perceived overweight was defined as feeling "Chubby" or "Very fat" to the question "How do you consider yourself?" The adolescents had to tick off one of the five possible answer categories: very fat, chubby, about the same as others, thin, very thin.

Physical activity was implemented as a continuous variable and was defined as: "outside of school, performing sports or exercise to the point of heavily breathing and/or sweating". We assigned values 1 through 8 to the response options: everyday, 4–6 days a week, 2-3 days a week; 1 day a week; not every week but at least once every two weeks; not every 14th day but at least once a month; less than once a month; never. This physical activity question, also used in the World Health Organization Health Behaviour in Schoolchildren (WHO HBSC) Survey Questionnaire [22], has previously been validated in the Young-HUNT population [22]. Sedentary behaviour is reported to be a risk factor for weight gain in youth [23] and was adjusted for in the analyses. Reading a book, playing or listening to music, watching TV, and doing homework were included in the variable. Social activities were also adjusted for, as these activities have been suggested to be important in the onset and spread of obesity [24]. The following social activities were included: visiting someone, receiving visit, being out with friends, and being at a meeting. To assess sedentary behaviour or social activities we used the following question: "Think back over the last week, the last 7 days. If you did any of the sedentary or social cultural activities listed above, tick off for about how many times you did this." Not once, once, 2 or 3 times, 4 times or more. For each activity, each response alternative was quantified with 1 to 4 and we computed two indices by summing the score for each question, one index for sedentary behaviour and one index for the social activities. These two indices (4–16) were introduced in the models as continuous variables.

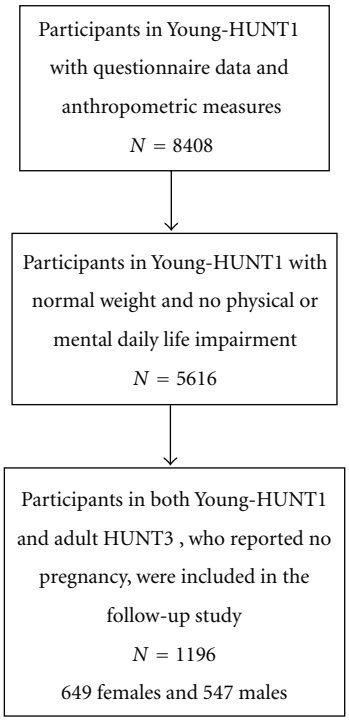

Figure 1: Sampling flow chart.

Eating habits are indicated as being predictors of weight gain from adolescence to adulthood [25]. To assess eating habits the following three questions in Young-HUNT1 were selected and used as continuous variables: "How often do you usually eat breakfast?" Answer categories were: every day, 4–6 days a week, 1–3 days a week, seldom or never and "How often do you do you eat" any of these items: "Vegetables" or "Fruits" each with five answer categories: more than once a day, once a day, every week but not every day, seldom, never.

2.3. Variables Used at Followup, HUNT3 (2006–08). Weight status in the followup population was defined, according to WHO recommendations, using BMI $\geq$ 25 kg/m^2 as overweight and BMI $\geq$ 30 kg/m^2 as obesity [26]. Central overweight was defined as WC $\geq$ 80 cm for females and WC $\geq$ 94 cm for males [26, 27]. Central obesity was defined as WC $\geq$ 88 cm or $\geq$102 cm, for females and males, respectively [26, 28].

The physical activity index was the product of frequency, intensity and duration scales of physical activity from the adult questionnaire [29]. A range from 0 through 15 was used as a continuous variable in the regression models.

Socioeconomic status (SES) was measured at followup in HUNT3 (2006–08) reclassifying the first digit in the Norwegian occupation classification (STYRK) into an approximation to the Erikson Goldthorpe Portocarero social class scheme (higher-grade professionals, lower-grade professionals, nonmanual employees, small proprietors, artisans and farmers, lower grade technicians, and unskilled workers) [30].

3. Statistics

Descriptive statistics were used to compare data for the Young-HUNT1 participants, included in the present study, with the total Young-HUNT1 population from which the final study sample was selected.

Separate independent t-tests were used to test age- and gender-specific differences in mean anthropometric measures at both baseline and followup comparing adolescents with and without self-perceived overweight and, in addition, comparing those who became overweight or obese at followup with those who did not.

Likelihood ratio Chi square were calculated from 2×2 contingency tables to determine the differences in prevalence of overweight and obesity status at followup between those reporting self-perceived overweight and those who reported no self-perceived overweight at baseline.

To deal with the possible differences in baseline BMI between the group who perceived themselves as overweight and the group who perceived themselves as about normal weight, we investigated the association between self-perceived overweight and weight gain from adolescence into young adulthood. Weight gain, that is, change in overall adiposity (delta BMI) was calculated by subtracting BMI at baseline from BMI at followup. The same calculation was done in regard to change in central adiposity (delta WC). Both BMI and WC were employed because they may reflect different aspects of adiposity.

In separate models, adjusted linear regression was used to examine the relationships between self-perceived overweight at baseline and weight gain (delta-BMI and delta-WC) as outcome variables. With an age span from 13 to 19 years at baseline it was expected that the youngest girls and boys should have a larger weight gain due to normal growth compared to the oldest participants and that the relationship between age and body mass was not linear. Since age was such a strong confounder we adjusted for age and age square. Additionally, we also adjusted for sex in the first model (model I).

In the second linear regression model the association was also simultaneously adjusted for the following factors at baseline: physical activity, eating habits (i.e., frequency of eating breakfast, fruits, or vegetables), social activities, sedentary behaviour, and at followup: socioeconomic status (SES) and physical activity.

Interaction between self-perceived overweight and sex was tested by introducing a cross-product term (self-perceived overweight $*$ sex) in the second model. Also possible interactions between self-perceived overweight and physical activity were tested in additional models by introducing respectively a cross-product term (self-perceived overweight $*$ physical activity) in one model implying physical activity at baseline and in another model physical activity at followup.

4. Ethics

All participants and guardians of adolescents younger than 16 years signed an informed consent to participation and

Table 1: Comparison of baseline and follow-up characteristics between adolescents who perceived themselves as overweight (74% girls, 26% boys), despite not being overweight versus those who did not perceive themselves as overweight (50.6% girls, 49.4% boys). ($n = 1196$).

	Baseline characteristics					Follow-up characteristics				
	Self-perceived overweight		No self-perceived overweight		P value	Self-perceived overweight		No self-perceived overweight		P value
		SD		SD			SD		SD	
BMI	21.8	1.7	20.4	1.7	N.S.	26.5	3.8	24.4	3.3	<0.001
Height	166.9	8.1	169.9	8.3	N.S.	170.3	8.0	173.7	9.1	<0.001
Weight	60.8	6.9	59.0	7.1	N.S.	77.0	13.3	74.0	13.0	<0.001
WC	71.9	5.5	70.0	5.9	N.S.	90.7	11.3	85.5	10.5	0.005
Age	15.9	1.8	15.9	1.8	N.S.	27.3	1.9	27.2	1.9	N.S.

Baseline BMI, height, weight, and WC are age adjusted.
BMI: body mass index in kg/m^2 and WC (waist circumference) in centimetres.
N.S.: not significant.

Table 2: The percentages of the normal weight adolescents (baseline, $n = 1196$) who became overweight or obese in young adulthood (followup). Adolescents who perceived themselves as overweight (self-perceived overweight) were compared to those who perceived themselves as normal weight.

		Overweight at followup			Obese at followup		
		Self-perceived overweight	No self-perceived overweight	P value	Self-perceived overweight	No self-perceived overweight	P value
Girls	BMI (%)	59	31	<0.001	16	6	<0.001
	WC (%)	78	55	<0.001	51	31	<0.001
Boys	BMI (%)	63	48	<0.05	23	10	<0.001
	WC (%)	55	29	<0.001	37	10	<0.001

BMI: overweight BMI $\geq$ 25 kg/m^2, obese BMI $\geq$ 30 kg/m^2. WC: overweight WC $\geq$ 80 cm and 94 cm, WC: obese WC $\geq$ 88 cm and $\geq$102 cm, respectively, in female and male adults.
Adolescents classified as normal weight who reported psychological or physical dysfunctions and those who reported pregnancy at followup were excluded.

use of data in research. Participation in the HUNT study was voluntary and approved by the Norwegian Data Inspectorate, the Directorate of Health and recommended by the Regional Committee for Medical Research Ethics, who also approved the present study.

5. Results

Totally, 649 girls and 547 boys participated in both Young-HUNT1 (baseline) and HUNT3 (followup) and met the inclusion criteria of having normal weight, not being pregnant, and without mental or physical impairment at baseline. Mean age at baseline was 15.9 years (SD: 1.8) both in girls and boys and mean BMI was 20.7 kg/m^2 (SD: 1.9) in girls and 20.4 kg/m^2 (SD: 1.8) in boys. More girls (22%) than boys (9%) reported self-perceived overweight. These values were not significantly different in those who participated in Young-HUNT1 and met the inclusion criteria but did not participate at followup (HUNT3) (data not shown). Mean age at followup was 27.2 years (SD: 1.9) in females and 27.1 (SD: 1.9) in males and mean BMI was 24.4 kg/m^2 (SD: 3.7) in females and 25.3 kg/m^2 (SD: 3.1) in males.

Using t-tests adjusted for age, no significant differences were found between the baseline characteristics of the normal weight adolescents perceiving themselves as overweight compared to those not perceiving themselves as overweight (Table 1). However, the differences between the follow-up characteristics were statistically different.

About half of the adolescents remained normal weight ($18.5 \leq$ BMI < 25 kg/m^2) as young adults (56% girls and 49% boys) while 30% of girls and 41% of boys became overweight and 8% of girls and 9% of boys became obese. The remaining percentages in girls and boys were classified as underweight and were as such not focused on in this paper. Using WC, slightly more girls (28%) compared to boys (21%) were defined as overweight, and substantially more girls (34%) than boys (9%) were defined as obese at followup.

At followup, overweight and obesity were more common among girls and boys who perceived themselves as overweight at baseline compared to those who did not perceive themselves as overweight. Adjusting for age did not change the prevalence data substantially (Table 2).

In the linear regression models, adjusted for age, age square and for sex, self-perceived overweight was significantly associated with weight gain into young adulthood. During the 11 years follow-up period, adolescents who perceived themselves as overweight had a mean difference in overall weight gain (delta BMI) that was 0.88 BMI units larger than those who did not report self-perceived overweight. Additionally, adjusted for all relevant confounders, adolescents who reported self-perceived overweight had a

higher gain of 0.66 BMI units than those, who did not report self-perceived overweight (Table 3). The difference between the two groups was significant ($P = 0.011$).

In relation to central adiposity using delta WC, the gain for the normal weight adolescents reporting self-perceived overweight was 3.46 centimetres more than those who did not reported self-perceived overweight, adjusted for all relevant confounders. The difference between the 2 groups was significant at $P < 0.001$.

When repeating the linear regression analyses stratified for sex, the effect estimates seemed higher in girls than in boys (Delta BMI in girls *B*: 0.89, CI: 0.3–1.5 and in boys *B*: −0.01, CI: −0.89–0.86). Delta WC in girls *B*: 4.1, CI: 2.0–6.2 and in boys *B*: 1.4, CI: −1.3–4.1). However, the linear regression models shown have not been stratified for sex because the interaction terms between self-perceived overweight and sex were not significant (delta BMI: $P = 0.14$ and delta WC: $P = 0.23$).

No statistical significant interactions were found between physical activity measured either at baseline or at follow-up level and self-perceived overweight in the determination of weight gain from adolescence to young adulthood.

Table 3: Multiple linear regression models showing the effect estimates of the associations between perceived overweight in normal weight adolescents and their weight gain into young adulthood measured as overall adiposity (BMI) and central adiposity (WC). Adolescents with normal weight who reported psychological or physical dysfunctions at baseline and pregnancy at followup were excluded. (*n*: 1196).

	B	CI (95%)	*P*
Overall weight gain (BMI)			
Self-perceived overweight			
Model I	0.88	0.4–1.3	<0.001
Model II	0.66	0.1–1.2	0.011
Central weight gain (WC)			
Self-perceived overweight			
Model I	4.32	2.8–5.8	<0.001
Model II	3.46	1.8–5.1	<0.001

Model I adjusted for sex, age, and age square.
Model II: additionally adjusted for physical activity at baseline and followup, sedentary behaviour, SES, social activities and eating habits (eating breakfast, vegetables or fruits).
B: effect estimates, CI: confidence interval, *P*: level of statistical significance.

6. Discussion

In this population based follow-up study normal weight adolescents who felt overweight at baseline had a larger weight gain, both measured as increase in BMI-units and waist circumference, than adolescents who perceived their weight about right. The associations remained significant after adjusting for potential confounding factors. Level of physical activity did not moderate this effect.

Defining overweight and obesity in adolescents is different from adults, as muscularity and sexual maturation [31] may vary at this age and consequently affect BMI. These aspects are, however, accounted for when defining normal weight as suggested by Cole et al. [21] In our study mean BMI was slightly lower in boys compared to girls; this may be due to earlier maturation of the girls. Differences in pubertal timing in adolescence may affect the perception of weight, when comparing one's own weight to peer's weight and could influence weight development. However, early pubertal timing in adolescents with normal body weight in Young-HUNT 1 has been found not to increase the risk of becoming overweight later [31].

In both sexes and in all age groups, mean BMI and mean weight at baseline were slightly higher and mean height slightly lower in those who reported self-perceived overweight compared to those who did not report this, as was the case in those who became overweight or obese at followup compared to those who did not. This could imply that a higher mean BMI might predict higher overall body adiposity in adulthood, as indicated by Singh et al. [32] and Reilly et al. [33], and we cannot totally ignore such an effect. However, the age adjusted differences did not reach statistically significance and in our study mean BMI in both genders and in nearly all age groups were as much as 2 to 3 BMI units beneath the cut-off level defining overweight, as proposed by Cole et al. [21] (varied from 20–23 BMI units corresponding to adult levels). Therefore, we believe that it is unlikely that these modest baseline differences would be responsible for our findings. Furthermore, employing weight gain as outcome we have tried to deal with the differences in baseline adiposity values as good as possible. In addition, we introduced the baseline values of BMI or WC in the respective regression models, but this did not change the results (data not shown). In the final results, we have chosen not to adjust for baseline BMI or WC, because this may also induce a bias [34].

Restricting the study sample to only normal weight adolescents may possibly have induced some selection bias. Because, if the exposure predicts baseline level of the outcome, conditioning on this baseline measure, that is, excluding low- or high-scoring individuals may induce spurious correlations between the exposure and change score [34]. However, since weight misperception may be present more strongly in the overweight and underweight adolescents [12, 35] and our objective was to investigate whether self-perceived overweight would affect weight gain in adolescents with normal weight [21]; our study population was strictly limited to girls and boys with a normal weight.

Weight development may be associated with socioeconomic inequalities [36], but adjusting for socioeconomic status based on vocational status at followup did not change any of the associations substantially.

Social activities were taken into account as possible confounders as suggested by previous studies [24, 37, 38]. We adjusted for physical activity at baseline in addition to physical activity at followup, as previous studies have documented that the current level of physical activity is more predictive of weight development than baseline physical activity level [39, 40]. Introduction of any of the cofactors changed the association.

6.1. Possible Pathways. Weight gain is caused by an imbalance between energy intake and expenditure. However, the development of weight may also be influenced by social factors as parental eating habits and SES, by psychological factors such as comfort eating, reward eating, and emotional eating, and of biological ones, for example, genetics. As Swinburn et al. [41] suggested, it is not only important to support individuals to counteract the effects of obesogenic environments, but the priority should be for policies to reverse the obesogenic nature of these environments.

The higher prevalence of self-perceived overweight among girls than boys in our study is in concordance with previous reports [4, 24]. Overestimating peer weight norms may contribute to self-perception of overweight [24]. This may in itself be experienced as a kind of psychosocial pressure [4, 13, 35], which again may have an impact specifically on abdominal adiposity [12]. Lynch et al. [42] suggested that unrealistic body size goals might be related to weight gain and proposed that, because of cultural focus on thinness, self-perception as overweight may lead to weight-related anxiety. They noted that obese adult women who saw themselves as obese lost weight, while those obese women whose ideal body size was normal weight gained more weight. Also among normal weight adult women and men did those who perceived themselves as slightly too large gain more weight. This supports our findings.

Our data indicate that as adults more boys (9%) than girls (8%) became overall obese expressed in BMI. When applying WC, however, substantially more girls (34%) than boys (9%) were defined as central obese at followup. This gender difference in WC is of such magnitude that an eventual adjustment of the thresholds for obesity classification, according to Katzmarzyk et al. [43], would not influence the results. A reason for such gender difference may be the larger media focus on looks directed towards girls than boys resulting in boys being more satisfied with their weight [8, 44], showing less slimming behaviour [45] and boys might consequently experience less psychosocial stress. According to Bangasser et al. [46], Yuan [4], and Bakker et al. [47], girls are more vulnerable to stress-related psychopathology. If girls are more prone to experience psychosocial pressure than boys, this may reflect the higher prevalence of girls with central obesity at followup as stress is shown to be associated with central obesity [12].

Adolescents seeing themselves as overweight may focus more on food and shift to unhealthy dietary behaviours resulting in weight gain [25]. Our data showed that eating behaviour (i.e., skipping breakfast) contributed significantly in the residual variation in the association between self-perceived overweight and becoming overweight and/or obese. This is in accordance with Mikkilä et al. [8] who found an association between eating behaviour and weight misperception.

The "dieting makes you fat" theory by Cannon and Einzig [48], and the study of Levin [49] on rodents supports the observation that overweight people who repeatedly try to lose weight have a tendency to become overweight again. Our study indicates that this theory also may be applicable in normal weight adolescents who feel overweight.

We investigated perceived pressure to slim by asking the normal weight adolescents: "Are you trying to slim" and defined perceived pressure to slim by combining the answers: "Yes" or "No, but I need to lose weight". The two concepts self-perceived overweight and perceived pressure to slim were highly correlated (R: 0.48 in girls and 0.34 in boys, $P < 0.01$). The effect estimates of perceived pressure to slim on weight gain showed the same tendency as self-perceived overweight did (data not shown).

6.2. Implications and Further Research. Having normal weight and being satisfied with their weight are favourable factors for an adolescent. Weight perceptions are, however, often unrealistic. Girls, in particular, tend to consider themselves as overweight, even though they are not, which may lead to psychosocial stress and unhealthy weight control practices such as skipping meals.

The finding that more girls (34%) than boys (9%) became central obese brings up the question whether girls would be more vulnerable for future comorbidities as for instance cardiovascular diseases. This may be an important public health issue for policy makers. In developing school programs, policy makers should take the relationship between self-perceived overweight and development of overweight into account, while aiming at correcting the weight norms and consequently reduce the obesogenic effect of self-perceived overweight.

Because early intervention in the prevention of overweight is desirable and self-perceived overweight among normal weight adolescents seems to be a risk factor, health policy makers should implement these findings in future development of health interventions. More longitudinal studies are warranted to confirm our findings and explore possible pathways.

7. Conclusion

This study demonstrates that the adolescents, classified as normal weight, though perceiving themselves as overweight, have a larger weight gain into young adulthood than those who do not experience self-perceived overweight. Physical activity seemed not to moderate the effect of self-perceived overweight on this weight gain. Public health interventions aiming to reverse the obesogenic nature of the environment may benefit from focusing on healthy body shapes and the quality of the content and dissemination of the health messages.

Conflict of Interests

The authors declare that they have no conflict of interests.

Acknowledgments

The present study was supported by a grant from The Norwegian Research Council. The Nord-Trøndelag Health Study (HUNT) is a cooperation between the HUNT Research Center, Faculty of Medicine, Norwegian University

of Science and Technology (NTNU), the Norwegian Institute for Public Health, and the Nord-Trøndelag County Council. The authors wish to thank Crystal Lee, Postdoctoral Research Fellow at the Boden Institute of Obesity, Nutrition and Exercise, University of Sydney and Imre Yanszki, Associate Professor at the Department of Public Health and General Practice, NTNU Norway for their help in the statistical part of the study.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 749832, 10 pages
doi:10.1155/2012/749832

Research Article

Understanding the Social Networks That Form within the Context of an Obesity Prevention Intervention

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Received 28 October 2011; Revised 14 February 2012; Accepted 3 March 2012

Academic Editor: Geoffrey C. Williams

Background. Antiobesity interventions have generally failed. Research now suggests that interventions must be informed by an understanding of the social environment. *Objective*. To examine if new social networks form between families participating in a group-level pediatric obesity prevention trial. *Methods*. Latino parent-preschool child dyads ($N = 79$) completed the 3-month trial. The intervention met weekly in consistent groups to practice healthy lifestyles. The control met monthly in inconsistent groups to learn about school readiness. UCINET and SIENA were used to examine network dynamics. *Results*. Children's mean age was 4.2 years (SD = 0.9), and 44% were overweight/obese (BMI $\geq$ 85th percentile). Parents were predominantly mothers (97%), with a mean age of 31.4 years (SD = 5.4), and 81% were overweight/obese (BMI $\geq$ 25). Over the study, a new social network evolved among participating families. Parents selectively formed friendship ties based on child BMI z-score, ($t = 2.08$; $P < .05$). This reveals the tendency for mothers to form new friendships with mothers whose children have similar body types. *Discussion*. Participating in a group-level intervention resulted in new social network formation. New ties were greatest with mothers who had children of similar body types. This finding might contribute to the known inability of parents to recognize child overweight.

1. Background

Although obesity has stabilized in some US populations, it is still at epidemic proportions, with 31.7% of all children 2–19 years of age overweight or obese (BMI $\geq$ 85th percentile) [1]. Anti-obesity efforts often fail [2, 3], and exactly why they fail is still unclear. The discouraging results of many studies, including the largest, most rigorous antiobesity trials to be completed, suggest that interventions must be informed by an understanding of the multifactorial forces shaping obesity-related behaviors, including the social environment [3–6].

Social context influences both the routine practice of healthy behaviors and the establishment of norms. Social networks are implicated in both. Social networks differ from social support. Yet, the terms are often used interchangeably. Methodologically, social support is measured from the respondent's perspective to assess the support (e.g., emotional, cognitive, and tangible support) an individual perceives to have, whereas social networks typically measure the presence or absence of friendships and task- or work-oriented relationships (which may or may not provide support) and treat the ties themselves as objects of study [7]. Social networks, the complex webs of social relationships and social interactions that connect individuals, have been shown to influence behaviors, whereas social support is generally thought not to influence behavior, but rather is considered a mechanism to cope with challenges and facilitate recovery from illness, injury, or disease [8]. Social network analysis allows us to see the whole group of individuals and their interconnectedness, identifying if new ties are established between people and what type of ties result. Weak ties (e.g., acquaintances) can introduce new ideas into a network, whereas strong ties (e.g., close friendships) can facilitate the dissemination of behaviors through a network. Diffusion studies show that people who are well integrated into a community (have many ties) generally adopt behaviors earlier than those who are less integrated (have fewer ties) [9, 10].

Although social networks exert measurable influence on our health [11–21], most of the work conducted focused on existing social networks. However, given that behavioral intervention trials often occur in a group context [22–24], measuring the development of new social networks and the ties that result is warranted. Once this question is answered, we can determine how to utilize this approach to potentially spread desired behaviors through new networks. Therefore, we set out to examine if families participating in a group-based obesity intervention form new social ties and, if so, what type of ties result. The effect of the randomized control trial on adiposity measures has been reported elsewhere [25].

2. Methods

2.1. Study Sample. Consistent with the Institute of Medicine (IOM) [26] and the Strategic Plan for NIH Obesity Research [27], we implemented a community-based, family-centered, culturally tailored obesity prevention randomized controlled trial (RCT). The intervention was designed for Latino families with preschool aged children and implemented in a public recreation center operated by Parks and Recreation in a neighborhood characterized by relatively high Latino concentration and low socioeconomic status. Study inclusion criteria were (1) self-defined Latino/a, (2) with a child aged 3–5 years, (3) valid phone number, and (4) planning on remaining in the city for 6 months. Participants underwent a 30-minute oral consent process in Spanish before providing written consent. Recruitment occurred between October 2008 and February 2009. The intervention occurred between March and June 2009. The study was approved by the Vanderbilt University Institutional Review Board (IRB no. 080673).

Study randomization occurred after baseline data collection. A total of 106 parent-child dyads were randomized, 92 had exposure to treatment and completed baseline data collection, 79 were retained and provided data at the end of the 3-month intervention period, resulting in an 86% retention rate for those who attended their first assigned session of the intervention or control conditions (refer to Figure 1). Analysis of RQ(1) included 79 cases; analysis of RQ(2) included 69 cases.

2.2. Study Design

2.2.1. Intervention Condition. The culturally tailored Salud Con La Familia program was designed to improve nutritional family habits, increase physical activity, and decrease screen time. All sessions were conducted in Spanish by the same trained facilitator. To ensure a sizeable treatment dosage [28], the intervention involved a series of 12 (90 min) weekly group sessions. The intervention was based on a best practice program developed by the National Latino Children's Institute (NLCI) [29]. Participants were randomly assigned to small groups (of 6–8 parent-child dyads) that met as a group throughout the study period. At each session, participants were assigned small group activities to practice the skills they needed to apply the information taught (e.g., how to choose appropriate portion sizes; how to be active with children; how to monitor screen time). Leadership roles were rotated through the group with the intention of increasing perceptions of group cohesion [30].

2.2.2. Control Condition. To guard against differential drop out between intervention and control groups, we offered a brief school readiness program as an alternative to the active intervention [31]. Participants met in groups of 8–12 at 3 times for 60 minutes over the 12-week study period. The program was based on the Dialogic Reading Model—C.A.R. (comment and wait, ask questions and wait, and respond by adding more), an empirically tested curriculum which teaches parents to read picture books with their children [32]. This model lends itself to all parents, including those with low literacy. The sessions were didactic and conducted in Spanish by the same facilitator who conducted the intervention sessions.

Transportation and childcare for siblings were provided to all study participants to overcome the most frequently cited barriers to study participation [33]. Participants received three small incentives after each wave of data collection (e.g., cutting board), totaling $60 per parent-child dyad.

2.2.3. Treatment Fidelity. A treatment fidelity plan was devised following the methodological practices suggested by the Treatment Fidelity Workgroup of the NIH Behavior Change Consortium [34]. The plan included facilitator training; identification of essential treatment components for verification; sampling to ensure treatment consistency; control for differences between interventionists; use of fidelity measures (e.g., frequency of sessions; participation rates). A study team member observed 3 modules of each condition (totaling 25 sessions) and determined that 100% of the intended key messages were fully discussed, all planned activities had occurred, and intervention content was never delivered during control sessions or vice versa.

2.2.4. Randomization. Participants were randomized in equal proportion to each treatment group by using a computer generated permuted block randomization scheme, with blocks of size 10. A biostatistician generated the randomization list and placed the assignments into nontransparent envelopes, which were sealed and numbered consecutively. After consent, participants received from the research coordinator the next numbered allocation envelope which was opened by the participant. The treatment assignment and number listed on the envelope were recorded by the research coordinator and the participant. Neither researchers nor participants were blinded to participant group allocation.

2.3. Data Collection. All data were collected in Spanish by trained data collectors at the community recreation center at baseline and at completion of the 3 month intervention.

2.4. Measures

2.4.1. Social Network. A social network survey was developed to assess change in social relationships over the course of the study period by capturing presence and absence of ties before and after the intervention. The full names of all study

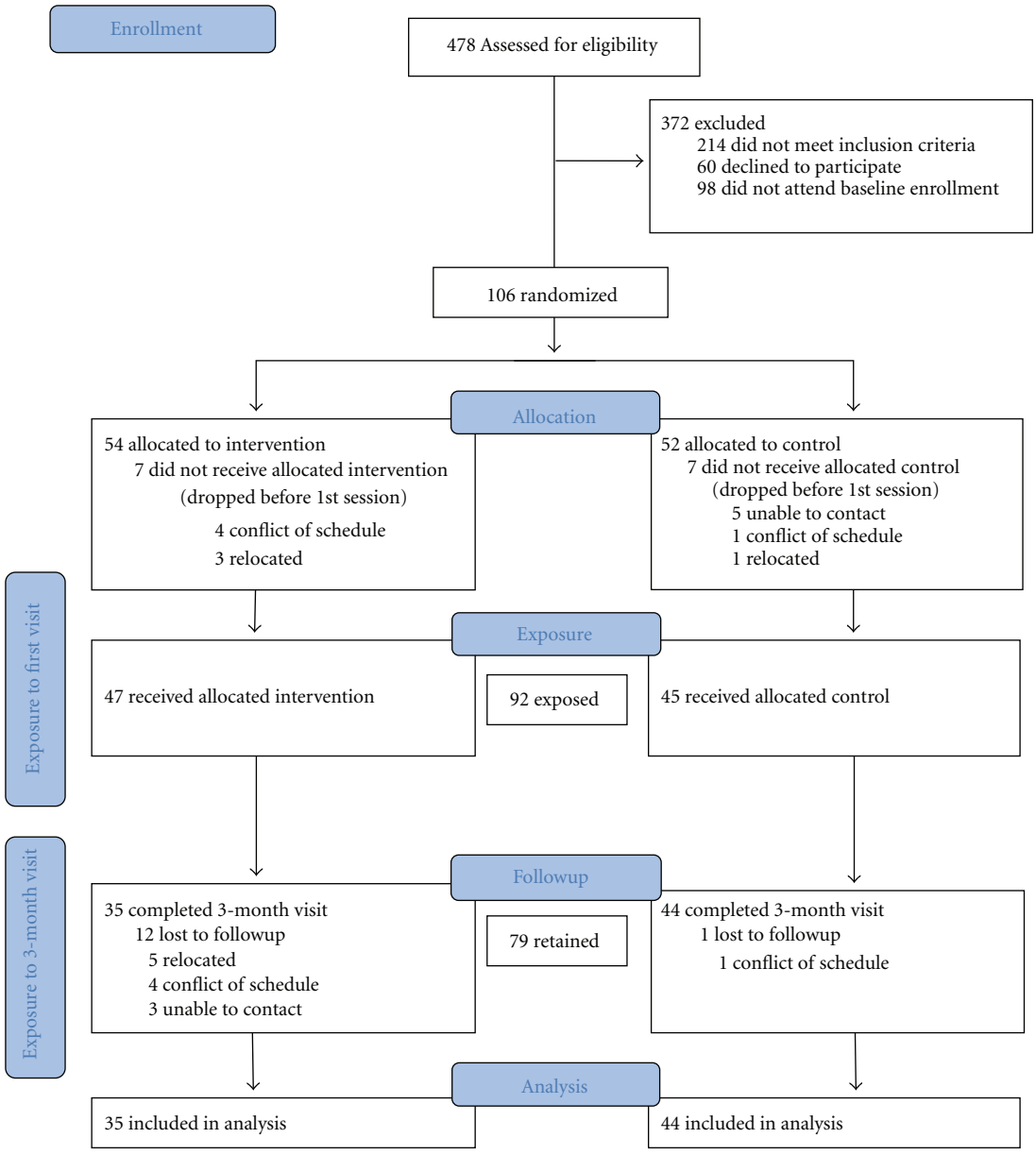

Figure 1: Flow of participants through the trial.

participants were listed on a check box roster. Respondents indicated the type of relationship they had with each other study participant (e.g., no relationship, friend, and acquaintance). Definitions for each type of relationship were provided in the instructions for consistent interpretation of these categories (see the appendix). The whole network was defined as all trial participants, so respondents evaluated their ties to all study participants not just the ones in their own study condition, in order to obtain complete data for analysis.

2.4.2. Height and Weight. Body weight was measured, while wearing light clothing without shoes after voiding, to the nearest 0.1 kg on a calibrated digital scale (Detecto, Webb City, MO, USA, Model no. 758C). Body height without shoes was measured to the nearest 0.1 cm with the attached stadiometer.

2.4.3. Body Mass Index (BMI). BMI was calculated (weight (kg)/height (m^2)) [33]. Because the amount of body fat varies for children by age and sex, BMI z-scores were used to provide a standard indicator of relative adiposity [35]. The BMI z-score was computed using the calculator from the Children's Hospital of Philadelphia based on the CDC Growth Charts [36].

2.4.4. Demographics. Parents completed a demographic survey in Spanish. Acculturation was measured using the widely used and previously validated Short-Acculturation Scale for Hispanics (SASH), with internal reliability $r = 0.81$ in our

Table 1: Measures of network structure and predicted change.

Measure of network structure	Definition	Predicted change after intervention
Degree centrality	Number of ties that an actor has with other actors in the network.	Increase
Constraint	Degree to which extent to which an actor's connections are to others who are connected to one another. This is important because less constrained networks would allow for the possibility of increasing potential connections through ties with others who are not already connected to others in ego's network, thereby enabling exposure to health information and health behaviors that are flowing through the network.	Decrease
2-step reach	How many people in the network a person could get to within two links of him/herself, expressed as a percentage of the total number of people in the network. This is a good measure of how well any individual could spread health information or health behaviors through the network by reaching out to friends and friends-of-friends.	Increase
Density	The number of ties among people in the network expressed as a percentage of all possible ties. If every person is tied directly with every other person the density is 100%. Increased density would allow for accelerated flow of desired health information or health behaviors through the network.	Increase

sample. [37] The SASH asks respondents to indicate the language they read and speak, use at home, think in, and use among friends (Spanish only, Spanish more than English, Spanish and English equally, English more than Spanish, and English only). Scores range from 1 to 5; a score <2.99 indicates a low level of acculturation.

2.5. Statistical Analysis. To answer RQ(1) we computed three ego-network-level measures (degree centrality, constraint, and 2-step reach) and one whole-network-level measure (density) of structure to determine if new relationships developed during the intervention period (definitions of terms noted in Table 1). T-tests were performed to compare intervention and control group using UCINET [38] and a bootstrap method in which observations are not assumed to be independent [39]. We created maps of each network in NetDraw [38].

To answer RQ(2), we used SIENA [40–42] to test for underlying network tendencies in network dynamics and selection effects. SIENA begins with the assumption of a continuous time parameter [43]. This provides the foundation for the assumption of a Markov process in which each subsequent change in the network is dependent upon previous network conditions. That is, newly formed network ties are dependent on the existing network structure, or as Snijders et al. [42] suggest "the total network structure is the social context that influences the probabilities of its own change" (p. 6). Finally, in this process it is assumed that actors have the possibility of forming new ties, maintaining ties, or dropping existing ties. We treated BMI as a constant covariate and controlled for several commonly observed tendencies in network dynamics: outdegree, reciprocity, and transitivity (definitions of terms noted in Table 2). In two separate models, we tested (a) whether parents tend to form ties with other parents who have a similar BMI, and (b) whether parents tend to form ties with other parents who have children with a similar BMI.

3. Results

3.1. Sample Description. Approximately 6 weeks passed between baseline data collection and the first intervention and control sessions, and in this time 14 randomized participants dropped from the study pool leaving a sample of 92 dyads exposed to intervention or control conditions (Figure 1). As Figure 1 shows, the attrition rate from initial exposure to 3-month followup was lower in the control group (15%) than in the intervention group (36%). There were no significant demographic or anthropometric differences at baseline between dyads who completed the 3-month follow-up data collection ($n = 75$) and randomized participants who did not finish the study ($n = 27$; results available upon request). Among the 35 dyads in the intervention group for which we have 3-month data, the median number of sessions attended was 7 out of the 12 offered.

The majority of participating parents were mothers, first-generation Mexican immigrants, with low levels of acculturation (mean SASH score 1.4) and education (25% of our sample had less than an 8th grade education). Children were typically US-born. Eighty-one percent of participating parents were overweight/obese (BMI $\geq$ 25 kg/m^2) as well as 42% of children (BMI percentile $\geq$85%). The groups

Table 2: Network effects included in the model.

Network effects	Definition	Variable type
Outdegree	Ties leaving an actor (number of people marked as friends). Measure of the level of activity in the network.	Control
Reciprocity	Reciprocity is the extent to which ties are reciprocated between actors. Over time if A selects B, then B will reciprocate and select A, or A will drop his/her ties to B. There is an equilibrium tendency toward dyadic relationships to be either reciprocated or null.	Control
Closure (transitive ties and 3 cycles)	The tendency for a friend of a friend to become a friend.	Control
Similarity	Actors tend to form relationships with others who are similar to them in particular ways. Also termed homophily effect or more colloquially known as the idea that "birds of a feather flock together."	Primary outcome

of dyads who completed the intervention and control conditions did not significantly differ on demographics or anthropometric measurements at baseline (Table 3).

3.2. RQ (1): Social Network Structure Change. Although given the option of indicating type of tie as friendship, acquaintance or transactional partner, no participant indicated acquaintance or transactional partner ties. Thus, the analysis is focused on friendship ties. At baseline, there were no significant differences between intervention and control groups in the four measures of network structure (degree centrality, constraint, two-step reach, and density). After the intervention, all network measures had changed in the predicted directions, in both intervention and control group, and all changes were significantly greater in the intervention group compared to the control group (Table 4).

3.2.1. Degree Centrality. The number of social ties people had with others in the network, averaged 1.5 at baseline. At study conclusion, intervention group members had developed more friendship ties compared to the control group (6.4 ties versus 3.9 ties).

3.2.2. Constraint. The degree to which a person's ties are with others who are connected to each other, declined at the end of the study period, in both groups, but significantly more so in the intervention group. This means that intervention group members not only had more ties, but also those ties were less likely to be people who were already friends with each other.

3.2.3. Two-Step Reach. The proportion of people in the network that any individual could reach through their friends and the friends of their friends, increased in both groups but significantly more so for the intervention group. At the beginning of the intervention, any person in the intervention group could have reached only 3% of the other group participants, whereas after the intervention they could have reached 32% of the other group members.

Although density more than doubled in the intervention group compared to the control group, at study completion the intervention group network was still a sparse network with fairly low density. Graphic representation of these network changes is given in Figure 2.

3.3. RQ(2): Characteristic of New Social Ties

3.3.1. Basic Network Effects. The Jaccard index, which measures how much change (related to ties created and ties dropped) occurs between points of data collection, was .256 [43]. Although a Jaccard index of .3 is recommended for discerning structural equivalence sets, in this study the slightly lower Jaccard index is considered acceptable given that the program brought together many mothers previously unknown to one another [43]. The model convergence was good as indicated by all t-ratio diagnostics being close to zero.

The negative parameter for outdegree was expected because most observed networks are sparse with densities well below .50. This makes intuitive sense in terms of the limit on the number of ties that any one actor can maintain and the potential costs that might be incurred with the formation of new ties [42].

The positive reciprocity parameter indicates that over time if person A selects person B as a friend, then person B will select person A, or person A will drop his/her tie to person B.

The significant positive transitive closure effect suggests that there is a tendency for a friend of a friend to become a friend. The positive and significant effect for 3 cycles also suggests that there is a tendency toward localized closure but the positive parameter indicates that this tendency is not toward a hierarchical structure, but rather toward localized exchange and generalized reciprocity [42]. That is, the positive 3-cycle effect represents a pattern in which person A selects person B, person B selects person C, and person C selects person A. The presence of this pattern indicates that no single actor is privileged as being chosen above others. The tendency toward closure suggested by the positive transitive ties and 3-cycle effects at first glance may seem at odds with the bivariate finding of decreased constraint noted above. This finding can be reconciled in light of the significant increase in density of the network from pre- to post-test. Constraint is a relative measure based on the extent to which actors have transitive or intransitive ties. With the increase in the number of new ties in the network, it would be

Table 3: Baseline demographic characteristics of latino parent-child dyads ($N = 79$).

Domain	Control		Intervention		P-value[1]
Child	Mean	S.D.	Mean	S.D.	
Age	4.1	0.9	4.2	0.9	0.85
Gender (% female)	54.6		45.7		1.00
BMI z-score	1.0	1.2	0.8	1.3	0.70
Waist circumference	56.7	7.3	55.7	5.8	0.48
Body fat percentage	34.0	8.2	34.1	9.9	0.97
BMI percentile[2]					
Underweight (BMI < 5%)	5%		3%		
Normal weight (BMI ≥ 5% < 85%)	45%		62%		
Overweight (BMI ≥ 85% < 95%)	25%		15%		
Obese (BMI ≥ 95%)	25%		20%		
Adult					
Age	32.3	5.7	30.7	6.0	0.22
Acculturation[3]	1.4	0.6	1.3	0.5	0.55
Relationship to child[4]	93.2		94.3		
Maternal education[5]					
<High school	63.6%		65.7%		
≥HS < college	27.3%		31.4%		
≥College	9.1%		2.9%		
BMI[6]	30.4	5.8	29.0	5.3	0.27
Waist circumference	99.4	16.3	100.8	21.4	0.75
Body fat percentage	40.3	7.3	40.0	5.8	0.85
BMI category[7]					
Underweight (BMI < 18.5)	0%		0%		
Normal (BMI ≥ 18.5 < 25)	18.2%		20.0%		
Overweight (BMI ≥ 25 < 30)	34.1%		45.7%		
Obese (BMI ≥ 30)	47.7%		34.3%		

[1] T-tests were used except for categorical variables (those reported only in percentages), where exact Fisher tests were used.
[2] Percentage of children by CDC weight status categories defined by BMI percentile for age. Percentages may not sum to 100% due to rounding.
[3] Short-Acculturation Scale for Hispanics (SASH).
[4] Percentage of respondents who are mothers.
[5] Percentage of adults by education category in each group.
[6] Usual measure of BMI (kg/cm^2).
[7] Percentage of adults by BMI category in each group: underweight category is omitted. The BMI categories are defined using the BMI measure (kg/cm^2) for the adult.

reasonable to see an increase in transitivity even if the ratio of transitive to intransitive ties has changed. A visual inspection of Figure 2 demonstrates the logic of this explanation. One can see that the overall number of participants that are active in the network has increased (in the pretest networks isolates are not depicted). On the periphery of both posttest networks one can see that many participants only have one or two intransitive ties, contributing to decreased constraint. Yet, at the same time, one can see an increased number of triangles in the posttest networks in comparison to the pretest network, indicating the tendency toward transitive closure.

3.3.2. Selection Effects. The results suggest a tendency for parents to form new friendship ties with other parents whose child's BMI z-score is similar to their own child's BMI z-score, ($t = 2.08$, $P < .05$; Table 5). There was no significant selection effect for maternal BMI in the formation of new social ties; that is, overweight mothers were not more likely to select overweight mothers as friends ($P > .05$).

4. Discussion

Several research teams have empirically linked social network structures to adult and adolescent obesity [13, 15, 21]. To date, very little research elucidates the network context of obesity among children. While many obesity interventions occur in a group setting, underlying group structure and group processes are not documented in the scientific literature. Our research demonstrates that a new social network evolved among families participating in a pediatric obesity group-based prevention trial. Moreover, these new social

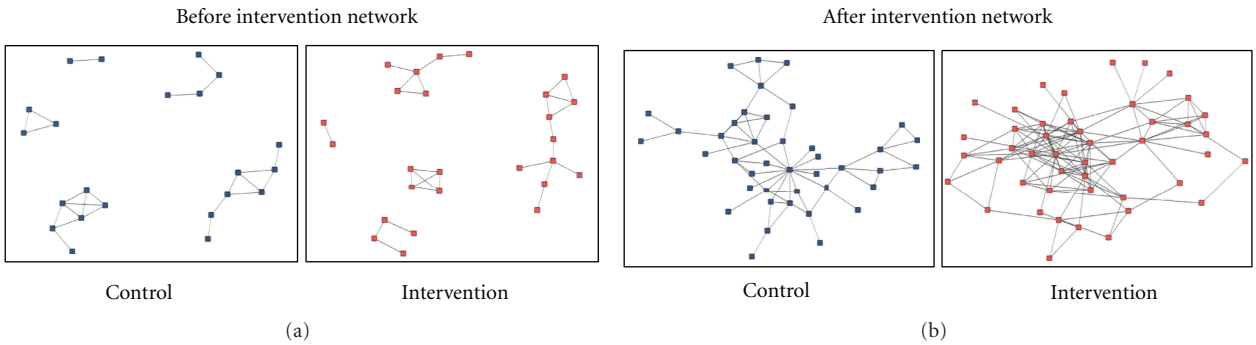

Figure 2: Mapping of social network changes over 3-month intervention. Each graph shows the study participants who have social ties with other study participants. These maps illustrate several points: First, some study participants already knew each other at baseline. This reflects the fact that the most effective recruitment strategy in this Latino population was word of mouth referrals. Importantly, there were no differences in preexisting network ties between control and intervention groups. Second, while some study participants already knew other study participants at baseline, half did not, and thus are not shown here, reflecting the average number of ties of 1.5 at baseline. Third, after the intervention, each group increased in the number of participants who had ties with others in the group.

Table 4: T-Tests of goup differences related to individual network attributes.

		Mean change in individual network attributes			
		Intervention Group (n = 35)	Control Group (n = 44)	Difference	P value
Degree Centrality	Before	1.52	1.45	0.07	0.847
	After	6.41	3.89	2.52	**0.006**
Constraint	Before	0.85	0.90	0.05	0.127
	After	0.52	0.68	0.16	**0.011**
2-step reach	Before	3.08	2.81	0.27	0.675
	After	32.53	23.99	8.54	**0.014**

Table 5: Parameter estimates.

Parameter	Estimates	Standard errors	t-statistic
Basic network effects			
outdegree (density)	−2.1628	0.1944	−11.1255
Reciprocity	2.0274	0.2817	7.1970
3 cycles	0.8184	0.2898	2.8240
Transitive ties	1.3133	0.2198	5.9968
Selection effects			
Similarity—Child BMI Z-score	1.2742	0.6133	2.08

ties formed in a predictable manner, with mothers forming friendship ties with other mothers' who had children of similar body type.

Normative expectations are perpetuated by the company we keep. If parents see predominately overweight children, this becomes the new normal. Social norms are thought to at least partially account for the clustering of health behaviors among social contacts [12, 13, 44]. Leahey et al. presented the first research to explicitly test this assumption. Their findings suggest that social norms specific to one's social network (subjective norms) influence weight more than broad societal level social norms (injunctive norms) [45]. Subsequently, social network phenomena might explain some of the factors that underlie the misperception of body size and the social context in which they develop and are maintained. Parental misperceptions of child weight status are well documented, even among parents of preschool aged children [46, 47], and affect the likelihood that parents will take action to ameliorate their child's weight problem [48].

We did not find overweight mothers to be more likely to select other overweight mothers as friends. Our null result is likely due to the low variability in our sample (more than 90% of participating mothers were obese) and small sample size for detecting selection effects. Others have clearly shown that adult and adolescent friendships cluster on the basis of weight status [6, 13, 15, 45].

There is evidence that social networks can spread positive health behaviors, such as smoking cessation, contraception use, and reduced drug and alcohol use [12, 15–17, 44]. Such findings raise the question of whether social networks—either existing or newly constructed—might also spread obesity-protecting behaviors, such as physical activity, consumption of fruits and vegetables, or sleep hygiene. This research lays the groundwork for understanding that new social networks can be formed in group-level interventions. Prudent next steps would be to examine the extent to which novel interventions could build new social networks to intentionally spread health behaviors. To explore such effects,

Table 6: Please place a check in the box next to each name describing the relationship you have with that person. For each name, indicate only your relationship and leave all other options for that person blank.

Participant name	Myself	Family member	Friend	Transactional partner	Acquaintance	No relationship
Ana Alvarez	☐	☐	☐	☐	☐	☐
Blanca Bins	☐	☐	☐	☐	☐	☐
Camila Cruz	☐	☐	☐	☐	☐	☐
Daisy Diaz	☐	☐	☐	☐	☐	☐
.....	☐	☐	☐	☐	☐	☐
.....	☐	☐	☐	☐	☐	☐

future health studies should include social network data. This study is a necessary first step in using social network analysis to strengthen group-based behavioral interventions that can be utilized in trials that aim to prevent or treat obesity.

5. Future Research

Given that many obesity prevention and early intervention behavioral trials utilize group settings, understanding new network formation could influence future trial design and implementation. Future group-based interventions might leverage the observed selection effect (mothers forming friendships based on child BMI) to intentionally increase group cohesion which, under favorable network conditions, may accelerate the uptake of prohealth knowledge, attitudes, and behavior across the whole network [11]. Alternatively, the observed selection effect might make it harder to intervene in individual behavior, in which case it would be prudent to counter the network effect by assigning parent-child dyads of varying BMI categories to work in groups together so that a high BMI is not seen as normative. Building on these findings and computer simulations of large social networks conducted by Bahr et al. [6], allowing parents to self-select partners in small group activities will likely lead them to cluster in social groups according to child BMI, and if unrestrained, current social forces will likely drive their children toward increasing obesity. It is also possible that just making parents aware of the tendency for mothers to selectively befriend mothers whose children have similar BMIs might be a useful way to correct body size and adiposity perceptions.

6. Study Limitations

Social ties in the control condition increased despite limited social interaction during the study period. This could reflect the fact that our study population, with low acculturation, feels socially isolated and yearns for connections with other Latinos in the same stage of life. One of the strengths of this study is the inclusion of rigorous network control variables in the modeling to rule out alternative explanations of our findings. The analysis cannot, however, rule out the effects of other individual differences in propensity to connect with others. We do not know if the new social ties were strong enough to withstand the test of time. Testing for influence effects was outside the scope of this paper. The evaluation of whether newly constructed social networks influenced health behaviors (i.e., physical activity) was untestable due to missing data. The analysis of whether newly constructed social networks influenced health outcomes (i.e., BMI) yielded nonsignificant results. These questions can be examined with additional waves of data collection and larger samples with complete data. Only friendship ties were reported (no acquaintance or transactional partner ties). It is unclear if this finding is indicative of the strength of the groups or an artifact of how the question was asked. We did not collect any process measures of role rotation during the intervention sessions, or a measure of perceived group cohesion. As with most community studies, we had attrition over the course of the intervention and note that this was greater in the intervention group than the control group. This could have biased our findings, but that is unlikely given that the noncompleters had similar initial anthropometric data to the completers.

7. Conclusion

The present study found that (1) a new social network can develop as a result of participating in an obesity prevention intervention in a group setting, and (2) study participants selectively form social ties based on their children's weight status. These findings should be taken into consideration as we develop pediatric obesity group-based intervention strategies that capitalize on the social environment.

Appendix

Social Network Instrument (English Translation)

Instructions. Listed below are the names of participants in The Salud Con La Familia Program at the Coleman Community Center. Please indicate your relationship to the participants.

> By "Family Member," we mean a blood relation or family link (such as a sister, cousin, or sister-in-law).
>
> By "Friend," we mean someone with whom you have close relationship or with whom you share feelings.
>
> By "Transactional partner," we mean someone who provides a favor or service to you or you provide for them (such as someone with whom you arrange

transport or childcare or a search for jobs or appointments, an employer, employee, client).

By "Acquaintance," we mean someone you know but who does not directly influence your daily life (such as a neighbor or colleague at work or church, whom you may greet or know by name but is neither a friend nor a person with whom you have dealings).

Please see Table 6 for details.

Conflict of Interests

The authors declare that they have no conflict of interests.

Acknowledgments

The authors thank Tokesha Warner for project management; Juan Escarfuller for intervention implementation; Josie Garza of the National Latino Children's Institute for curricular input; and Metropolitan Government of Nashville & Davidson County Parks and Recreation Department leaders Roy Wilson, Paul Widman, Stevon Neloms, and Tommy Lynch for their support throughout study implementation and partnership. This study was funded by the State of Tennessee Project Diabetes Implementation Grant (GR-09-25517-00, Barkin (PI)) and the Vanderbilt CTSA grant (NCRR/NIH 1 UL1 RR024975, Bernard (PI)). S.B. Gesell was supported by the American Heart Association Clinical Research Grant Program (09CRP2230246). ClinicalTrials.gov Identifier: NCT00808431. Vanderbilt IRB no. 080673.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 290589, 9 pages
doi:10.1155/2012/290589

Research Article

Motivation for Participating in a Weight Loss Program and Financial Incentives: An Analysis from a Randomized Trial

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Received 9 November 2011; Revised 20 January 2012; Accepted 12 February 2012

Academic Editor: Geoffrey C. Williams

This analysis investigated if changes in autonomous or controlled motivation for participation in a weight loss program differed between individuals offered a financial incentive for weight loss compared to individuals not offered an incentive. Additionally, the same relationships were tested among those who lost weight and either received or did not receive an incentive. This analysis used data from a year-long randomized worksite weight loss program that randomly assigned employees in each worksite to either a low-intensity weight loss program or the same program plus small financial incentives for weight loss ($5.00 per percentage of initial weight lost). There were no differences in changes between groups on motivation during the study, however, increases in autonomous motivation were consistently associated with greater weight losses. This suggests that the small incentives used in this program did not lead to increases in controlled motivation nor did they undermine autonomous motivation. Future studies are needed to evaluate the magnitude and timing of incentives to more fully understand the relationship between incentives and motivation.

1. Introduction

In today's obesogenic environment, losing weight through behavioral means can be a difficult task that requires a high level of self-monitoring, making healthy choices in the face of more desirable choices, and working against longstanding eating and physical activity habits. To overcome these barriers and successfully lose weight, high levels of motivation for weight loss and participation in a weight loss program are required. There is some evidence to suggest that this motivation drops during the course of a weight loss attempt. For example, adherence to weight loss recommendations such as self-monitoring, typically start at a high level and drop over time [1]. One possible way to help encourage participants to continue the behaviors needed for weight loss after motivation has waned is to provide financial incentives for weight loss.

Financial incentives have been used as a way to encourage individuals to take part in preventative health behaviors, such as weight loss. A review by Kane et al. [2] found that for a variety of preventive health behaviors, introducing financial incentives led to an increase in positive health behaviors. Looking specifically at weight loss, financial incentives have often been used in one of two ways. First, researchers have used behavioral deposit contracts. In these programs, participants are asked to deposit a set amount of money to participate in the program. They can earn the money back if they reach the study weight loss goal(s). The results from these studies have been generally positive in the short term (e.g., [3]). Another approach for using financial incentives is to provide an incentive, such as money or entry into a lottery for money, to the participant for meeting a specified target or for each pound lost (i.e., there is no deposit required). Finkelstein and colleagues [4] used this approach and tested

different levels of payment for weight loss ($5, $7, and $14 per percent of initial weight lost) as well as different payment schedules (consistent, early payment only, late payment only). The findings suggested that weight loss was associated with the magnitude of payment at the first follow-up visit and was associated with retention at the second follow-up. Finally, a study published in 2008 compared the effect of behavioral contracts (deposits were matched by the study), to a lottery for a financial reward, to a no financial incentive condition [5]. During the 16-week study, weight losses were greater in both of the financial incentive arms compared to the control arm. For a more comprehensive review of financial incentives and their role in weight loss, please see [6].

Despite the short-term positive outcomes when using financial incentives, controversy surrounding the long-term impacts of these incentives remains. Much of this controversy stems from the Cognitive Evaluation Theory (CET) by Deci and Ryan [7]. This theory suggests that providing tangible external rewards for a behavior that is interesting will lead to a reduction in intrinsic motivation for the behavior. This theory was developed in response to a number of laboratory studies that compared the intrinsic motivation of individuals doing a task that is considering interesting, such as completing a word puzzle, in exchange for a reward to individuals completing the same task without the reward. A consistent finding in these studies was that when participants had prior knowledge that they would receive a reward for completing the activity, their intrinsic motivation for the task was lower than the comparison group's who were not given rewards [8]. This conclusion held in cases where rewards were task contingent (i.e., participants were rewarded for doing the task) as well as when rewards were performance contingent (i.e., participants had to complete the task at a certain level to receive the reward). Deci and colleagues suggest that the decrease in intrinsic motivation is a reaction caused by shifting the focus from doing the activity for the purpose of self-improvement and because it is interesting to a focus on earning the reward. The proposition of rewards decreasing intrinsic motivation is a part of the meta theory developed by Deci and Ryan: Self-Determination Theory [9]. This broader theory suggests that for a behavior to be instigated and continued, an individual must feel that they are doing a behavior to better themselves, and they are inspired to carry out the behavior of their own will. In other words, the person is autonomously motivated. Conversely, if an individual engages in a behavior in reaction to outside forces (i.e., they are demonstrating controlled motivation), the behavior is not likely to be continued. The authors suggest that practitioners who are interested in helping others to change behavior should do so in a manner that encourages participants to maintain high levels of autonomy.

Despite the popularity of CET, there are critics who believe the utility of this theory is limited to specific circumstances. For example, Eisenberger and colleagues responded to Deci and Ryan's theory suggesting that the meta-analysis published in 1999 overstated the reach of the undermining effect of rewards. Specifically, they argue that undermining occurs mostly for task contingent rewards and that performance contingent rewards can actually increase intrinsic motivation [10]. More recent work suggests the tenants of CET hold true but only for those who have control-oriented causal orientation (i.e., those who view their behavior as highly influenced by forces outside of themselves) [11]. These studies, along with the limited conditions under which the CET theory has been tested (viz., in laboratory settings), lead to a need to test CET in alternative contexts. Specifically, it is important to test this theory in a situation where incentives may be used to promote long-term behavior change.

If CET extends to health behaviors, use of financial incentives may be problematic because autonomous motivations for weight loss, exercise, and continuing in the weight loss program have all been found to be associated with weight loss success during weight loss programs. Williams and colleagues found that autonomous motivation to remain in a weight loss program measured early in a weight reduction program was predictive of weight loss at 23-month follow-up [12]. Similarly, Webber and colleagues found that autonomous motivation for participating in a weight loss program measured shortly after a weight loss program began was predictive of overall weight loss in a 16-week intervention [13]. Interestingly, neither autonomous motivation for participating in the weight loss program measured prior to the program beginning nor controlled motivation measured at any time were predictive of weight loss in this study. Other studies have found that autonomous motivation for exercise is also associated with greater weight losses [14, 15]. Finally, researchers found that a behavioral weight loss intervention developed to enhance autonomous motivation was more successful than a health education control group [16].

As a result of autonomous motivation consistently predicting weight loss success, there is a need to understand whether the CET proposition regarding changes in motivation that occur after an external reward is given holds true in weight loss programs when financial incentives are used. Some argue that intrinsic motivation, as described by SDT, is not relevant to health behaviors because these behaviors are not inherently interesting [15]. However, exercise, a major predictor of weight loss [17], can be interesting, and intrinsic motivation for exercise has been found to be associated with weight loss [18]. Therefore, research is needed to understand which types of tasks CET can be applied to and in what contexts. Despite the uncertainty regarding how interesting weight loss behaviors really are, offering financial incentives could still be construed by participants as controlling, therefore, leading to decreases in autonomous motivation. If this is the case, the shift in internalized motivation seen in studies of interesting behaviors could extend to health behaviors, making offering financial incentives detrimental once the incentives end. In other words, providing a financial incentive may undermine autonomous motivation for participating in a weight loss program and instead lead to increases in controlled motivation. This shift then may lead to limited maintenance of weight loss behaviors beyond the formal weight loss program.

This paper tested the extension of CET and SDT to financial incentives for weight loss within a worksite weight loss program. This extension was tested in two ways. First, it tested whether there were decreases in autonomous or increases in controlled motivation for participating in a weight

loss program among participants randomized to receive an offer of a financial incentive as compared to those who were randomized not to receive an offer of a financial incentive. Secondly, this study investigated whether there are decreases in autonomous motivation for participating in a weight loss program among individuals who lost weight and were randomized to receive an incentive as compared to those who lost weight and were randomized to an intervention that did not receive a financial incentive. This study also investigated whether there were differential increases in controlled motivation among the same groups. Because the incentive in this study was performance contingent, not everyone who was offered an incentive ultimately received payment. Presumably, if there is a negative effect of a financial incentive, it may be strongest for those who actually receive the incentive as opposed to those who only receive the offer. Studying both the offer and the receipt of the incentive will provide maximal insight into the effects of the incentives on motivation for participating in a weight loss program.

2. Methods

Data for this analysis are from the "WAY (Worksite Activities for You) to Health" research study, a large group randomized, worksite-based intervention trial. This trial was designed to test the effects of two minimal intensity weight loss interventions compared to a "usual care" healthy dining program among overweight/obese employees at 17 community college worksites from the North Carolina Community College System. All participating campuses had access to the Winner's Circle Dining Program (WC), a program focused on increasing access to healthier food options at work [19].

2.1. Study Design. Overweight employees at campuses enrolled in the research study received one of the following interventions: Winners Circle (WC) only (not included in this analysis), WC + Web-based weight loss program (WEB), or WC + WEB + cash incentives for weight loss (Web plus Incentives; WPI). For colleges assigned to the WEB and WPI groups, the employees were offered the opportunity to access a self-directed study website which included behavioral weight control lessons, an online study progress tracking system, and weekly tips. This intervention was modeled after the self-directed weight loss intervention described by Tate and colleagues but involved no ongoing professional E-mail support [20]. For participants randomized to WPI, the website was identical to the WEB condition but also showed a personalized incentive chart showing exactly how much the participant would earn (cash incentive) for the weight loss achieved at each follow-up measurement when his/her baseline weight was compared to follow-up weight. Participants were offered $5.00 for each 1% of their initial body weight lost at the 3-, 6-, and 12-month assessment visits, up to 10%. Thus, a participant could earn a maximum cash incentive of $150 over the duration of the study if he/she lost 10% of baseline weight at 3 months and maintained that weight loss at the 6- and 12-month follow-ups. This level of incentive was chosen because it was identified during pilot work as being a feasible level of payment to be offered as part of an employer sponsored weight loss program. To maximize retention, all participants who completed follow-up assessment visits received a stipend of $5, $10, and $20 for the 3-, 6-, and 12-month assessments, regardless of weight loss status. Using the language of Deci and Ryan, the incentives provided for weight loss would be considered performance-contingent rewards, while the stipends for completing the assessments would be considered task-contingent [7].

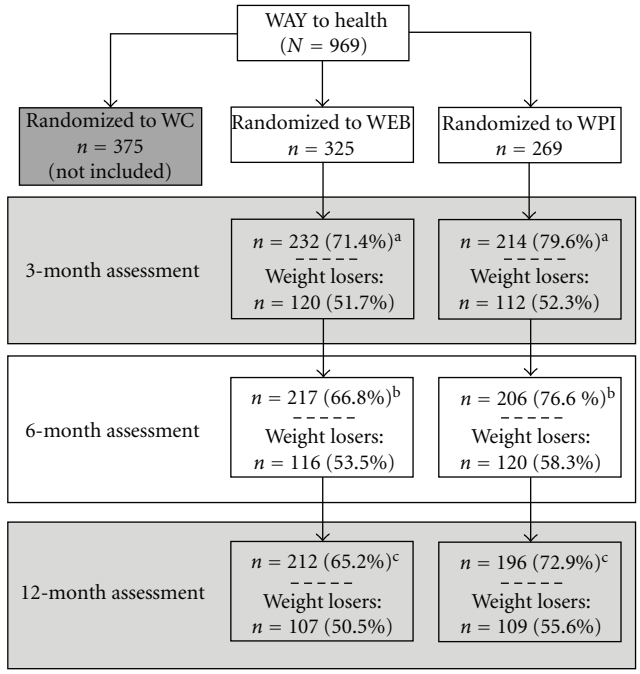

Figure 1: Participant flow diagram. Note. Randomizations numbers refer the number of cases who were randomized to intervention groups and reminded eligible throughout the study. The top values for each subsequent assessment point represent the number of individuals for whom their objective weight and/or TSRQ values are available. The bottom values report the number of individuals who had lost at least 0.5% of their initial body weight. The lower percentage is the proportion of the returning participants who lost weight during that assessment period. $^{a}\chi^2 = 4.82$, $df = 1$, $P = 0.03$; $^{b}\chi^2 = 6.91$, $df = 1$, $P = 0.009$; $^{c}\chi^2 = 3.99$, $df = 1$, $P = 0.05$.

The study protocol for WAY to Health was approved by the IRB at the University of North Carolina Chapel Hill and Research Triangle Institute.

2.2. Participants. This analysis includes only data from participants from community colleges randomized to the WEB and WPI intervention arms of the WAY (Worksite Activities for You) to Health trial (see Figure 1). This decision was made because the focus of this study is on comparing the effect of the offer or receipt of incentives on motivation. Because the WEB and WPI group vary only on the presence of incentives, comparing these two groups provides a clear comparison in which to test this study's hypotheses. The effect of incentives on motivation was investigated in two ways. First, the impact of the *offer* of incentives was investigated using participants who were randomized into either

Table 1: Baseline demographic characteristics.

	All participants ($N = 594$)	WEB ($n = 325$)	WPI ($n = 269$)	P value
Age (years; M ± SD)	47.68 ± 9.72	47.61 ± 10.03	47.75 ± 9.35	0.86
Weight (kg)	92.87 ± 20.27	93.83 ± 20.75	91.71 ± 19.66	0.21
BMI (kg/m^2)	33.50 ± 6.59	33.36 ± 6.58	33.65 ± 6.62	0.60
Autonomous motivation	5.66 ± 0.95	5.63 ± 1.00	5.68 ± 0.88	0.55
Controlled motivation	2.24 ± 1.05	2.26 ± 1.07	2.21 ± 1.02	0.59
College education or higher (n, %)	369 (62.1%)	204 (62.8)	165 (61.3)	0.74
Female	463 (77.9)	237 (72.9)	226 (84.0)	<0.001
Married	413 (69.5)	230 (70.8)	183 (68.0)	0.52
White/Non-Hispanic	487 (82.0)	268 (82.5)	219 (81.4)	0.86

*Note. Values are mean ± standard deviation. No responses were given for specific demographic questions: education status ($n = 28$), gender ($n = 28$), marital status ($n = 29$), and race ($n = 31$).

the WEB or WPI intervention groups and attended the follow-up assessments at 3, 6, and/or 12 months. Second, in order to investigate changes in motivation over time from *receipt* of an incentive apart from changes in motivation caused by weight loss, the second set of analyses will utilize data only from individuals who lost weight at either the 3-month or 6-month assessment. Weight losers were defined as participants who lost a minimum of 0.5% of their initial body weight (the minimum weight loss that was eligible for an incentive within the WPI intervention).

Ten community colleges were randomized into the WEB and WPI study arms. Within these groups, there were 5 colleges assigned to each condition. The sample includes 594 individuals who remained eligible for the duration of the study. Bivariate analyses were used to test for differences in baseline demographic and anthropomorphic characteristics and motivation variables between the WEB and WPI groups. The WEB and WPI were similar at baseline, although WPI contained more women than WEB ($\chi^2 = 14.52$, $df = 1$, $P < 0.001$; see Table 1). Participants from WPI group were more likely to return for follow-up assessments than those from the WEB group (P's ≤ 0.05). Returning participants in the WEB and WPI groups were demographically similar (all P's > 0.06), with the exception of gender. Similar to the overall group composition, there were more women in the returning WPI group than the WEB group (3 months: $\chi^2 = 7.23$, $df = 1$, $P = 0.007$; 6 months: $\chi^2 = 9.08$, $df = 1$, $P = 0.003$; 12 months: $\chi^2 = 4.67$, $df = 1$, $P = 0.03$).

Among the weight losers ($n = 300$), there were significantly more women in the WPI group (90.2%) than the WEB group at the 6-month assessment (79.1%, $\chi^2 = 5.26$, $df = 1$, $P = 0.02$). For the remaining variables, there were no significant differences between the groups (all P's > 0.15). Because of the difference in gender representation of the groups, gender was entered as a covariate in all analyses.

2.3. Measures. Study staff, blinded to treatment condition, collected objective weight measurements at the start of the program and at months 3, 6, and 12. Participants were weighed with shoes off, wearing light street clothing using a digital scale (Tanita BWB, 800). Measurements were recorded to the nearest tenth of a pound. Weight change was computed by subtracting the baseline weight from the weight at each follow-up assessment visit.

Motivation for participating in a weight loss program was measured using the Treatment Self-Regulation Questionnaire [21] and was completed at the same time points as the weight measurements. This questionnaire assesses motivation for starting, or continuing, participation in a weight loss program via the participant's endorsement of statements of autonomous and controlled motivation. An example item from the autonomous subscale is "I have remained in this program because I feel like it is the best way to help myself." The controlled subscale included items such as "I have remained in the program because others would have been angry at me if I did not." Responses to these items were given on a scale of 1 ("Not at all true") to 7 ("Very true") and were averaged to indicate a summary assessment of autonomous and controlled motivation. At baseline, participants completed the full TSRQ assessing motivation to begin a weight loss program; a subset of items assessing motivation to continue in a weight loss program were used at later assessments to reduce participant burden. The autonomous motivation subscale included 6 items at baseline and 3 items thereafter. The internal consistency of this scale at the four time points ranged from 0.63 to 0.78 (Cronbach's coefficient alpha). The controlled motivation subscale included 12 items at baseline and 5 items thereafter. The internal consistencies of these scales were also acceptable with values between 0.66 and 0.88.

2.4. Statistical Analysis. The primary aim of this analysis was to test whether the offer or receipt of an incentive would lead individuals to show differential changes in autonomous and controlled motivation for remaining in a weight loss program. For the first set of analyses, the motivation to remain in a weight loss program of individuals who were randomized to receive an offer of a financial incentive were compared to those in the same program but were randomized not to receive the offer of the incentive. It was hypothesized that among those who were offered a financial incentive (WPI), autonomous motivation would decrease at a greater rate than those who were not offered an incentive (WEB). Conversely, controlled motivation was hypothesized to increase in WPI at a greater rate than in WEB. The second set of analyses compared the motivation of individuals who received an incentive for weight loss relative to individuals who also lost weight but were randomized to a condition that did not provide an incentive. Again it was hypothesized that WPI would show greater decreases in autonomous motivation after the receipt of the incentive than WEB. Controlled motivation was expected to increase in WPI compared to WEB. To test

these hypotheses, PROC MIXED was used to test mixed effect regressions. The first level of the models included the individual growth curves and the time varying covariate weight loss (kilograms of weight loss). The second level included gender as a control variable, the dummy variable for intervention group, and the interaction term between month and the intervention group. A third level of the model was tested that would account for the nesting of employees within the worksite. However, this model was ultimately rejected because there was too little variance at the third level to estimate random intercepts. The final model tested used the following equations:

$$\begin{aligned}
\text{Level 1}: \quad & Y_{ij} = \beta_{0j} + \beta_{1j}(\text{Month})_{ij} + \beta_{2j}(\text{Weight Change})_{ij} \\
& \quad + r_{ij}, \\
\text{Level 2}: \quad & \beta_{oj} = \gamma_{00} + \gamma_{01}(\text{Intervention})_j + \gamma_{02}(\text{Female})_j \\
& \quad + \mu_{0j}, \\
& \beta_{1j} = \gamma_{10} + \gamma_{11}(\text{Intervention}), \\
& \beta_{2j} = \gamma_{20}.
\end{aligned} \tag{1}$$

In this model, fixed effects were estimated for changes by time (Month) and intervention group while controlling for the effect of weight loss and the dummy coded control variable for gender. The cross-level interaction term (indicated by Υ_{11}) was tested to assess if the effect of the intervention group varied over time. The only random effect included in the model was for the intercept. If support were found for the hypotheses about autonomous motivation decreasing more in the WPI group, the coefficient for the Intervention × Month interaction (Υ_{11}) would be significant and negative. If support for the controlled motivation hypotheses were found, the Intervention × Month coefficients in those analyses would be positive.

The above model was tested separately for autonomous and controlled motivation. The analyses of changes in motivation after receiving an incentive included motivation measured at the current and the subsequent assessment (i.e., weight losers at 3 months were used to assess changes in motivation between 3 and 6 months). Data analysis was completed using SPSS version 19 and SAS software version 9.2.

3. Results

The scores on the autonomous and controlled motivation scales were first examined in a cross-sectional manner. There was a significant difference between the WEB and WPI groups at 3 months ($t(df = 407) = -2.17$, $P = 0.03$), where the WPI group reported higher levels of autonomous motivation (see Table 2). At 6 months, the difference was marginally significant ($t(df = 368) = -2.01$, $P = 0.05$) but the difference was not significant at 12 months ($t(df = 333) = -0.98$, $P = 0.33$). There were no significant differences by intervention group on controlled motivation at any time (P's > 0.29). Although this comparison of means provides some evidence that the WPI group that was offered incentives did not have autonomous motivation for remaining in a weight loss program that was significantly lower nor controlled motivation that was higher from WEB, it does not account for individual changes in motivation over time. Therefore, the effect of the offer of incentives was analyzed over time using longitudinal methods.

Table 2: Motivation by intervention group.

	WEB	WPI	P value
Autonomous motivation			
3 Months	5.13 ± 1.24	5.39 ± 1.13	0.03
6 Months	5.51 ± 1.34	5.77 ± 1.13	0.05
12 Months	5.31 ± 1.42	5.46 ± 1.34	0.33
Controlled motivation			
3 Months	2.26 ± 1.04	2.36 ± 1.11	0.35
6 Months	2.24 ± 0.95	2.22 ± 0.98	0.78
12 Months	2.19 ± 1.16	2.32 ± 1.05	0.29

*Note. Values are mean ± standard deviation.

Between baseline and the end of the intervention, there was a significant decrease in autonomous motivation for participating in a weight loss program (see Table 3, $P < 0.001$). Autonomous motivation decreased approximately 0.03 units per month during the intervention. There were no differences between the WEB and WPI groups on autonomous motivation throughout the study ($P = 0.42$). There were also no differences in changes between the groups over time (Intervention × Month, $P = 0.83$). This indicates that any changes in autonomous motivation over time were not related to the intervention group assignment. As suggested by prior studies, weight loss was significantly associated with changes in autonomous motivation such that, all other things being equal, on the 7-point scale, a one-kilogram weight loss was associated with a 0.08 unit increase in autonomous motivation ($P < 0.001$). Finally, women reported having autonomous motivation for participating in the weight loss program 0.34 units higher than men ($P < 0.001$).

Similar to autonomous motivation, controlled motivation for remaining in a weight loss program was associated with weight loss. For controlled motivation, a one-kilogram weight loss was associated with an increase in controlled motivation of 0.02 units (see Table 4; $P = 0.005$). There were no changes in controlled motivation over time ($P = 0.19$). No differences between intervention groups were found ($P = 0.96$), and there were no differences in changes in controlled motivation between the groups ($P = 0.30$). Controlled motivation did not differ between men and women ($P = 0.84$).

Next, the effect of *receiving* an incentive was tested using the subsample of weight losers. As shown in Table 3, there was a significant increase in autonomous motivation between 3 and 6 months such that all other things being equal, there was an increase of 0.13 units of autonomous motivation for each additional month of the intervention ($P = 0.003$). Among weight losers, there were no significant differences in the level of autonomous motivation between the WEB and WPI groups ($P = 0.07$). Additionally, there was no significant group by time interaction ($P = 0.94$).

Table 3: Changes in autonomous motivation.

Assessments	All participants BL, 3, 6, 12		3-Month weight losers 3, 6		6-Month weight losers 6, 12	
Fixed Effects	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Intercept	5.13***	0.09	5.33***	0.18	5.30***	0.19
Month	−0.03***	0.01	0.13**	0.04	−0.00	0.02
Intervention	0.06	0.07	0.24	0.13	0.16	0.15
Intervention by month	0.00	0.01	−0.00	0.06	−0.03	0.03
Weight change (negative values represent losses)	−0.08***	0.01	−0.08***	0.02	−0.08***	0.02
Female (Reference: male)	0.39***	0.10	0.25	0.18	0.45*	0.20
Random effects (variance components)						
Intercept	0.36***	0.04	0.47***	0.10	0.71***	0.11
Residual	0.92***	0.04	0.74***	0.08	0.62***	0.07
Goodness of fit						
−2LL	4604.3		1096.3		1068.9	
AIC	4620.3		1112.3		1084.9	
BIC	4655.0		1139.5		1112.2	
Number of observations	1530		370		359	
Number of subjects	566		222		222	

*Significant at $P < .05$; **significant at $P < .01$; ***significant at $P < .001$.

Table 4: Changes in controlled motivation.

Assessments	All participants BL, 3, 6, 12		3-Month weight losers 3, 6		6-Month weight losers 6, 12	
Fixed effects	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Intercept	2.26***	0.09	2.42***	0.16	2.24***	0.18
Month	−0.01	0.01	0.06	0.03	−0.00	0.02
Intervention	0.00	0.08	−0.15	0.13	−0.01	0.14
Intervention by month	−0.01	0.01	−0.06	0.05	0.03	0.02
Weight change (negative values represent losses)	−0.02*	0.01	−0.01	0.02	−0.01	0.01
Female (reference: male)	−0.02	0.10	−0.08	0.17	0.04	0.19
Random Effect (variance component)						
Intercept	0.52***	0.05	0.60***	0.09	0.72***	0.09
Residual	0.57***	0.03	0.47***	0.05	0.33***	0.04
Goodness of fit						
−2LL	4153.3		1018.1		938.0	
AIC	4169.3		1034.1		954.0	
BIC	4204.0		1061.4		981.3	
Number of observations	1529		370		359	
Number of subjects	566		222		222	

*Significant at $P < .05$; **significant at $P < .01$; ***significant at $P < .001$.

Weight loss was associated with autonomous motivation, where each additional kilogram of weight loss was associated an increase of 0.08 of reported autonomous motivation ($P < 0.001$), all other things being equal. In 3-month weight losers, autonomous motivation did not differ between men and women ($P = 0.15$). The same pattern of results was found for when weight losers at 6 months were used to assess changes in autonomous motivation between 6 and 12 months, although in this analysis, women reported higher autonomous motivation than men ($P = 0.03$).

Similar to the analyses run for autonomous motivation, the effect of receiving an incentive on controlled motivation was first assessed using weight losers at 3 months examining changes in controlled motivation between 3 and 6 months (see Table 4). There was a trend for controlled motivation to increase over time ($P = 0.09$); however, this did not reach statistical significance. There were no significant differences by intervention treatment group ($P = 0.24$) nor were there any differences by intervention groups over time ($P = 0.72$). Unlike autonomous motivation, changes in controlled motivation were not related to changes in weight ($P = 0.72$), and there were no differences by gender ($P = 0.65$).

Finally, data from weight losers at 6 months was used to assess changes between 6 and 12 months on controlled motivation for participation in a weight loss program. The pattern of results was identical to those with 3-month weight losers.

4. Discussion

Although research has been conducted using financial incentives to encourage weight loss, no study to date has looked at the effect of these incentives on motivation. This paper addresses this gap by testing whether the assertions of the CET extend to motivation for participating in a weight loss program within a program offering financial incentives. The results of this study compared a group randomized to receive a financial incentive for weight loss with a group randomized not to receive the incentives. Comparisons were made based on the *offer* of the incentive, as well as comparisons within a subset of the groups who were eligible to receive the incentives. The results suggest that neither the offer nor the receipt of a small incentive for weight loss leads to decreases in autonomous motivation or increases in controlled motivation for participating in a weight loss program.

Additionally, this study found that weight loss was consistently associated with changes in autonomous motivation to continue participating in the weight loss program. These results support past research suggesting that autonomous motivation measured after the weight loss program begins is a predictor of overall weight losses in both short [13] and longer weight loss interventions [12]. In this analysis, motivation was assessed at months 3 and 6 of a one-year trial. Moreover, this repeated finding suggests that focusing on improving autonomous motivation for weight loss during a weight loss attempt may be beneficial. Similar results for controlled motivation for participation were only found when examining individuals who did and did not lose weight. This is not as consistent with prior studies as the finding for autonomous motivation. Williams and colleagues found controlled motivation measured by the TSRQ was associated with BMI change at the end of a weight loss intervention, but it was not associated with weight loss maintenance [12]. Webber and colleagues found controlled motivation was not associated with overall weight losses in a shorter term study [13]. Clearly, more research is needed before conclusions about the relationship between controlled motivation for participating in a weight loss program and weight loss can be solidified.

In this study, there were no statistically significant relationships found between receiving an offer of a financial incentive and changes in motivation nor were there relationships found for those who actually received an incentive. There are several plausible explanations for these findings. First, the incentives paid for weight losses in this study were small and perhaps inadequate to lead to changes in motivation for weight loss program participation. In this study, the maximum incentive for weight loss was \$150. Although some individuals received this maximum incentive, the actual mean payment across the three assessment visits was \$18.90 (median = \$15). For most participants, this is less than the attendance stipend (e.g., \$15 at 6 months or \$20 at 12 months). This may have diluted the effect of the incentive as a motivator for continuing efforts to lose weight.

A second plausible explanation for the lack of changes in motivation related to the incentives is the delay between the behaviors required for weight loss and the payment of the incentive. In this study, incentive payments were made during the study assessment visits at months 3, 6, and 12 of the intervention. By comparison, in the study by Volpp and colleagues, where mean payments were \$273 during a 16-week program, the incentives were provided either weekly (in the lottery condition) or monthly (in the contract condition; [5]). The longer lag between the behavior change and the receipt of the incentive may have forced participants in this study to rely more on other sources of motivation rather than the incentives. Further research into the perceived value, the amount, and the timing of cash incentives, as well as their impact on motivation for weight loss, will help clarify this relationship.

Another possibility is that changes in motivation may have occurred, but the measurement of motivation was too distal from when the incentive was received for the change to be detected. In other words, changes in motivation may have occurred immediately after the incentive was received but then dissipated between then and the next measurement. No research to date has investigated the duration of impact that financial incentives may have on motivation, but prior weight loss studies have found that the effect of incentives disappears during weight loss maintenance [22]. Future studies may want to include more observations of motivation to explore this relationship.

Finally, the lack of significant relationships between the incentives and motivation in this paper may be a result of insufficient sample size. The analyses presented in this paper have adequate power to detect effect sizes equal to or greater than $d = 0.23$ for the analyses investigating the offer of incentives and effect sizes greater than $d = 0.54$ for the analysis of receiving the incentives (estimated using the "Optimal Design" software [23]). The effect sizes for changes in motivation between the intervention groups over time ranged from 0.004 to 0.08 (very small to small effects [24]). These effects could be statistically significant if the sample size was much larger.

There are several strengths of this study. This study is the first to look at the relationship between financial incentives for weight loss and motivation to participate in a weight loss program. This is an important area for exploration

because there is strong support from both employees and employers for using incentives within worksites to promote weight loss among employees [25], and theory suggests that use of such incentives may decrease autonomous motivation. This study utilized data from a worksite weight loss program of a similar intensity to what may be offered in employer sponsored weight loss programs. With these similarities, the results can be generalized to other worksite-based weight loss programs. Additionally, the amount of the incentives offered was decided upon based on the results of a survey of employers. The incentives used in this study were similar in magnitude to what employers may be willing to pay as part of an independent worksite weight loss program. Additionally, the demographics of this sample are similar to the demographics of participants in other worksite health promotion programs, namely, that the sample was predominately white, college-educated women [26]. Thus, results may be generalizable to the typical worksite-based weight loss program participants within some, but not all, worksites. This study was also large enough to allow for a secondary analysis restricted to individuals who lost weight. By focusing only on participants who lost weight within these two groups, any changes in motivation triggered by weight losses would have been similar across groups. Finally, weight loss in this study was measured using standardized protocols with in-person weights and the assessment of motivation included reliable/valid measures of motivation.

Despite these strengths, there are limitations that need to be considered. First, because this study focused on changes in motivation for participating in a weight loss program over time, it only included participants who completed the study questionnaires and excluded those with incomplete data. This may have introduced bias into the analyses where only participants who were highly motivated to lose weight, or earn incentives, completed follow-up assessments. Additionally, only one measure of motivation for participating in a weight loss program was used in this study (Treatment Self-Regulation Questionnaire). This reliable measure assesses overall motivation for participating in a weight loss program but does not specifically assess money as a motivator. Additionally, not all items of this measure were included in order to reduce participant burden. Future research may want to consider using additional measures of motivation for weight loss as well as motivation to participate in a weight loss program.

5. Conclusions

This is the first study to investigate the relationship between financial incentives and motivation for participating in a weight loss program. In this sample, there was no relationship between either the offer or the receipt of an incentive for achieving weight losses and subsequent changes in either autonomous or controlled motivation for participating in a weight loss program. These results may generalize to other worksite programs offering incentives of similar magnitude. Further research is needed to investigate this relationship using other measures of motivation (e.g., including directly assessing the motivation for money as a catalyst for changing behavior). Additional research to identify how the amount of the incentive and the timing of the incentive payments influence motivation, and ultimately weight loss, will make an important contribution to the field of obesity research.

Conflict of Interests

The authors declare that they have no competing interests.

Acknowledgments

This paper was funded by the Centers for Disease Control's Grant no. DP000102 and by Lineberger Comprehensive Cancer Center's Cancer Control Education Program, which is funded by National Cancer Institute Grant no. CA57726. The authors would like to thank the 17 community colleges and all of their employees for participating in this trial. They would also like to thank Carolyn Naseer and Jiang Li for their assistance with the data collection and management.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 740519, 8 pages
doi:10.1155/2012/740519

Research Article

Financial Motivation Undermines Maintenance in an Intensive Diet and Activity Intervention

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Received 5 November 2011; Revised 20 January 2012; Accepted 30 January 2012

Academic Editor: Geoffrey C. Williams

Financial incentives are widely used in health behavior interventions. However, self-determination theory posits that emphasizing financial incentives can have negative consequences if experienced as controlling. Feeling controlled into performing a behavior tends to reduce enjoyment and undermine maintenance after financial contingencies are removed (the undermining effect). We assessed participants' context-specific *financial motivation* to participate in the Make Better Choices trial—a trial testing four different strategies for improving four health risk behaviors: low fruit and vegetable intake, high saturated fat intake, low physical activity, and high sedentary screen time. The primary outcome was overall healthy lifestyle change; weight loss was a secondary outcome. Financial incentives were contingent upon meeting behavior goals for 3 weeks and became contingent upon merely providing data during the 4.5-month maintenance period. Financial motivation for participation was assessed at baseline using a 7-item scale ($\alpha = .97$). Across conditions, a main effect of financial motivation predicted a steeper rate of weight regained during the maintenance period, $t(165) = 2.15$, $P = .04$. Furthermore, financial motivation and gender interacted significantly in predicting maintenance of healthy diet and activity changes, $t(160) = 2.42$, $P = .016$, such that financial motivation had a more deleterious influence among men. Implications for practice and future research on incentivized lifestyle and weight interventions are discussed.

1. Introduction

The use of financial incentives is a strategy to motivate healthy behavior change that has become routine practice over the past decade. A 2008 survey of major US employers found that over 70% of employee wellness programs were using financial incentives to encourage participation and/or performance [1]. In particular, financial incentives have been increasingly used to help motivate complex healthy behavior changes, such as increasing physical activity, improving diet, and in weight loss interventions more broadly. The use of (nonfood) rewards in obesity treatment has also been recommended by the World Health Organization [2].

Over the past 30 years, health behavior interventionists have identified a number of factors that influence the efficacy of financial incentives for *initiating* weight loss, as well as physical activity and improvements in diet [3–20]. For example, Volpp and colleagues recently published a high impact paper demonstrating that low-intensity intervention paired with small financial incentives can produce impressive initiation of weight loss [18]. However, to date, far less attention has been paid to the issue of weight and health behavior change *maintenance* after financial incentives are removed. A small fraction of the extant studies have assessed maintenance, and those that have typically reported very limited success [14–20]. In the Volpp et al. study [18] at the end of the 16-week incentivized phase, both financial incentive groups lost significantly more weight than did the control group; however, 12 weeks into a maintenance phase the incentive groups had regained much of the weight they had initially lost, and the differences between conditions were no longer significant. A follow-up trial explicitly designed to use financial incentives to achieve extended weight loss lengthened the incentivized phase to 24 weeks and reduced

the maintenance phase to 8 weeks. In this case, the difference between incentive and control groups remained significant at 8 weeks but was no longer significant after 12 weeks of maintenance [19]. A 2007 systematic review of financial incentives in treatments for obesity/overweight included nine studies with follow-up of one year or more. Results showed that incentives produced no improvement in weight loss maintenance at 12 or 18 months, after the incentives were removed. In fact, there was a trend toward weight regain *above baseline* at 30-month follow-up [20].

Self-determination theory (SDT) is a theory of motivation that may provide some insight into why weight loss interventions emphasizing financial incentives have struggled to achieve successful maintenance [21, 22]. At the core of SDT is the concept of autonomous motivation, characterized by feeling free and acting for the sake of rewards that are inherent to the activity itself. This inherent reward could be positive emotions, such as interest and enjoyment (i.e., intrinsic motivation), or the satisfaction associated with action that is personally meaningful (i.e., identified extrinsic motivation). Importantly, an emerging body of evidence shows that autonomous motivation is positively related to persistence and maintenance of healthy lifestyle changes. Specifically, self-reported autonomous motivation has been shown to predict greater maintenance of physical activity and weight loss [23, 24]. In a 3-year randomized controlled trial, Silva and colleagues contrasted an intervention designed to promote autonomous motivation for exercise and weight management to a general health education control condition [25–28]. After 3 years, the intervention designed to support autonomous motivation produced significantly better maintenance of both exercise and weight loss, relative to control, and the effects were mediated by autonomous motivation (both intrinsic motivation and identified extrinsic motivation) [29].

Many studies have demonstrated that extrinsic rewards (including financial incentives) tend to undermine intrinsic motivation, an effect often referred to as "the undermining effect." A meta-analysis of 128 studies on the undermining effect found that performance-contingent rewards increase extrinsic motivation while the contingency is in place, but at the expense of decreasing intrinsic motivation [30]. Moreover, the resulting decrease in intrinsic motivation persists well after the contingency is removed (i.e., poor maintenance). SDT posits that the negative relation between extrinsic rewards and intrinsic motivation can be explained by the fact that contingent rewards have a tendency to feel subtly controlling, thwarting peoples' psychological need for autonomy, and distracting them from potentially enjoyable aspects of the targeted activity.

This led us to wonder—is *undermining* responsible for the pattern of poor maintenance observed in weight loss and lifestyle interventions that have emphasized financial incentives? On the one hand, the general pattern of poor maintenance observed across pay-for-performance weight loss and lifestyle intervention trials has been consistent with the undermining effect. On the other hand there are some noteworthy differences between the ways extrinsic rewards have typically been used in the context of experiments investigating the undermining effect versus how financial incentives have typically been used in weight loss interventions. Few studies of the undermining effect have tested the impact of extrinsic rewards for longer than a few hours or days; by contrast, weight loss interventions are typically interesting in assessing maintenance weeks or months later. Further, the typical laboratory experiment investigating the undermining effect has involved administration of a reward at a single time point, leading Deci et al. [30] to conclude from their meta-analysis that more studies are needed "that examine repeated administration of rewards over time" (p. 650). The pay-for-performance weight loss interventions conducted by Volpp and others have typically involved repeated payments for weight loss achieved incrementally over the course of multiple weeks. Furthermore, studies of undermining effects have typically involved rewarding participants for a *behavior that is intrinsically motivated at baseline*, that is, behaviors that are interesting or enjoyable (e.g., Soma puzzles). In the case of obesity interventions, participants' baseline levels of intrinsic motivation for eating healthy foods and being physically active is likely modest. Collectively, these differences introduce reasonable skepticism about whether the undermining effect is relevant in the context of weight loss and lifestyle interventions and support the need for more research on this topic.

The present research is intended to offer an early contribution toward exploring the question of motivational undermining in the context of the Make Better Choices trial—a study testing intensive lifestyle interventions designed to promote health changes in diet and activity using performance-contingent financial incentives (in addition to coaching and support from mobile technology). Based on the self-determination theory, we hypothesized (H1) that self-reported financial motivation (i.e., motivation derived from performance-contingent financial incentives offered for eating healthy and being physically active) would be *negatively related to maintenance* of both health behavior change and weight loss (after performance-contingent financial incentives were removed). We further predicted (H2) that financial motivation would be *unrelated to initiation* of either health behavior change or weight loss.

We also tested two potential moderators of the predicted undermining of maintenance effects: gender and socioeconomic status (SES). First, several authors have previously reported that males report lower trait levels of autonomy orientation and/or high levels of controlled motivational causality orientation [31–34]. Recently, Hagger and Chatzisarantis [35] demonstrated that motivational causality orientation moderates the undermining effect of rewards on intrinsic motivation. Thus, we predicted (H3) that gender would moderate the undermining of maintenance effects. Second, the economic utility of financial intensives is inversely related to incomes or socioeconomic status, as such, financial incentives may feel more controlling to those low in SES. Thus, we predicted (H4) that SES would moderate the undermining of maintenance effects.

2. Materials and Methods

The study design and methods are described in detail in an open source study protocol paper published in BMC Public Health [36] and will be described briefly.

2.1. Study Sample. Chicago area adults of ages between 21 and 60 years were recruited through community advertisements. To be eligible, individuals were required to report all of the following: (a) <5 fruits and vegetables (FV)/day; (b) >8% caloric intake from saturated fat (Fat), (c) <60 min/day moderate/vigorous physical activity (PA), and (d) >90 min/day targeted sedentary screen time (Sed; television, movies, recreational internet use, and videogames). All procedures were approved by the Institutional Review Boards of the University of Illinois at Chicago and Northwestern University.

2.2. Two-Week Baseline Phase (and Final Eligibility Screening). Candidates who self-reported all four risk behaviors were screened by a Bachelor level research assistant (coach). The coach trained participants to accurately estimate and use a handheld device to record and upload dietary intake, moderate-vigorous-intensity physical activity, and targeted recreational sedentary screen time. During the two-week baseline (run-in) phase, participants wore an accelerometer, recorded diet and activity on the handheld device, and submitted data daily to the coach.

2.3. Randomization. Candidates who displayed all four risk behaviors throughout baseline, as evidenced by handheld and accelerometer data, were randomized (stratified by gender) using a computer-generated sequence of randomly permuted blocks. The four behavioral intervention groups differed based on the behaviors that were targeted/incentivized. Each group was assigned to target a different combination of two behavior goals, one related to diet (FV or Fat) and one related to activity (PA or Sed): (1) increase FV and PA (FV↑PA↑), (2) decrease Fat and increase PA (Fat↓PA↑), (3) increase FV and decrease Sed (FV↑Sed↓), or (4) decrease Fat and Sed (Fat↓Sed↓).

2.4. Intervention Phase (Initiation). Coaches tailored behavioral strategies based on participants' baseline data. For example, those who asked to decrease Fat were shown the ten foods that supplied their greatest saturated fat grams and coached to reduce portion size or number for those foods. For the first week of treatment ($T \times 1$), daily diet and activity goals were set midway between baseline behavior and the ultimate daily goal. From the second treatment week onward, full goals were set for the two targeted behaviors to which the participant was randomized: 5 fruit and vegetable servings, saturated fat intake < 8% of calories, physical activity ≥ 60 minutes, or sedentary recreational activity ≤ 90 minutes per day. Participants were expected to reach their behavioral targets during treatment week 2 and to maintain them during week 3. During the three treatment weeks, they uploaded data daily and communicated as needed with their coaches via telephone or e-mail, per preference, to problem-solve around adherence barriers.

2.5. Performance-Contingent Financial Incentives. During the 3-week intervention phase, participants could earn a $175 incentive for fully meeting goals for both targeted behaviors. Thus, participants could earn just over $50/week ($175/3) for meeting their health behavior goals; a relatively small financial incentive in comparison to the amount of time and effort required for success.

2.6. Follow-Up Phase (Maintenance). To explore the potential for maintenance of healthy behavior changes, the study included a 17-week follow-up phase. Immediately after the intervention phase, participants were informed that attainment of diet and activity targets was no longer required; payment was now contingent solely upon recording and transmitting handheld data on a predetermined schedule. This follow-up phase in this study is analogous to the "free choice periods" included in many experiments on rewards and undermining, wherein activity is considered an indicator of intrinsic or autonomous motivation (i.e., "free-choice behavior"). Recording was required daily for the first week following treatment, for three consecutive days in post-treatment weeks two and three, biweekly for the next six weeks, then monthly until the final follow-up. Participants could earn incrementally larger financial incentives (from $30 to $80) for uploading data during consecutive follow-ups. All recording-contingent incentives were received at the end of follow-up.

2.7. Handheld Tool. Participants used a personal digital assistant to record and self-regulate their targeted behaviors. They were instructed to carry the device and record immediately after executing a behavior. During treatment and follow-up, the handheld device displayed two decision support feedback "thermometers"—one for diet (F/V or Fat) and one for activity (PA or Sed). Once activated, goal thermometers were continually updated in response to data entry. The goal thermometers also enabled participants to observe the potential impact of a food or activity choice.

2.8. Measures. Demographic information, anthropometric data, and motivation for health behavior change were assessed during screening. Demographic data gathered include gender, age, ethnicity, marital status, education, income, and household size. Participants estimated their annual household income on the following 11-point scale: $0–15 k, $15–20 k, $20–25 k, $25–30 k, $30–35 k, $35–40 k, $40–45 k, $45–50 k, $50–60 k, $60–75 k, and > $75 k.

2.8.1. Financial Motivation. Context-specific financial motivation for participating in the study was measured using modified items from the Motives for Physical Activities Measure [37]. Before answering these questions, the nature of the study was explained to participants and, specifically, the potential for earning performance-contingent financial incentives in exchange for making healthy behavior changes.

Seven items were altered to ask about eating as well as activity changes and the degree to which financial incentives were a motive for participating in the study (e.g., "Because I want to earn extra money"; $\alpha = .97$). Participants responded on a 7-point Likert scale (1: not at all true for me; 7: very true for me).

2.8.2. Assessment of Individual Behaviors. Saturated fat and FV consumption were measured from daily intake recordings. To prevent superfluous calories (e.g., in sweetened beverages) from inflating the fat gram allowance, the saturated fat goal for those randomized to decrease Fat was determined using the Harris-Benedict equation [38] to estimate calories needed to maintain weight. Minutes of physical and sedentary activity were measured cumulatively by an end-of-day 24-hour activity log in which participants accounted for every 15-minute block of each day.

2.8.3. Composite Diet-Activity Improvement Score. In order to quantify overall change across four behaviors (FV, Fat, PA, and Sed), we developed a composite healthy diet and activity improvement score, weighting each behavior equally. All variables were transformed to better approximate normality, using square root transformation for the count outcomes (FV, PA, and Sed) and arc sine transformation for the percentage outcome, Fat [39]. To allow direct comparisons between interventions on these disparately measured variables, each individual health behavior was standardized to provide a common metric using a modified z-score (where 1 unit represents a 1-standard deviation change), with higher values representing greater healthy lifestyle improvement. Z-scores for time points after baseline were standardized relative to the overall baseline distribution to reflect improvement relative to baseline. To reflect the effect of treatment across multiple health behaviors, the mean of all four individual z-scores at each time point was calculated, as recommended [40], to derive a composite index that expressed each participant's overall healthy behavior change. We refer to this as a "composite diet-activity improvement score."

2.8.4. Weight. Weight was measured at three times: at baseline, the end of prescription, and at the end of the follow-up phase. A trained staff member weighed participants (to the nearest 1 lb) on a calibrated beam balance scale without shoes and wearing light clothing. Two measures were recorded at each visit.

3. Results and Discussion

3.1. Study Sample. The final sample of 204 adults included 48 males, 46.6% minorities, 25% with no more than a high school education, and mean age 33.3 years (s.d. = 11.01). Except for one individual, all participants attained behavioral targets during the 3-week initiation period (thus earning the \$175 performance-contingent incentive); the majority did so promptly. The median time taken to achieve consumption of five FV was nine days (i.e., two days after the full five FV goal was set). The median time taken to attain each of the Sed, Fat, and PA targets was eight days (i.e., one day after the targeted amount was set as a goal).

3.2. Group Effects. Group effects have been reported previously [41]. The primary finding was that the group assigned to FV↑Sed↓ produced significantly greater change in composite diet-activity improvement score after the 3-week intervention phase, relative to the other three groups (FV↑PA↑, Fat↓PA↑, Fat↓Sed↓). Further, the FV↑Sed↓ group maintained this advantage through the end of the 17-week Follow up Phase.

The effects reported herein related to financial motivation were independent of group assignment. None of the financial motivation x group interactions were significant; thus, all secondary analyses reported in this paper were conducted collapsing across Groups.

3.3. Financial Motivation → Initiation of Healthy Changes. Two linear regression models were run regressing initiation of healthy changes from the baseline phase to the end of the (incentivized) intervention phase onto financial motivation. Healthy change outcomes were (1) initiation of composite diet-activity improvement score change and (2) initiation of weight change (loss). As predicted, financial motivation was unrelated to initiation of healthy change during the incentivized intervention phase, unrelated to healthy lifestyle improvement initiation ($\beta = -.10$; $P = .12$), and unrelated to weight loss initiation ($\beta = .014$; $P = .19$).

3.4. Financial Motivation → Maintenance of Healthy Changes. Next, two linear regression models were run regressing maintenance of healthy changes from the baseline phase to the end of the follow-up phase onto financial motivation. Maintenance of healthy change outcomes was (1) maintenance of composite diet-activity improvement score change and (2) maintenance of weight change (loss). Financial motivation was unrelated to maintenance of composite diet-activity improvement score, $\beta = -.08$, $P = .23$. However, Financial motivation was negatively related to maintenance of weight change, $\beta = .034$, $P = .03$; that is, those who were higher in Financial motivation weighed more on average at the end of the follow-up phase, after controlling for weight during the baseline phase (see Table 1 & Figure 1).

3.5. Financial Motivation x Gender → Maintenance of Healthy Changes. We ran two linear regression models that tested the interaction between financial motivation and gender predicting change from the baseline phase to the end of the follow-up phase in terms of (1) maintenance of composite diet-activity improvement score change and (2) maintenance of weight change (loss). Gender interacted with financial motivation to predict maintenance of composite diet-activity improvement score change ($\beta = .17$, $P = .02$), such that financial motivation undermined maintenance of composite diet-activity improvement score more among men (see Table 2). The gender by financial motivation interaction did not predict maintenance of weight loss

Table 1: Regression model predicting weight at the end of follow-up (maintenance).

	B	SE	β	t	P-value
Constant	5.40	2.779		1.94	<.05
Financial motivation	1.51	0.705	.034	2.15	<.05
Baseline weight	0.97	0.015	.986	62.44	<.001

Note. The positive β and t statistics associated with financial motivation imply a positive relation with total body weight at the end of follow-up and thus a negative relation with weight loss from baseline to the end of follow-up.

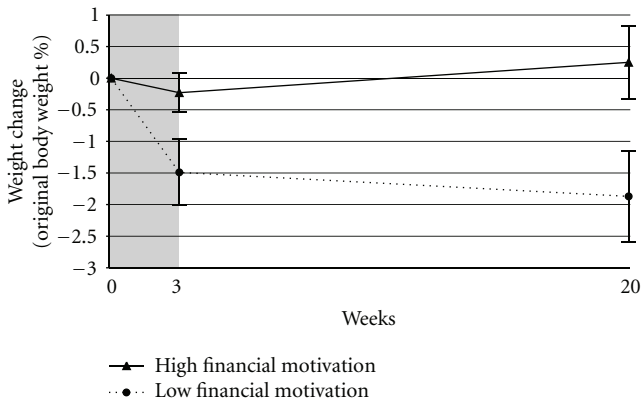

Figure 1: Financial motivation predicting weight change (% of original body weight). high: top quartile; low: bottom quartile.

Table 2: Regression model predicting composite diet-activity score (diet-activity) at the end of follow-up (maintenance).

	B	SE	β	t	P-value
Constant	.635	0.069		9.19	<.001
Financial motivation	.086	0.071	−.084	−1.21	.23
Gender	−.012	0.068	−.012	−0.17	.86
Baseline diet-activity	.654	0.115	.404	5.69	<.001
Financial motivation					
x Gender	.172	0.071	.169	2.42	.016

($\beta = -.022$, $P = .139$), though the main effect of financial motivation remained significant even controlling for this interaction term.

The gender x financial motivation interaction predicting maintenance of composite diet-activity improvement score is illustrated in Figure 2. Participants in the top and bottom quartiles with respect to financial motivation were categorized as "high" or "low," respectively, yielding four groups. Simple slopes were calculated for each group: (i) high financial motivation males; $t(70) = -4.15$, $P < .001$; (ii) low financial motivation males; $t(70) = -2.17$, $P < .05$; (iii) high financial motivation females; $t(70) = -2.70$, $P < .01$; (iv) low financial motivation females; $t(70) = -3.51$, $P = .001$.

3.6. Financial Motivation x SES → Maintenance of Healthy Changes. We ran two linear regression models that tested the interaction between financial motivation and SES predicting change from the baseline phase to the end of the follow-up phase in terms of (1) maintenance of composite diet-activity improvement score change and (2) maintenance of weight change (loss). Participants' estimates of annual income were negatively skewed; the modal response (28%) reported an annual household income greater than $75,000. The interactions between financial motivation and income were not significant.

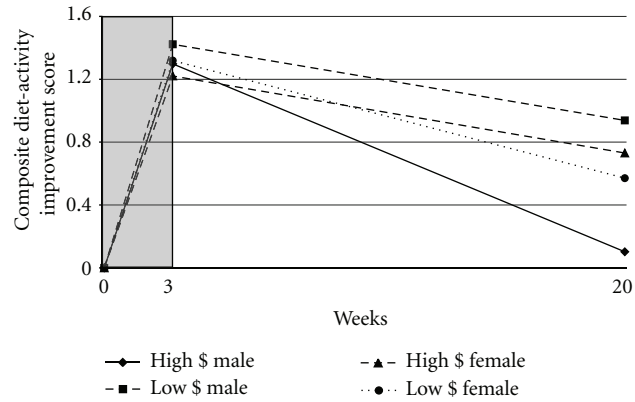

Figure 2: Financial motivation x gender predicting composite diet-activity improvement score. $: financial motivation. high: top quartile; low: bottom quartile.

4. Conclusions

In the Make Better Choices Trial, participants were offered performance-contingent financial incentives for making healthy behavior changes (related to diet and activity) over the course of three weeks. While financial motivation was unrelated to healthy behavior or weight change during this 3-week initiation or intervention phase, after performance-contingent financial incentives were removed (and after a 17-week follow-up phase), financial motivation was negatively related to weight loss maintenance. Financial motivation was also negatively associated with maintenance of healthy behavior changes among men, more so than for women. This research represents, to the best of our knowledge, the first evidence for the undermining effect within the context of an intensive healthy lifestyle intervention. Furthermore, past research on the undermining effect has typically involved lab experiments with relatively small samples, rewards administered at a single time point, short follow-up periods, and behaviors with high levels of baseline intrinsic motivation. This research is among the first to provide evidence for the undermining effect in a study with a relatively large sample ($n = 204$), an extended incentivization period (3 week), an extended follow-up period (17 weeks), and behaviors for which there was only modest levels of intrinsic or autonomous motivation at baseline.

Based on the self-determination theory (SDT), the reason that financial incentives have the potential to undermine autonomous motivation, and thus maintenance after

being removed, is that incentives are often experienced as subtly controlling. A meta-analysis of studies related to the undermining effect found that this is especially true of tangible, performance-contingent incentives [30], as were used in this study. As noted earlier, a number of studies have found that men tend to have a more controlling (and less autonomous) orientation to the world, in general [31–34]. Recently, Hagger and Chatzisarantis [35] demonstrated that these same causality orientations can moderate the undermining effect of rewards on intrinsic motivation. Specifically, in the context of a lab experiment, the authors found that control-oriented participants assigned to a reward condition exhibited significantly lower levels of intrinsic motivation (less time spent on a puzzle activity during a free choice period) compared to those assigned to a no reward condition: a replication of the classic undermining effect. In contrast, there was no significant difference in intrinsic motivation levels between reward conditions for autonomy-oriented participants. Hagger and Chatzisarantis interpret their findings as indication that autonomy-oriented causality orientation protects individuals from the undermining effect of rewards on intrinsic motivation. We offer a similar, speculative interpretation for the financial motivation by gender interaction observed in the present study. That is, we suspect that females in our sample tended towards a more autonomy-oriented causality orientation, which protected them from the undermined maintenance of healthy behavior changes that males in our sample exhibited. Because the present study involved secondary analysis of data, measures of motivational orientation were not included. A future study might test this interpretation by measuring global causality orientation and investigating whether the financial motivation by gender interaction remains significant after controlling for a financial incentive by causality orientation interaction term (i.e., mediated moderation [42, 43]). Related follow-up research might investigate further individual differences and contextual factors relating to the *interpretation* or experience of financial incentives in an intensive lifestyle intervention.

Another useful direction for future research would be more studies of intensive lifestyle interventions that experimentally vary the way financial incentives are framed. Prior work has already demonstrated in lab settings that different reward contingencies and interpersonal contexts each influence intrinsic motivation by virtue of influencing the interpretation of rewards [30, 44]. One might argue that a limitation of this study pertains to the correlational (versus experimental) nature of the data. Correlational data, and cross-sectional designs in particular, make it difficult to draw causal inferences. It is important to consider, however, that using experimental designs to investigate the potential for undermining in the context of healthy behavior change intervention may pose ethical challenges. In the case of behaviors typically studied in the lab (e.g., Soma puzzles), the cost of undermining intrinsic motivation into the future is relatively low. The benefit to science gained from conducting such experiments typically outweighs the cost of potentially reducing participants' enjoyment of Soma puzzles. The ethical ramifications of turning a participant off to healthy eating and/or physical activity in the future are far more serious; thus, more consideration must be exercised on the part of researchers, and Institutional Review Boards (IRBs) are more likely to raise concerns.

Despite these challenges, it is our position that more research on the issue of financial incentives and potential undermining in health behavior interventions is sorely needed. At their best, financial incentives may be a useful tool in helping people initiate healthy habits, or even grow to enjoy healthy behaviors. A number of studies have recently demonstrated that offering small financial incentives increase enrollment and reduce disparities by encouraging otherwise underrepresented groups to enroll in both physical activity and weight loss interventions, thereby enhancing intervention reach [45–47]. Furthermore, the high potential value of research in this area can also be explained by the fact that financial incentives are already being widely used in health behavior interventions. As noted earlier, one survey of large US employers found that over 70% of employee wellness programs were using financial incentives to encourage participation and/or performance in 2008; this represented an increase from 62% in 2007 [1], and the World Health Organization has recommended using rewards in obesity treatment, specifically [2]. Popular consumer websites, such as stickk.com, have also contributed to making financial incentives for healthy behavior changes an increasingly routine practice. As a result of this existing infrastructure, research that illuminates the use of financial incentives can have a swift, significant, and positive impact on public health.

In conclusion, the findings from this study demonstrate that financial incentives have the potential to undermine successful maintenance in an intensive lifestyle intervention. Specifically, participants who reported being more motivated by the MBC intervention's financial incentives were worse off in terms of their diet and activity (among men), and their body weight (men and women) at the end of a 17-week follow up period. Our interpretation of these findings is that financial incentives, when overemphasized, have the potential to be interpreted as controlling, thereby undermining autonomous motivation and subsequent maintenance of targeted health behaviors. Researchers and practitioners who are planning to use financial incentives in health behavior interventions may do well to consider framing those incentives in ways that are autonomy supportive and investing resources in the collection of follow-up data to investigate behavioral maintenance after incentives have been removed.

Acknowledgments

The Make Better Choices trial was supported by National Institutes of Health (NIH) Grant HL075451 to Dr. B. Spring, by the Robert H. Lurie Comprehensive Cancer Center Grant (NIH P30 CA060553) and by NIH F31 MH070107 to Dr. Schneider. We thank Sarah Altman, Katherine Bailey, Katty Cavero, Michael J. Coons, Neil Doran, Anne Maloney, Dennis McChargue, Sherry Pagoto, Anjali Pandit, Jim Painter,

Michael Painter, Christine Dutton Pellegrini, Alex Pictor, Natalie Ritchie, Megan Roehrig, and Stephanie Russell for technical assistance and thank Joanna Buscemi, Alyson Sularz, and Kristen Pavle for their thoughtful feedback on earlier versions of this paper.

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Hindawi Publishing Corporation
Journal of Obesity
Volume 2012, Article ID 327259, 12 pages
doi:10.1155/2012/327259

Review Article

Parental Influences on Children's Self-Regulation of Energy Intake: Insights from Developmental Literature on Emotion Regulation

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Received 4 November 2011; Accepted 11 January 2012

Academic Editor: Jutta Mata

The following article examines the role of parents in the development of children's self-regulation of energy intake. Various paths of parental influence are offered based on the literature on parental influences on children's emotion self-regulation. The parental paths include modeling, responses to children's behavior, assistance in helping children self-regulate, and motivating children through rewards and punishments. Additionally, sources of variation in parental influences on regulation are examined, including parenting style, child temperament, and child-parent attachment security. Parallels in the nature of parents' role in socializing children's regulation of emotions and energy intake are examined. Implications for future research are discussed.

1. Introduction

Children's development of emotional self-regulation is important for many aspects of their health and wellbeing, including their ability to tolerate frustration [1], curb aggressive impulses [2], delay gratification [3], and express emotions in socially acceptable ways [4]. Children who are able to regulate their own emotions are better able to interact with their peers [5], whereas poor emotion regulation in preschool-aged children has been related to higher levels of externalizing behaviors [6–8]. Children's deficits in the ability to self-regulate their own behavior have been linked to rapid weight gain and obesity in middle childhood [9].

There is a strong body of evidence to support that parents play an important role in children's development of self-regulation of emotions in the early years [7, 10, 11]. At birth, infants lack control over their emotional arousal. Instead, infants' emotional arousal is regulated by their own biological needs and how parents respond to those needs. Parents comfort infants when they express negative emotions as well as arouse positive emotions in their infants through play and other stimulating interactions [12]. For example, if a one-month-old infant experiences an aversive stimulus, the infant's crying signals to the parent that he or she is upset. Parents' actions such as calming or soothing the infant serve to regulate the child's emotions. Therefore, young infants rely heavily on their parents to regulate their emotions. As children age, they require less assistance in regulating emotions. For example, a four-year-old might self-sooth in response to an aversive stimulus instead of immediately crying.

Children's self-regulation of *energy intake* refers to children's ability (inborn and socialized) to eat and not eat in response to cues of hunger and satiety [13]. The development of self-regulation of energy intake in childhood is important for many aspects of health and wellbeing. Notably, overweight children have been found to have deficits in self-regulation of energy intake compared to normal weight peers [14, 15]. Researchers have demonstrated that preschool

children are capable of self-regulation of energy intake [16, 17]. At the same time, large individual differences in children's self-regulation of energy intake have been found. Temple and colleagues found food to be more reinforcing for overweight children than for normal weight children [18]. Additionally, fMRI studies have demonstrated greater anticipatory and consummatory reward responses in brain regions of overweight adolescents compared to normal weight adolescents [19]. To the extent that individuals are motivated by external cues, they may be less sensitive to internal signals of hunger and less able to self-regulate their energy intake in the presence of external food cues. Given that socialized (non-inborn) aspects of self-regulation of energy intake develop in the context of parent-child interactions during feeding with parents, parents are likely to play an important role in the development of such individual differences. A small but growing body of research is indicating that this is the case; individual differences in parents' feeding practices have been linked to individual differences in children's self-regulation of energy intake [20–24]. At the same time, there are gaps in our knowledge of how parents influence children's development of self-regulation of energy intake.

There is a large body of research on parental influences around emotion regulation, and this represents an exemplary model system for understanding parenting influences on children's development of self-regulation of energy intake. Thus, the literature on how parents influence children's emotion regulation can provide useful information for child obesity researchers concerning how parents may contribute to an obesogenic environment by influencing the development of children's self-regulation of energy intake. The purpose of this paper is to examine the literature on children's early development of emotion regulation, and in particular, parents' role in this development, to provide insight into the developmental processes by which parents influence children's self-regulation of energy intake.

2. The Influence of Parents on Children's Self-Regulation of Emotions and Energy Intake

Throughout the first year of life, infants gradually increase their ability to control their own emotional states [25, 26] and they begin to self-regulate emotions before the second half-year of life [27]. Individual differences in children's abilities to regulate their emotions are apparent by this time, and whether they intend to or not, parents substantially influence these individual differences [4].

Power [28] indentified some of the ways that parents can help children regulate their emotions. These parental techniques are relevant as infants progress through toddlerhood into their preschool years and beyond. They include (1) modeling emotion regulation or specific emotion regulation strategies; (2) responding to their children's emotional expression by acknowledging emotions, helping children process their emotions, helping children calm down, or questioning/punishing emotional expression; (3) assisting children in the moment by teaching them various emotion regulation strategies (e.g., attend to relevant stimuli, seek out appropriate information, analyze the situation, generate, and evaluate alternatives) and (4) motivating children through various social and material rewards and punishments [28]. This line of research on parental influences on children's self-regulation of emotions provides a useful framework that researchers interested in parental influences on children's self-regulation around food can utilize. For example, children experience both stress and hunger in the presence of their parents. Parents' reactions to children in these situations influence how children react to future experiences; therefore, how parents interact with their children influences children's self-regulation of both emotions and eating. The following discussion of each of these parenting processes shows how the literature on parental influences on children's emotional regulation can inform our understanding of the impact of parents' behaviors on children's self-regulation of energy intake.

2.1. Parental Modeling. Parents may not be aware of it, but they model behaviors around both emotional expressivity and food intake beginning when their children are infants. The literature on self-regulation of emotions indicates that parents provide very important models by which children learn to express emotions and later learn to control emotional expressivity. For example, researchers have found that infants in their first half-year of life mimic the emotions of their parents [2, 6, 29]. When parents display a wide range of positive and negative emotions in appropriate social contexts, their children are more likely to learn which emotions are appropriate to display in which situations; conversely, when parents display high levels of anger or personal distress, children are less likely to observe and learn appropriate ways to regulate and express their negative emotions [30].

Similarly, parents can provide both positive and negative models of self-regulation of energy intake through their own eating practices. For example, researchers have found that parents report that they often eat foods during meals that they would like their child to eat [31]. However, parents' modeling behaviors may either be conducive or not conducive to children developing good self-regulation of energy intake. After being asked if they want seconds, parents who respond by saying that they are full provide a positive model to their child. However, parents who say they are "stuffed" but then ask for dessert may provide negative models. To this point, Johnson and Birch found parental self-report of disinhibited eating was correlated with children's lessened ability to self-regulate energy intake [20]. It may be that parents who report disinhibited eating are providing negative models of self-regulation of energy intake, thereby setting forth the pathway to poor self-regulation of energy intake in their children. Although, to our knowledge, most of the literature on modeling and energy-intake deals with food acceptance [31], and little-to-no work has been conducted on parent modeling and self-regulation of energy intake with children. Some research has been conducted on peer modeling and energy intake in children. Notably, Salvy et al. found differences in the amount of food consumed by overweight and normal weight children when alone and with

peers. Overweight children consumed more when in solitude than when in the presence of peers [32]. As discussed by the authors, one possible reason for the lessened amount consumed in the presence of peers for overweight children is that normal weight children were modeling lower energy intake amounts and overweight children modified their intake amounts accordingly when in the presence of normal weight peers [32]. Researchers interested in understanding parental contributions to children's self-regulation of energy intake should further examine how parents model behaviors around their own regulation of energy intake and the influence of these parental behaviors on children.

2.2. Parental Responses to Children's Behavior. Research in the area of emotional expressivity indicates that the specific ways in which parents respond to children's emotions, beginning in infancy and continuing throughout early childhood, are influential in shaping children's self-regulation of emotions. Parents' acceptance of positive and negative emotions is important for optimal development of emotional expression and emotional regulation because children whose parents are accepting of their negative and positive emotions feel free to express both types of emotions when distressed and are better able to eventually express these emotions in socially accepted ways [7, 33, 34]. Parental responses to their children's negative emotions should also be contingent on children's behavior, as well as appropriate given the child's behavior, age, and needs (see Black and Aboud for review of responsive parenting) [35–38]. In contrast, the parental practice of over-control around emotions occurs when parents respond in punitive, distressed, or minimizing ways to children's expressions of negative emotions [13, 14]. Punitive responses include anger or threats, for example, "Stop that crying or I will give you something to cry about." Minimizing responses are those that fail to validate the child's emotions by belittling them, for example, "Oh, you're being a baby." Distressed responses are those in which parents respond to their children's negative emotions by displaying distressed negative emotions themselves (e.g., a frustrated or angry vocal tone). All of these responses show a lack of acceptance of the child's emotion and do not help the child learn to deal with that emotion in a productive way. Parental over-restriction of emotional expressivity has been linked to children's lessened capacity to regulate their own emotions and thus to undesirable outcomes for children [39].

Research has indicated that negative parent reactions to children's negative emotions can have one of two possible outcomes. First, they can ultimately result in greater negative emotional expressivity in children since the children become frustrated with having to continually suppress their emotions [11, 40]. For example, researchers have found that school-aged children whose parents react in more punitive ways to their negative emotions have deficits in their ability to regulate emotion and express higher levels of externalizing behaviors based on teacher reports [6–8]. The second possible outcome is that some children succeed in suppressing their negative emotions, leading to flat emotional expressivity (suppression of both negative and positive emotions), and possibly to later internalizing problems [11].

Similarly, parental responses to children's expressions of hunger and satiety cues are likely to be important influences in shaping their children's self-regulation of energy intake. Parents can respond to children's cues in ways that encourage optimal self-regulation of energy intake (e.g., letting children leave the table when they say they are full, encouraging children to reflect on how full they are before they are served some more, encouraging children to slow down the rate of eating) or in ways that interfere with self-regulation of energy intake (e.g., refusing to believe children's statements about fullness and encouraging them to eat more). Just as parental restriction of children's emotional expressivity has been thought to interfere with children's ability to self-regulate their own emotions, parental restriction around food has been linked to deficits in self-regulation of energy intake in children [24]. Parental restriction around food occurs when parents overly restrict the quantities and types of foods available for the child to eat [41]. Findings from a laboratory assessment of satiety in children suggest that children whose parents reported more restrictive and controlling feeding behaviors ate more beyond satiety compared to their peers [42, 43]. Thus, researchers interested in the development of children's self-regulation of energy intake should examine over-restriction of foods parents make available to children as well as overcontrol of the amount of food children can eat as a possible mechanism for children developing less than optimal self-regulation of energy intake. Additionally, researchers should further look into different types of control that parents use (i.e., overt control and covert control) [44] and the reasons why parents restrict foods (i.e., restriction for health and restriction for weight) [45]. Children who experience too much parental control around eating may not learn to identify their own satiety cues and thus may have poor abilities to self-regulate their energy intake. To this point, researchers have found associations between controlling parent feeding practices (as assessed by survey measures) and children's lessened ability to self-regulate energy intake [20]. Thus, as parental overcontrol of young children's emotional expressivity results in children not learning adaptive ways of expressing emotions (either over- or underregulating their emotions), parental over-restrictiveness around food may diminish children's ability to read their own hunger and satiety cues and respond with appropriate self-regulation of energy intake. Some children may thus overeat when parents are not present to monitor their eating, and others may undereat.

In addition to affecting the development of their children's abilities to self-regulate energy intake through controlling their children's food intake or access to certain foods, parents may also affect their children's energy intake through the ways in which they respond to children's emotions surrounding food. Parents present infants with new textures, tastes, and temperatures during meals. This can elicit frustration, sadness, and even anger from children, who, in turn, can also frustrate and anger the parents, altering the emotional context of the meal altogether. This is an important process for researchers interested in self-regulation of energy intake to better understand because parental responses to children's negative emotions *around* food have the potential to influence the child's view of that particular food or the

process of eating in general. For example, if a parent responds with anger or frustration to the child's refusal to eat spinach, this response may serve to increase the emotionally negative quality of spinach for the child. Similarly, if having sweets is always associated with emotionally happy occasions like holidays or birthdays, this would increase the emotionally positive quality of sweets.

2.3. Parental Assistance in Helping Children Self-Regulate. According to Gottman et al., parents who engage in "emotion coaching" are highly aware of their children's emotions, they are accepting of their children's emotions (positive and negative) and assist them in the process of understanding their emotions and expressing their emotions in socially appropriate ways [11]. A parent might engage in emotion-coaching by saying, "I can see you are angry and it is OK to be angry. You cannot scream in here. Take a deep breath and use your words to tell me what is wrong." These techniques used by parents have been associated with better self-regulation of emotions in children [8]. These findings have great potential to inform researchers interested in understanding parental influences on children's ability to self-regulate energy intake. Parents can assist children in the process of self-regulation of energy intake by helping them attend to relevant stimuli (e.g., appropriate portion size, internal fullness, or hunger cues), encouraging them to seek out appropriate information (e.g., reading and understanding food labels), and generating and evaluating alternatives (e.g., considering options when they are hungry for a snack). Theoretically, parents can engage in *intake-coaching* by understanding and accepting their children's cues of hunger and satiety and assisting their children with making appropriate choices about the types and amounts of foods that they consume. It is important for parents to assist children with *appropriate choices*. For example, if choosing from a children's menu, parents can present their children with a few acceptable choices instead of the entire menu. Additionally, given that portion sizes have increased in recent years [46], parents can control the amount of food presented to children when out at restaurants by modifying portions on their children's plates before they begin eating. This can be accomplished through splitting large portioned meals between two children or packaging some food as leftovers before beginning a meal. Researchers should investigate whether these parental practices of *intake-coaching,* a concept similar to scaffolding energy intake, foster better self-regulation of energy intake in children.

2.4. Motivating Children through Rewards and Punishments. As noted above, punitive parental responses to children's expression of negative emotion have negative consequences for children's emotion regulation. Much of the time, parents respond to children's emotions with no conscious intent to socialize them, such as when they show frustration and distress themselves when their children cry. Often, however, parents consciously try to motivate their children to suppress their display of negative emotions by threatening punishment or offering rewards. These practices do suppress the expression of emotion in the immediate situation. However, when this is a common practice, children are less likely to learn how to productively deal with their negative emotions [11, 40].

Similarly, some parents may try to motivate self-regulation of energy intake through external rewards and punishments. Experiments have indicated better ability to self-regulate energy intake in children who have been encouraged by caregivers to pay attention to internal cues of hunger and satiety rather than external cues such as rewards [21]. Rewards tend to increase the amount of a food consumed, however, evidence suggests that they might also undermine children's natural intrinsic motivation to eat that particular food (see Cooke and colleagues [47] for a review). Birch and colleagues found that children who were instructed to finish their meals before receiving a reward consumed more after preload than their same-aged peers who had been instructed to pay attention to internal cues of fullness [48]. Their experiment was meant to simulate the real-life condition in which parents require children to clean their plate before engaging in a desired behavior. For example, a parent might say, "Jimmy, you can go play with your sister once you finish your chicken and broccoli." It has been theorized that contingency-based parent behaviors such as this impair children's ability to self-regulate their energy intake. Punishments are likely to be counterproductive because they are likely to override sensitivity to internal cues of fullness and hunger.

Additionally, parents often comfort children with food [49]. For example, some children receive a lollipop as a reward for enduring a shot at the doctor's office. Although this is a mundane example, it is a demonstration of how two things that are not at all related (emotional/physical pain and candy) can become related over time. Later in life, people who find comfort in food because of childhood experiences, might be more likely to turn to a pint of ice cream to cope with a breakup or a candy bar as a pick-me-up after getting reprimanded by their boss. Although parental reports of providing food as comfort have not been associated with overweight status in children [50, 51], high parental use of this technique has the potential of teaching children to rely on food to cope with difficult emotions or stress and may influence energy intake over time and should be further investigated by researchers. Additionally, parents may be less likely to admit using food to comfort their children on self-report measures or may not even be aware if they do this often. Thus, more observational studies of feeding behavior in the home would be useful.

3. Sources of Variation in Parental Influences on Children's Emotion Regulation and Energy Intake

Studies examining parental influences on children's emotion regulation have examined the role of numerous sources of variation that relate to parent-child interaction patterns relevant to children's development of healthy patterns of emotional self-regulation. These sources of variation have included variations in parenting (e.g., parenting style), variations in children (e.g., the child's inborn temperament), and

variations in the parent-child relationship (e.g., child-parent attachment security). We next explore implications of these sources of variation for the development of children's energy intake.

3.1. Parenting Style. Parenting styles are a useful way to examine constellations of parenting behaviors. Parenting styles are relevant to self-regulation of both emotions and eating because, as Rhee suggested, they can be looked at as the "emotional background" in which parenting practices take places (page 23) [52]. Although parenting styles were first conceptualized by Baumrind [53], scholars further elaborated these styles using dimensions of demandingness and responsiveness [54]. Parents with an *authoritative* style are highly demanding and highly responsive, those with an *authoritarian* style are highly demanding and low in responsiveness, those with an *indulgent* style are highly responsive but low in demandingness, and those with an *uninvolved* style are low in both.

The authoritative style presents an optimal context for fostering children's self-regulation in many situations since authoritative parents are more likely than other parents to model positive and socially appropriate emotional responses to frustrating situations and to provide adaptive emotional coaching [55]. In contrast, authoritarian parents are more likely than other parents to model undercontrolled, angry emotions in frustrating situations and to respond in a punitive fashion to their children's expression of negative emotions [55].

These parenting styles have also been hypothesized to be relevant for explaining differences in children's self-regulation of energy intake. Rhee [52] suggested that researchers look at feeding behaviors that authoritative parents engage in because these are likely the most effective for children's health and well-being. Authoritative parents might require that their children finish their meatloaf and peas before playing with their toys but give into their children's needs when he or she expresses that they cannot eat any more food; for example, they might change their request such that their child eat some of the meatloaf and peas rather than all. This would be conducive to children developing good self-regulation around eating because it would encourage them to pay attention to their own internal cues of hunger and fullness. Additionally, parents responding to children's cues of hunger and fullness should empower children to self-regulate energy intake instead of energy intake being regulated solely by parents. In contrast, it is unlikely that authoritarian parents would be responsive to children's negative emotions around food or children's requests to eat or not eat due to feelings of hunger or fullness. Given what is known in the literature related to emotion regulation, parental lack of responsiveness to children's cues of hunger and satiety paired with parents being demanding might result in a flattening of these cues and, as a result, be detrimental to self-regulation around eating in children of authoritarian parents.

In support of these ideas, findings of a study that examined the relation of the four parenting styles to the overweight status of first-grade children indicated that children with authoritarian mothers were at the highest risk for being obese, whereas children with authoritative mothers were at the least risk [56]. Similarly, adolescents with authoritative parents were significantly more likely to consume fruit and to have positive attitudes toward fruit consumption than those with authoritarian parents [57]. It is important for researchers to look further into the relation between parenting style and children's overweight status to examine whether children's self-regulation of energy intake does in fact mediate this association.

Researchers have found some interesting differences across ethnicities in regards to how parenting styles relate to child outcomes. For example, in contrast with the typical research findings that children of authoritative parents have better outcomes, Tamis-LeMonda et al. found that authoritarian parenting styles were associated with positive child outcomes in low-income African-American families [58]. Given that this research was done among only one economic strata of African-American families, researchers do not yet know if these findings are due to differences in culture, income, or both [58]. Hughes and colleagues found a similar relationship between feeding styles and weight status; their studies suggest a *negative* relationship between authoritarian feeding styles and weight status in low-income, ethnically diverse samples [59, 60]. Understanding findings across low income samples of children is especially important given that, in the United States, people of low SES have a higher rate of obesity than people who are not low SES [61].

Highly permissive parenting (including both indulgent and uninvolved) has also been linked with young children's poor emotion regulation and aggressive behavior [62], indicating that parents' sensitive responsiveness alone is not sufficient for children's development of optimal emotion regulation. Permissive parents may be less likely than authoritarian parents to scaffold their children's development of healthy emotional regulation by modeling appropriate emotional expressivity and providing "emotion-coaching." Similarly, they may be less likely to provide children with the motivation and guidance needed to help them develop effective self-regulation of energy intake.

In support of this idea, Rhee and colleagues found that indulgent and uninvolved parents were twice as likely as authoritative parents to have overweight children, though these children were at less risk than those with authoritarian parents [56]. However, Hughes and colleagues found in a low-income sample, parents' use of indulgent feeding styles actually predicted the greatest risk for childhood obesity, even greater than the authoritarian feeding styles [59]. Parents who engage in indulgent feeding place few demands on their children's eating behavior, although the few demands they do make are nondirective and supportive. It is possible that these children lack the scaffolding provided by authoritative and authoritarian parents to help teach self-regulation of energy intake. Again, research on whether or not self-regulation of energy intake and low parental scaffolding mediate the relationship between indulgent parenting/feeding and higher child BMI is needed.

Hughes and colleagues did not find differences in children's energy intake as a function of parents having an uninvolved style of parenting. The authors reasoned that

uninvolved parents should be unlikely to foster self-regulated eating habits in their children; although not measured in their study, they also speculated that uninvolved parents may provide a generally poor diet for their children. Future research on the feeding patterns of uninvolved parents is needed [60].

3.2. Child Temperament. Self-regulation of emotions and energy intake are both likely to be influenced by children's inborn traits. Although temperament is defined as a stable and enduring trait [63], the behavioral manifestations of infants' temperament are modified over time as a consequence of repeated interactions with parents and others. Thus, some researchers have studied temperament from a more developmental, cyclical perspective to better understand how infants' inborn temperament influences their development of emotion self-regulation. For example, Thompson approached the subject of parental influence on children's self-regulation of emotion from a bidirectional point of view; he argued that both intrinsic components (e.g., temperament) and extrinsic components (e.g., parental socialization) are involved in the development of emotional regulation. That is, although it has been demonstrated that temperament can be influenced by environment, the child's temperament can also influence the way that people react to the child [12]. According to Cassidy, "When an infant's strategic response to a mother's caregiving is considered, two contributions of temperament are acknowledged: (a) the response is likely to fall within a range that is constrained by the infant's temperament and (b) infants are not only responsive to their mother's caregiving behavior but also contribute to shaping its nature" (page 244) [33].

Infants are born with different levels of emotional reactivity that influence their care-giving environment [64]. People often refer to highly reactive infants as fussy or difficult and infants who are not reactive as easygoing. A fussy baby might elicit more frustration from his or her caregiver than an infant who rarely cries. Additionally, a fussy baby might elicit a different response from his or her caregiver upon crying than an infant who rarely cries. According to the dynamic viewpoint of temperament posited by Thompson, Cassidy, and others, the difference in quantity or quality of caregiver response to the infant's emotional expressivity has the potential to shape the infant's subsequent emotional expressivity. In turn, the way the infant comes to express emotions elicits further emotional socialization from the parent [65]. Thus, a fussy infant might elicit greater expression of personal distress from a parent, which may increase the infants' negative emotionality over time, whereas another parent who responds to the infants' crying with comforting may decrease the infants' negative emotionality.

Borrowing from the literature on the development of self-regulation of emotions, it is evident that temperament is likely to be an important factor in the cyclical process of how interactions with parents influence children's self-regulation of energy intake. For example, parents may be more tempted to use foods to comfort and sooth infants and children who have more difficult temperaments, and the parent-child interactions surrounding foods are likely to be more stressful for infants with highly reactive temperaments compared to infants who are more easily soothed. Some research evidence for this exists. Agras and colleagues found child temperament to mediate the relationship between parent overweight and child overweight. Specifically, children of overweight parents who were rated as highly emotional in the Children's Behavior Questionnaire [66] were more than twice as likely to be overweight at 9.5 years than children of overweight parents who were not highly emotional [67]. However, specific ways in which temperament influences interactions between children and their parents around food are not well known. Therefore, researchers interested in the developmental processes by which parents influence children's self-regulation of energy intake should take child temperament into account.

3.3. Child-Parent Attachment. Research about the influence of attachment on children's interactions with their parents and children's subsequent self-regulation of emotions is also likely to have important implications for understanding the relation between children's attachment and self-regulation of food intake. Based on their caregivers' history of success in providing comfort and protection to their infants when they are distressed, infants have expectations as to how their caretaker will react to future expressions of distress and form strategies based on these expectations that they will use later when distressed in order to seek comfort from their caregivers. These individual differences in the strategies that infants use to gain comfort from their caregivers can be seen in the Strange Situation Paradigm, the classic method of assessing security of infant-caregiver attachment [68]. After entering an unfamiliar room with their caregiver, secure infants explore the room freely when their caregiver is present, using the caregiver as a secure base. Security of attachment is assessed primarily as a function of infants' behavior during reunions, after being separated from their caregiver. If securely attached infants become distressed during separations, they immediately seek proximity to the caregiver upon reunion and are calmed easily by their caregiver, and if not distressed, they still show accepting behavior towards their caregiver in reunion episodes and clearly prefer the caregiver over the stranger. In contrast, infants classified as insecure-avoidant show less distress during separation and turn away from the caregiver upon reunion, and those classified as insecure-ambivalent cannot be comforted. They show ambivalence toward the caregiver, mixing clinging, and proximity-seeking behavior with displays of anger, such as hitting.

Cassidy has proposed that individual differences in children's emotion regulation can be predicted from their attachment histories [33]. Numerous studies have found that parents of securely attached infants are more likely than those of insecure infants to respond to them with sensitivity [69]. Because of this, Cassidy [33] hypothesized that children with secure attachment histories should develop healthier patterns of flexible emotion regulation than those with insecure histories. Particularly, since their mothers have been more likely to respond in a sensitive way to their emotional cues, secure infants should be more likely to express both negative and positive emotions in a healthy way by neither

suppressing nor heightening their emotional expressivity, but rather, expressing both in appropriate contexts.

In contrast, children with insecure-avoidant attachment histories are hypothesized to suppress their expression of negative emotions, becoming emotionally overregulated since their mothers have generally rejected their expression of negative emotions during the course of their early development [33].

Results of several studies support the idea that caregivers of insecure-avoidant infants inadvertently socialize them to minimize their emotional expressivity, leading to emotional overregulation. For example, these infants had been found to approach their mothers in the "Strange Situation" primarily when calm and contented rather than when distressed [70, 71], even though heart-rate measures indicated that they were actually more physiologically distressed by separations than were secure babies. Avoidantly-attached infants have also been found to use self-soothing behaviors such as thumb sucking when distressed more often than other infants do [72]. In toddlerhood, children with avoidant attachment were found to be more likely than other children to show flat affect during stressful situations, indicating suppression of negative emotions [73]. Interestingly, however, avoidantly attached preschoolers have been found to more angry and aggressive with peers than secure children in childhood [74] and adolescence [75]. It may be that avoidantly attached children generally try to suppress their negative emotion, but continual suppression of negative emotion may lead to frustration and, ultimately, to poor emotional regulation later in development.

At the other end of the spectrum, children with insecure-ambivalent attachment histories are expected to become emotionally underregulated since their mothers have been likely to respond inconsistently, especially when these infants are distressed [76]. As a result of this history of maternal lack of consistency, these infants maximize attachment behaviors when distressed; that is, they become clingier, and they cry and fuss more to get the caregiver's attention [77]. Some evidence also supports the idea that caregivers of insecure-ambivalent infants inadvertently socialize them to maximize their expression of fearful negative emotions. For example, ambivalent infants show more fear and cry more in laboratory procedures during infancy [78] and toddlerhood [79], and as preschoolers, these children are more fearful when exploring a new environment [80] and when interacting with peers [81].

Since insecure attachment is related to children's poor emotion regulation, it may also be related to children's poor regulation of energy intake and thus be a risk factor for childhood obesity. In one of the only studies that has examined the relation between attachment and obesity, Anderson and Whitaker [82] argued that since insecure attachment is related to children's poor emotion regulation, it may be a risk factor for childhood obesity. They reasoned that emotion regulation should be related to obesity since poorly regulated children experience greater stress, and the stress response has been linked to obesity [83, 84]. In addition, problems with regulating negative emotions such as fear, sadness, and anger have been found to predict eating in the absence of hunger and disinhibited eating [85, 86]. Using the large national sample from the Early Childhood Longitudinal Study, Anderson and Whitaker found that insecure attachment, assessed at 24 months of age, predicted an increased risk of childhood obesity at age 4.5 years. This was found even after controlling for potentially confounding variables, including the quality of mother-child interaction, parenting practices related to obesity (e.g., having regular family dinners, duration of breastfeeding, television/video viewing time, etc.), maternal health and BMI, and SES [82].

However, this study did not investigate mechanisms that might explain the link between insecure attachment and an increased risk of obesity. The researchers suggested that poor emotion regulation mediates this relationship, but children's emotion regulation was not assessed. Moreover, different types of insecure attachment (avoidant versus ambivalent) might affect children's emotion regulation in different ways. Since both over- and underregulation of emotional expression are nonoptimal emotion regulation strategies, both types of insecure attachment may increase the risk of obesity by increasing children's physiological stress. However, if disinhibited eating, rather than stress, is the key mediator of the relation between insecure attachment and obesity, and if disinhibited eating is related to emotional underregulation, it may be that anxious-ambivalent children are at particularly high risk for obesity. In a cross-sectional study done with adults, disinhibited eating was found to mediate the relation between anxious attachment style (analogous to insecure-ambivalent attachment style in infancy) and higher adult BMI. However, avoidant attachment was unrelated to both disinhibited eating and having a higher BMI [87]. Longitudinal studies are needed that directly examine children's stress reactions and disinhibited eating as possible mediators of the relation between both types of insecure attachment and obesity.

In addition, future research should investigate whether parent-child attachment security relates to differences in the ways that parents feed their children and socialize their eating habits. Since research has found strong links between infants' attachment security and parental sensitivity [88–90], it may be that parents of insecure infants are less sensitive in interactions surrounding food. For example, they may be more controlling or restrictive during such interactions, which may in turn lead to an increased risk for obesity.

4. Summary

Obesity is increasing in children at epidemic rates [91] with one-third of children in the United States currently overweight or obese [92]. Given that increases in childhood obesity are not fully explained by genetics alone, researchers need to concentrate on the obesogenic environment of children including factors in the family environment. As evidenced thus far, parents are key figures in socializing their children's behaviors and self-regulation of energy intake. However, little is known about the developmental process by which parents influence children's self-regulation of energy intake. Researchers interested in this process can learn from

the large body of research on how parents influence children's regulation of emotions.

This research provides important insights regarding how parents might influence children's development of self-regulation of energy intake and how variations in parenting, child temperament, and the parent-child relationship might affect this. To date, research examining the relation of parenting to children's overweight status has found links between children's overweight status and the ways that parents respond to their children's eating, particularly in terms of restricting or controlling children's food intake and the use of rewards and punishments to do this. However, whether or not children's energy intake mediates the relationship between food parenting practices and children's overweight status has rarely been examined directly. In addition, the role of parental modeling and parental coaching in the development of children's self-regulation of energy intake has rarely been studied. Future studies should include more observational research of parent-child interactions surrounding food since parents may underestimate their use of particular food parenting strategies, such as the use of sweets as a reward. Parents also may be unaware of their emotional responses to children's eating behaviors or of the ways they might coach children's self-regulation of energy intake.

Parents' socialization of children's eating behaviors (including modeling, responding to children's eating behaviors, coaching, and using rewards and punishments) is likely to change over time in response to developmental changes in their children's self-regulation of eating and their children's subsequent eating behaviors. Thus, longitudinal studies are needed to examine bidirectional relationships between food parenting practices, children's self-regulation, children's eating behaviors, and children's overweight status over time. Longitudinal studies are also important for examining the role of how moderating factors such as parenting styles, child temperament, and parent-child attachment affect the relation between food parenting practices and children's self-regulation of energy intake. To date, most studies have not gone beyond simply finding relations between these factors and children's overweight status; for example, insecure attachment has been found to be related to increased risk of child obesity [82]. Some of the research on parenting styles has gone further, finding relations between parenting styles, particular kinds of parental feeding practices, and children's overweight status over time [56]. In discussing the results of these studies, obesity researchers have often speculated that children's self-regulation of energy intake may mediate these associations, but research specifically investigating children's self-regulation of energy intake as a mediator that may explain the relation of food parenting practices and children's overweight status is lacking.

Whereas researchers in the area of self-regulation of energy intake have many opportunities to learn from the literature on self-regulation of emotions, it is also important to note that the two domains do not function independently; instead, there are a variety of overlapping contexts in which food and emotions exist. Food influences emotions and emotions influence peoples' behaviors when eating food [93]. Similarly, eating is often an emotional experience. In this sense, there is an interesting intersection between food and how emotions are regulated. For this reason, researchers interested in the role of self-regulation of energy intake in childhood obesity should conduct assessments of children's general self-regulation as well as self-regulation of energy intake to see if the two are related.

Future research should also examine the role of the broader economic and cultural context on how parents influence children's development of self-regulation of energy intake. According to Bronfenbrenner's ecological model of development, parent-child interactions are nested within larger socioeconomic and cultural contexts and cannot be fully understood apart from these larger contexts [94]. Parenting in low-SES samples differs from parenting in middle- and upper-income samples in a multitude of ways, including types of maternal employment, single-mother families, and lower maternal education [95]. One key factor likely to be relevant to parents' influence on children's self-regulation of both emotions and energy intake is the high degree of stress present in low-SES environments. Stress has been found to have a substantial impact of parenting, as it has been related to more insecure attachment [96] and a greater use of authoritarian parenting practices [97]. Also, as noted previously, the relation of different parenting styles to child outcomes varies according to SES and cultural differences [58]. Low-income parents are also more likely to experience food insecurity, which may affect food parenting. For example, food insecurity has been associated with maternal reports of using compensatory feeding practices, that is, giving children extra food or more energy-dense foods such as soda [98]. Low-income families are also more likely to serve calorie-dense fast foods and processed foods to their children since they are less expensive than fresh fruits and vegetables, as well as more filling [99]. Additionally, low-income parents might be more likely to give their children calorie-rich "comfort" foods to help them deal with stress since low-income families face more economic stress and stressful life events [60]. Finally, different ethnic groups are likely to have different culturally based customs regarding serving and eating food. For example, Hispanic mothers have been found to use a more indulgent feeding style in several studies, granting most of their children's requests for food [60, 100].

Although it is common for researchers interested in self-regulation of energy intake to assess children's ability to regulate energy intake with children alone, the process by which parents influence children's development of self-regulation is important; therefore, researchers interested in parental contributions to the development of children's self-regulation of energy intake should study it within the context of parent-child relationships. Multidisciplinary teams of researchers with knowledge of nutrition and physiology should collaborate with developmental psychologists in order to fully understand the complex process by which parents influence children's self-regulation of energy-intake.

Conflict of Interests

The authors declare that they have no competing interests.

Acknowledgments

This research was supported by funds from R01 HD062567. This work is a publication of the United States Department of Agriculture (USDA/ARS) Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine, Houston, Texas, and had been funded in part with federal funds from the USDA/ARS under Cooperative Agreement no. 58-6250-0-008. The contents of this publication do not necessarily reflect the views or policies of the USDA nor does mention of trade names, commercial products, or organizations imply endorsement from the U.S. government.

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