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Behavioral Determinants of Obesity: Research Findings and Policy Implications

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Editorial Board

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Editorial

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1. Introduction

Obesity is a public health concern worldwide associated with significant health risks and comorbid conditions [1, 2]. During the years between 1980 and 2008, the international prevalence of obesity has increased twofold. In 1980, 5% of men and 8% of women were obese, according to the body mass index (BMI) reference of $\geq 30\,kg/m^2$. Almost three decades later, 10% of men and 14% of women presented with obesity. Current databases document that more than half a billion adults worldwide are obese; more women than men are obese, with estimates of 297 million and 205 million, respectively [3]. Childhood obesity is increasing at a similar pace. In 1990, 4.2% of children were overweight and obese, and this percentage increased to 6.7% in 2010. Of great concern is the forecasted number of children who are to be obese by the year 2020: an estimated 9.1% or 60 million children worldwide [4]. Moreover, given that childhood obesity has been shown to track into adulthood [5, 6] and has been lined with significant health-related conditions and psychological effects [7], obesity prevention is imperative. Understanding the determinants of obesity is crucial for informing and developing effective prevention efforts, which should be based on a scientific understanding of the multiple and complex risk factors for obesity. The etiology of obesity is multifaceted; there are factors from multiple contexts, and interactions between factors that led to obesity are not yet well understood [7]. Indeed, a comprehensive approach is needed to potentially reverse the global pandemic of obesity [7, 8].

2. Ecological Approach to the Study of Obesity

This special issues focuses primarily on the behavioural factors associated with obesity (dietary intake; physical activity) with consideration of the contextual factors including the home, school, and neighborhood environments, which can affect health. Successful models of addressing obesity have examined behaviours and the environment, with the goal of altering the obesogenic environment through public health strategies aimed at promoting healthful eating and physical activity [1, 9]. The ecological model of obesity has been described as “multilevel (e.g., regions, nations, states, cities, and neighborhoods),” taking into consideration the “multistructural components (e.g., physical environment, socioeconomic status, and social capital)” and “multifactorial lifestyle behaviours (e.g., diet, physical activity, and stress)” at “multi-institutional (e.g., school, local government, family, and local agency)” levels. Moreover, this ecological approach accounts for the interrelationships among these influences to better understand and measure the behavioural factors that negatively influence weight [10].

3. Behavioural Influences on Energy Intake and Energy Expenditure

More recently, research has concentrated the behavioural influences on obesity, that is, specific behaviors that may contribute to weight gain through overeating or reduced physical activity and the mechanisms by which the environment can affect health. Review of the literature points to the specific eating behaviors that are associated with obesity. These obesity-promoting behaviours include frequent fast food consumption, eating occasions away from home, large portion sizes, high consumption of beverages high in sugar, and breakfast omission [11–17]. In addition to these behavioural factors, multistructural variables such as the physical environment and socioeconomic status have been shown to have a significant influence on food intake and energy expenditure [10, 18]. Environmental influences consist of the proximity of large supermarkets, the concentration of fast food establishments and restaurants in any given area, the availability of recreational areas for physical activity, and socioeconomic status, each of which may favorably or negatively influence dietary behaviours and physical activity patterns [8, 19–22]. For example, large supermarkets provide a wide variety of healthful foods at reasonable prices, which may influence food purchasing behaviours [21] and thus the availability of more healthful foods at home [23]. Finally, there has been substantial interest in ensuring a healthful eating environment in schools and the important association between the home environment and nutrient intake [14, 24].

4. Contributions of this Special Issue Relating to the Behavioural Determinants of Obesity

As illustrated in the array of articles presented in this special issue, environmental and societal transitions including changing dietary practices, modernization of lifestyles, urbanization, and globalization of the food supply have influenced the increasing prevalence of obesity in developed and developing countries [6, 25]. Using cross-sectional data from a national study, Z. Abdeen and colleagues (2012) observed that slightly more than 60% of Palestinians who were between the ages of 18 and 64 years were overweight (38%) or obese (24.4%), and obesity was prevalent in urban areas. While the study design did not permit the investigators to examine potential contributing factors for the prevalence of obesity the results illuminate the changes in food consumption and physical activity patterns which were associated with urbanization. Demographic variables including age, educational level, sex, and marital status were also associated with BMI. Relative to men, higher levels of obesity and lower physical activity levels were documented among less educated Palestinian women. The authors noted that low physical activity among females may be partly due to the lack of exercise facilities for girls and women in Palestine. Moreover, girls' attitudes and beliefs about sports and outdoor physical activity need to be taken into account when interpreting these findings. In developing countries, girls are more engaged in domestic chores and less in playground activities [6]. In addition to culture, individual level and social factors relating to meal planning may be important considerations when examining gender-related differences in obesity. In fact, in this special issue, T. J. B. Dummer and collaborators (2012) observed among females that the time between adolescence and adulthood is a critical period for weight gain. In addition to the physiological changes which occur with maturation, young adulthood is a period when independence peaks in relation to food planning, purchasing, and preparation. Nutritional health has been shown to be associated with an individual's environment not only in terms of access to healthful foods through food purchasing and preparation, but also through opportunities for physical activity.

An emerging body of research focuses on the role of the built environment in influencing food choice and physical activity and, by extension, obesity. Factors of the built environment include proximity to grocery stores and fast food establishments, quality of schools, opportunities for social interactions with neighbors, and places for walking and other types of physical activities. Unfavorable built environments such as few parks or recreational facilities, low perceived neighborhood safety, increased access to restaurants, and convenience stores were associated with higher body mass index scores among adolescents, particularly those of low socioeconomic status [21]. In developed countries, socioeconomic status, income level, and education are inversely correlated with obesity [18, 22], whereas in developing countries, there is a high prevalence of obesity among those of higher economic status living in urban settings [6].

When examining the potential association between socioeconomic status, the built environment, fast food outlet exposures, and overweight, A. Lebel and colleagues (2012) observed that characteristics of one's residence, such as the percentage of fast food establishments, financial insecurity, and diversity in social status, accounted for an important component of the territorial distribution of overweight. Moreover, for urban women of low socioeconomic status, the number and proximity of fast food restaurants significantly predicted obesity risk. Fast food outlet exposure was also examined among adolescents by T. Khan and co-investigators (2012) in the early childhood longitudinal study. Utilizing price data and contextual outlet density data, the findings revealed that higher fast food prices, higher median household income, and reduced access to fast food establishments were associated statistically with reduced intake of fast food among children (T. Khan et al., 2012) . The findings of these studies (T. Khan et al. 2012; A. Lebel et al., 2012) point to the important role of the built environment and socioeconomic status (SES) in relation to food choice. Community-level interventions are necessary to ensure access to healthful foods and physical activity. Understanding the socioeconomic differences and relevant aspects of built environments can inform the development of programs aimed at reducing obesity.

The articles in this special issue point to a complex relationship between SES and obesity that needs to be better understood. Numerous reports [19–22], including articles in this special issue, have found associations between obesity and SES (or proxies for SES, e.g., education), but the mechanisms tying SES to obesity are not well understood. Interestingly, Z. Abdeen and colleagues (2012) found that the SES/obesity association varied by gender—high education was associated with greater waist-height ratios for men but the opposite was true for women. Z. Abdeen and investigators (2012) cite lack of exercise facilities as a potential contributing factor to obesity among women in Palestine. One wonders whether more highly educated Palestinian women may have better access to appropriate exercise facilities, facilitating decreased levels of obesity; lack of exercise might be a possible mechanism tying low SES to high rates of obesity. In addition to having better access to exercise facilities, the literature suggests that higher-SES individuals have access to better-quality food [22]—this is supported by T. Khan and colleagues' (2012) finding that higher-SES individuals consumed fast food less frequently and L. H. McArthur and co-authors' (2012) finding that cost was a barrier to healthy snacking. This suggests that higher SES individuals have greater resources to protect themselves from an obesogenic environment. Further studies are needed to elucidate the mechanisms tying SES to obesity. This question has profound policy implications, especially if public resources are required to overcome economic barriers to combating obesity.

Technology has enabled investigators to obtain data from all fifty-nine public and private schools in Alberta, Canada to employ a web-based method of surveillance of behavioural factors relating to weight and physical activity among students in grades seven to ten. K. E. Storey and colleagues (2012) found that nonoverweight adolescents consumed more healthful breakfast meals and snacks. These healthful eating habits were related to a higher consumption of carbohydrate and fibre, significantly less fat, and significantly greater activity levels compared with obese adolescents. Meal behaviours were also examined by location. While consuming food outside of the home eating environment has been associated with increase in weight [14, 18], K. E. Storey and investigators did not find significant differences between BMI classification and food intake away from home. Differences in variables studied, study design, and the types of food consumed away from home may have led to varying results. Thus, the association between eating behaviours and body weight is complex. A true understanding of the association between meal behaviours and weight status requires consideration of the potential mediating influence of physical activity or other food-related factors such as convenience, palatability, and reduced cost [10], which may affect intake.

In this special issue, L. H. McArthur and colleagues found that cost and availability were barriers to healthful snacking, but location did not influence snacking patterns of college students (2012) . Eating behaviors among youth are influenced by foods available not only at home, but also at school, where they spend a significant proportion of their time. These studies (L. H. McArthur et al., 2012; K. E. Storey et al., 2012) highlight the importance of the school environment, for both adolescents and college students, in terms of availability of healthful meals and snacks and providing programs which promote healthful eating and daily physical activity. In addition to a healthy school environment, ensuring that the home food environment provides healthful foods will assist with efforts to control body weight. In the health-is-power intervention study, T. A. Ledoux and colleagues (2012) found that home availability of fruits and vegetables and weekly stress were related to fruit and vegetable intake among African-American and Hispanic women, a segment of the population who is at risk for obesity. Since energy-controlled diets that are rich in fruits and vegetables may help to achieve and maintain weight loss, these findings are of importance and can inform nutrition education programs targeting this population.

While individual studies published in this special issue present data on specific correlates of obesity, taken together, the findings emphasize that obesity needs to be studied within the framework of the broader social and community contexts within which individual behaviours relating to dietary intake and physical activity occur. Targeting multiple lifestyle behaviours may be an effective means of preventing weight gain, rather than focusing on one specific determinant associated with excess energy status and weight [17]. In addition, these papers add to the growing body of evidence suggesting that healthy lifestyles can only be sustained if the environment and culture which support unhealthy lifestyles are addressed [9]. Unhealthful nutrition habits and reduced physical activity are likely to endure, increasing the risk among today's youth for obesity and chronic diseases in the future, unless public health initiatives are designed to be multilevel and take into consideration the multiple correlates that influence behaviours surrounding dietary intake and physical activity. Future studies need to be designed to evaluate the interactions among behavioural and environmental risk markers for obesity in order to advance prevention efforts and intervention programs.

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Research Article

Home Availability and the Impact of Weekly Stressful Events Are Associated with Fruit and Vegetable Intake among African American and Hispanic/Latina Women

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Background. Mediating and moderating variables may interfere with the association between neighborhood availability of grocery stores (NAG) and supermarkets (NAS) and fruit and vegetable (FV) intake. *Objective*. The purpose of this study was to test mediation of home availability of FV (HAFV) and moderation of impact of weekly stressful events (IWSE) on the association between NAG and NAS with FV consumption among African American (AA) and Hispanic/Latina (HL) women. *Methods*. Three hundred nine AA and HL, 25–60 year old women in the Health Is Power (HIP) randomized controlled trial completed validated measures of HAFV, IWSE, and FV intake at baseline. Trained field assessors coded NAG and NAS. Institutional Review Board approval was obtained. *Results*. NAG and NAS were not associated with FV intake or HAFV, so HAFV was not a mediator. HAFV (std. Beta = .29, $P < 0.001$) and IWSE (std. Beta = .17; $P < 0.05$) were related to FV intake ($R^2 = 0.17$; $P < 0.001$), but IWSE was not a moderator. *Conclusion*. Increasing HAFV and decreasing the IWSE should increase FV consumption. The extent to which the neighborhood environment is related to the home food environment and diet, and the mechanisms for the association between IWSE and diet should be examined in future research.

1. Introduction

Adequate consumption of fruits and vegetables may reduce risks for cardiovascular disease [1], obesity [2], and diabetes [3] among adults. African American and Hispanic/Latino adults present with higher rates of heart disease [4], obesity [5], and diabetes [6] compared with their white peers. Data from the National Health and Nutrition Examination Survey showed the majority of African American [7] and Hispanic/Latino [8] adults failed to meet United States Department of Agriculture Dietary Guidelines for dietary intake of fruits and vegetables and had lower intake of fruits and vegetables compared with their white peers [9]. Increasing fruit and vegetable consumption among African American and Hispanic/Latino adults may reduce disparities in related health outcomes.

Ecologic models posit that health behaviors such as fruit and vegetable consumption are influenced by individual, sociocultural, organizational, community and policy level factors [10–13]. Low-income Hispanic/Latino and African American neighborhoods have fewer stores that sell fruits and vegetables compared with higher income or white neighborhoods [14–21]. However, neighborhood availability of food stores has been associated with diet quality only in *some* studies [15, 22–27]; not all [28–35]. This suggests that the association between neighborhood availability of food stores and diet is complicated by other variables, which may be potential targets for tailored interventions aimed at increasing fruit and vegetable consumption among underrepresented groups [36]. It is possible that unidentified mediators and moderators of the association between neighborhood availability of food stores and diet have compromised the ability to detect a relationship between the two consistently.

The association between neighborhood food store availability and fruit and vegetable intake may differ depending on food store type. Supermarkets are large self-service food markets of household foods and nonedible goods [15, 37]. Grocery stores are small "mom and pop" stores that sell a limited number of household foods and nonedible goods [15, 37]. Supermarkets offer a larger variety of healthy, high-quality fruits and vegetables at lower cost compared with smaller neighborhood grocery stores [24, 38]. Women who shop at supermarkets eat more fruits and vegetables compared with those who shop at grocery stores [24] suggesting neighborhood availability of supermarkets has a stronger influence on fruit and vegetable consumption compared with neighborhood availability of grocery stores. Unfortunately, low-income predominantly Hispanic or Latino and African American neighborhoods typically have fewer supermarkets compared with grocery stores [16, 25, 39] suggesting the quality of stores available in low-income predominantly Hispanic or Latino and African American neighborhoods may contribute to poor dietary habits and low intake of fruits and vegetables.

Home availability of fruits and vegetables may mediate the relationship between neighborhood availability of grocery stores and supermarkets and fruit and vegetable intake. No known studies have examined the relationship between neighborhood availability of grocery stores and supermarkets and home availability of fruits and vegetables, but it is assumed that food purchases from supermarkets and grocery stores are primarily for the home. The relationship between home availability of fruits and vegetables and dietary intake of fruits and vegetables has been shown among adults [40, 41]. In addition there is an association between food purchases from supermarkets and dietary intake [42–45]. No known studies have tested whether home availability of fruits and vegetables mediates the association between neighborhood availability of grocery stores and supermarkets and fruit and vegetable intake.

Food shopping and meal preparation require substantial time, attention, and planning. Qualitative and quantitative studies have shown that higher fruit and vegetable consumption is associated with greater time and effort spent in food purchasing and meal preparation [46–50]. Perceived stress has been inversely related to diet quality [47, 51, 52], perhaps because the time and attention needed to cope or deal with stressful events overrides time and attention needed for healthy food shopping and meal preparation. It is possible the impact of weekly stressful events moderates the associations between neighborhood grocery store and supermarket availability, home availability of fruits and vegetables, and fruit and vegetable intake.

The purpose of this study was to determine whether home availability of fruits and vegetables mediates the association between neighborhood availability of grocery stores or supermarkets and fruit and vegetable intake; whether the impact of weekly stressful events moderates the associations between (1) neighborhood availability of grocery stores or supermarkets and home availability of fruits and vegetables and (2) home availability of fruits and vegetables and dietary intake of fruits and vegetables (see Figure 1). The moderating effect of the impact of weekly stressful events would be most relevant for household food shoppers and meal preparers. Women are the primary food shoppers and meal preparers in most households particularly among African American and Hispanic or Latino families [53]; therefore, only women were examined in this study.

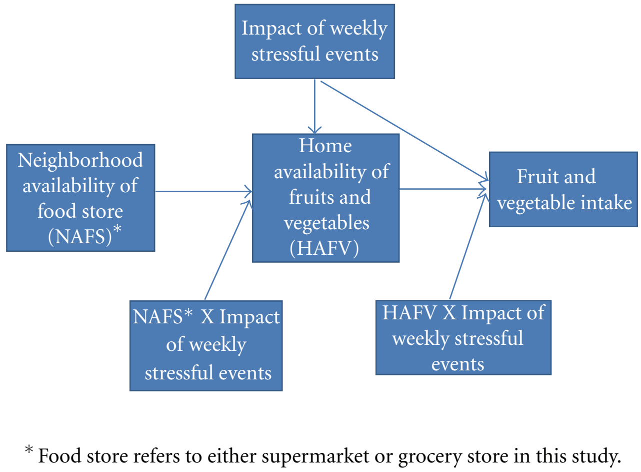

Figure 1: Conceptual model of the association between neighborhood availability of food stores and fruit and vegetable intake.

2. Method

2.1. Design and Sample. A descriptive cross-sectional study was conducted using baseline data from a larger randomized controlled trial, Health Is Power (HIP) [53]. The purpose of HIP was to test a transcultural, community-based intervention to increase physical activity and improve dietary habits among African American and Hispanic or Latina women from Houston and Austin, TX [53–55]. Four hundred ten apparently healthy African American and Hispanic or Latina women (311 in Houston and 99 in Austin) participated in HIP. In Houston, 84.6% identified as African American and 15.4% identified as Hispanic or Latina; all subjects in Austin identified as Hispanic or Latina. The study sample and design have been described previously [53, 54].

2.2. Individual Measures

Demographics. Women completed interviewer-administered questionnaires and a physical assessment at the baseline (T1) health assessment. The Maternal and Infant Health Assessment (MIHA) was used to measure subjects' education, parents' education, and income. The MIHA is modeled on the Centers for Disease Control and Prevention's Pregnancy Risk Assessment Monitoring System (PRAMS)and is considered valid for African American and Hispanic or Latina women of all income statuses [56].

Fruit and Vegetable Intake. Consumption of fruits and vegetables, the dependent variable (see Figure 1), was measured using the National Cancer Institute's *Fruit and Vegetable Screener* [57, 58]. Respondents reported fruit and vegetable consumption in terms of frequency and amount consumed over the last month. The *Fruit and Vegetable Screener* has adequate validity ($r = 0.68$ in men, 0.49 in women) in white adults when compared with the By-Meal Screener [57], and similar validity in ethnic women from underrepresented groups when compared with the National Cancer Institute's *Diet History* Questionnaire reported servings of fruits ($r = 0.52$) and vegetables ($r = 0.23$). Raw, frozen, canned, and juice varieties of fruits and vegetables are included in the screener [54], and scores reflect average number of servings of fruits and vegetables consumed per day. Scores may be as low as zero without upper limit.

Weekly Stress Inventory (WSI). The impact of weekly stressful events was hypothesized to moderate the association between neighborhood availability of supermarkets and grocery stores and home availability of fruits and vegetables and also the association between home availability of fruits and vegetables and fruit and vegetable consumption (see Figure 1). The WSI is a self-report questionnaire of the number of stressful events within the past week (WSI-event) [59] and the perceived impact of those events (WSI-impact). The WSI-impact scale scores were used in this study only. For the WSI-Impact, respondents indicate how stressful each of 87 stressful events of the last week were on a Likert-type scale (1 = "happened but not stressful"; 7 = "extremely stressful") [59]. Scores on the WSI-impact can range from 0 to 696 with high scores indicating multiple stressful events that were perceived as very stressful. In a standardization sample, the internal consistency proved excellent for the WSI-impact with coefficients ranging from 0.93 to 0.97, with no difference by sex or race [59]. Internal consistency for this sample was 0.92, which is very good. The WSI has been validated and used among ethnically and socioeconomically diverse samples [59, 60].

Home Availability of Fruits and Vegetables. Questionnaire requires respondents to indicate from a list of 32 foods, which foods and the version of the food (fresh, canned, or frozen) they had in the home in the last month [61]. Scores may range from 0 to 32. This instrument has demonstrated good internal consistency (Cronbach's alpha = 0.77) and moderate test-retest correlation (ICC $r = 0.50$) [61]. For the purpose of this study, a sum score for total home availability of fruits and vegetables was used in analyses, with higher scores indicating greater abundance of fruits and vegetables available in the home in the last month. Fruit juice was included in the category of fruit, but potato salad, coleslaw, and French fries were excluded. Home availability of fruits and vegetables was hypothesized to mediate the relationship between neighborhood availability of supermarkets and grocery stores and fruit and vegetable intake (see Figure 1).

2.3. Environmental Measures

The Goods and Services Inventory (GASI) . Instrument [62] was used by trained personnel to measure 19 types of goods and services within a defined area. This study used only neighborhood availability of grocery stores and supermarkets, which were the independent variables (see Figure 1), as these are the primary sources of fruits and vegetables purchased for the home [63]. The number of neighborhood grocery stores and supermarkets may be as low as zero without an upper limit.

2.4. Procedure

Individual Data Collection. Subjects were recruited via advertisements in local media and through posted announcements in bulletins of community partners to participate in a health promotion intervention aimed at increasing physical activity and/or fruit and vegetable consumption. Interested subjects completed a telephone-administered inclusionary screener, which included a brief description of the study and the Physical Activity Readiness Questionnaire (PAR-Q) [64]. Because the goal of the intervention was to increase physical activity, women who were already physically active were not eligible to participate. HIP inclusion criteria included healthy women (i.e., nonpregnant or lactating women without serious health complications) who were not physically active between the ages of 25 and 60 years old. HIP exclusion criteria included physically active women outside of the desired age range who were not willing or able to agree to study procedures (e.g., increase physical activity or change diet). The study protocol was approved by the University of Houston Committee for the Protection of Human Subjects before recruitment began. Women who met inclusion criteria gave written consent and completed a baseline (T1) health assessment. At the T1 assessment, subjects completed an interviewer administered questionnaire and anthropometric measures of BMI and body fat, and they were given a take home packet to complete prior to the next meeting (approximately one week later). The packet contained more detailed questionnaires not found in the interviewer-administered survey, including the WSI [65–67]. Baseline data from HIP subjects, who had complete data on all target variables of this study, were included in this study.

Environmental Data Collection. To complete environmental assessments, neighborhoods were first mapped using Geographical Information Systems (GISs) technology. Subjects' addresses were geocoded, and a subjects' neighborhoods were defined as the area within an 800 meter (0.5 mile) radius circumscribed around their home. An intersect command in ArcGIS was used to combine the neighborhood buffers and street centerlines to create a buffer streets layer. Field assessors completed an interactive training using standardized training PowerPoint slides with pictures and operational definitions over the course of a half day and completed at least four hours of field training. Environmental assessment procedures have been previously described in detail [39, 53, 54, 66, 68–70].

Statistical Analyses. Data were screened for data entry errors or outliers before initiating data analysis. Preliminary data inspection assessed violation of the assumptions of

Table 1: Demographic characteristics of African American (AA) and Hispanic or Latina (HL) women of Health Is Power.

	AA $N = 202$ M, SD	HL $N = 107$ M, SD	Total $N = 309$ M, SD
Demographic variables			
Age	45.43, 9.22	46.44, 10.09	45.78, 9.52
BMI	34.52, 8.02	33.49, 8.29	34.16, 8.11
Study variables			
Neighborhood availability of supermarkets	0.30, 0.57	0.27, 0.54	0.29, 0.56
Neighborhood availability of grocery stores	0.84, 1.25	1.11, 1.96	1.01, 1.66
Impact of weekly stressful events	79.97, 64.24	67.35, 46.11	76.47, 59.91
Home availability of FV	20.91, 6.23	20.97, 5.89	20.93, 6.10
FV intake (average serving/day)*	3.21, 3.08	2.44, 2.03	2.94, 2.79

$^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

normality, linearity, multicollinearity, and homoscedasticity. Bivariate Pearson correlations and Chi square tests were conducted to determine if there were relationships or differences among or between the study variables and demographic variables. All analyses were adjusted for those demographic variables that were significantly correlated with study variables. Bivariate Pearson correlations among study variables among African American and Hispanic/Latina women separately showed that the study variables were related in similar patterns of significance (data not shown); therefore, it was decided to combine the sample to increase power to detect shared associations. All models were adjusted for race. The spread of WSI-impact scores was negatively and fruit and vegetable intake scores were positively skewed so they were log transformed prior to inclusion in analyses.

Mediators and Moderators Analyses. Please see Figure 1 for conceptual model of variables tested in this study. Mediators are variables that are part of the causal pathway between two related variables [71]. Moderators are variables that are not on the causal pathway between two related variables but influence their relationship [71]. For example, gender may be a moderator when an association between two variables exists among males but not females [71]. Variables that mediate an association between an independent variable and dependent variable are related to both the independent variable and dependent variable as part of the causal pathway [71]. Mediators explain some of the variance in the dependent variable; therefore, controlling for mediators changes the strength of the association between the independent variable and the dependent variable. To test for mediation, the association between two variables is tested with and without controlling for the hypothesized mediator. If the association is different depending on whether the mediator was controlled or not, mediation is determined. To test for moderating effects, the interactions between the hypothesized moderator and IV are tested, and, if significant, moderation effects are determined. Five linear regression analyses excluding cases pairwise were conducted. Model 1 tested the association between neighborhood availability of grocery stores, impact of weekly stressful events, and the interaction between neighborhood availability of grocery stores and impact of weekly stressful events with home availability of fruits and vegetables after adjusting for demographic variables. Model 2 tested the association between neighborhood availability of supermarkets, impact of weekly stressful events, and the interaction between neighborhood availability of supermarkets and impact of weekly stressful events with home availability of fruits and vegetables after adjusting for demographic variables. Model 3 tested the association of home availability of fruits and vegetables, impact of weekly stressful events, and the interaction between home availability of fruits and vegetables and impact of weekly stressful events with fruit and vegetable intake after adjusting for demographic variables. Model 4 tested the association between neighborhood availability of grocery stores and fruit and vegetable intake after adjusting for demographic variables. Model 5 tested the association between neighborhood availability of supermarkets and fruit and vegetable intake after adjusting for demographic variables. Standardized betas (std. Beta) were presented to assess the magnitude of the association between the independent and dependent variables. Analyses were performed using PASW18.0 (2010, Chicago, IL). The level of significance was set at $P < 0.05$.

3. Results

Three hundred nine women from the HIP project provided complete data for this study. The full HIP sample has been described previously [16, 53, 55, 66, 68–70], and Table 1 provides a brief description for this study. African American women reported greater fruit and vegetable intake compared with Hispanic or Latina women. Chi square test for independence showed African American women had significantly more education ($P = 0.009$) and income ($P < 0.001$) compared with Hispanic or Latina women in this sample (data not shown) [54, 55].

Table 2 shows correlations for the total sample among demographic and study variables. Neighborhood availability

Table 2: Correlations among demographic, neighborhood availability of supermarkets and grocery stores, the impact of weekly stressful events, home availability of fruit and vegetable (FV), and FV intake among African American and Hispanic or Latino women from Health Is Power.

	Age	BMI	NAS	NAG	Impact of weekly stressful events	HAFV	FV intake
Age	1						
BMI	0.10	1					
NAS	−0.08	0.04	1				
NAG	0.08	**0.12***	**0.16****	1			
Impact of weekly stressful events	−**0.23****	−0.03	−0.08	−**0.18***	1		
HAFV	0.03	−0.06	0.09	0.03	−0.07	1	
FV Intake	0.08	−0.01	0.08	−0.05	−**0.19***	**0.31****	1

NAS: neighborhood availability of supermarkets; NAG: neighborhood availability of grocery stores; HAFV: home availability of FV; $^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

Table 3: Linear regression analyses of the association of home availability of fruit and vegetables and fruit and vegetable intake with neighborhood availability of grocery stores and supermarkets, impact of weekly stressful events, home availability of fruit and vegetables, and interaction effects after controlling for demographic variables among African American and Hispanic or Latino women from Health Is Power[†].

Model	Independent variables	Std. Beta	Dependent variables	Model[†] R^2	P
1	NAG	0.11	HAFV	0.03	0.81
	Impact of weekly stressful events	−0.08			
	NAG X impact of weekly stressful events	0.15			
2	NAS	0.10	HAFV	0.02	0.90
	Impact of weekly stressful events	−0.06			
	NAS X impact of weekly stressful events	0.01			
3	HAFV	0.29***	FV intake	0.17	<0.001
	Impact of weekly stressful events	−0.17*			
	HAFV X impact of weekly stressful events	0.05			
4	NAG	−0.03	FV Intake	0.05	0.02
5	NAS	0.10	FV Intake	0.06	0.007

NAS: neighborhood availability of supermarkets; NAG: neighborhood availability of grocery stores; HAFV: home availability of FV; $^{*}P < 0.05$, $^{***}P < 0.001$.
[†]All models adjusted for age, BMI, race, education, and income.

of grocery stores and supermarkets was significantly positively related. The impact of weekly stressful events was negatively related to grocery stores and fruit and vegetable intake. Fruit and vegetable intake and home availability of fruits and vegetables were significantly positively related. Age was significantly negatively related to impact of weekly stressful events; BMI was significantly negatively related to neighborhood availability of grocery stores. Group differences on each of the study variables across income and education groups showed that there were no differences across education groups (less than high school education, high school, some college, and college graduate) on fruit and vegetable intake, home availability of fruits and vegetables, impact of weekly stressful events, neighborhood availability of grocery stores, or supermarkets. There were no differences across income groups (<100%, 101–200%, 201–300%, 301–400%, and 401% + federal poverty level) on home availability of fruits and vegetables, impact of weekly stressful events, neighborhood availability of grocery stores, or supermarkets, but there were significant differences on fruit and vegetable intake ($F(4, 278) = 3.84$, $P = 0.002$) with those earning 201–300% federal poverty level (FPL) consuming significantly less fruits and vegetables compared with those in the 401% + FPL category (mean difference 0.47, $P = 0.002$). Given the differences on some study variables by race and income and significant associations between demographic and study variables, all linear regression models tested were adjusted for these potential confounding variables (i.e., race, income, BMI, age).

See Table 3 for linear regression results of all models. Linear regression analyses showed neither the association of neighborhood availability of grocery stores (Model 1) nor neighborhood availability of supermarkets (Model 2) with home availability of fruits and vegetables was significant, after adjusting for potential confounding demographic variables. The association of home availability of fruits and vegetables on fruit and vegetable intake was significant, after controlling for potential confounding variables (Model 3). Home availability of fruits and vegetables (std. Beta = 0 .29, $P < 0.001$) and impact of weekly stressful events (std.

Beta = −0.17, $P < 0.05$) were unique predictors in this model, but the interaction between home availability of fruits and vegetables and the impact of weekly stressful events was not significant ($P > 0.05$); therefore, the impact of weekly stressful events was not a moderator. Neither neighborhood availability of grocery stores (Model 4) nor neighborhood availability of supermarkets (Model 5) was unique predictors of fruit and vegetable intake after adjusting for demographic variables indicating home availability of fruits and vegetables was not a mediator of neighborhood availability of either food environment variable and fruit and vegetable intake.

4. Discussion

Among African American and Hispanic or Latina women, home availability of fruits and vegetables was positively and impact of weekly stressful events was inversely related to fruit and vegetable intake, but the impact of weekly stressful events did not influence the degree to which home availability of fruits and vegetables was related to fruit and vegetable intake (i.e., impact of weekly stressful events was not a moderator). Other studies have shown that home availability of fruits and vegetables was related to fruit and vegetable consumption among adults [40, 41, 45]. In one study, those who were of the opinion that "there was not much fruit in my household" were less likely to consume fruit daily, and those who believed "the person who cooks in my household does not cook many vegetables" were less likely to consume vegetables daily [45]. Others have shown subject self-report on inventories of home availability of fruits and vegetables was related to dietary intake of fruits and vegetables [40, 41]. Based on results of this study, those of others, and theory, changes to the home food environment should promote changes in the diets of household members. In one study, African American and Hispanic/Latina households had fewer essential nutrients compared with foods available in white households [72], demonstrating the need for interventions to improve the health quality of foods available in African American and Hispanic/Latina households. While there have been some pilot studies showing interventions aimed at changing the home food environment are feasible and acceptable [73, 74], there have been no known large randomized controlled trials to test effectiveness of such interventions.

The impact of weekly stressful events was not related to home availability of fruits and vegetables, but it was inversely related to fruit and vegetable consumption. The mechanism for the association between the impact of weekly stressful events and fruit and vegetable consumption is not known but several explanations seem plausible. The average American makes over 220 decisions regarding food acquisition, preparation, service, consumption, and storage per day [63]. The Food Choice Process Model posits distal life course events and experiences, the present social and personal context, and proximal personal food thoughts and values have a reciprocal relationship with food behaviors [75] indicating that urgent and emergent stressors of high impact may interfere with food decisions at each level of this model. Research has shown that demands on time from work [76], family [77, 78], or both [46] have been related to unhealthy eating habits like eating out or skipping meals. Mothers and fathers reported coping with work and family stress by reducing time and effort for meals, reducing expectations for food and eating, and compromising food and eating for other family needs [77]. Moreover, a body of qualitative research reported women in low-wage, insecure, inflexible jobs with children perceived unexpected events, noncontributing partners, and minimal control over their environment to be barriers to healthy food purchasing and preparation [79]. Future research should examine the extent to which the impact of weekly stressful events competes with time and attention for food behaviors.

A second possible explanation for the inverse association between the impact of weekly stressful events and fruit and vegetable consumption is that chronic stress may trigger emotional overeating [51, 76, 77, 80]. Theories of overeating suggest some obese individuals, overeat in response to negative emotions, but normal weight individuals who are not preoccupied with their weight, dieting, or food actually eat less in response to negative affect [78, 79, 81]. Foods consumed during emotional overeating are usually energy dense [82]; therefore, diets of emotional overeaters may lack fruits and vegetables. More research is needed to understand the mechanisms for the association between chronic stress and fruit and vegetable intake, so that interventions to promote fruit and vegetable consumption can target stress in the most effective manner.

Neighborhood availability of neither grocery stores nor supermarkets was related to either home availability of fruits and vegetables or fruit and vegetable intake, so home availability of fruits and vegetables was not a mediator of fruit and vegetable intake. Results were consistent with a number of other studies that failed to show an association between neighborhood availability of fruits and vegetables and fruits and vegetables consumption [29–35] but were inconsistent with studies that did find this association [22–27] and with ecologic models, which posit environmental factors influence behaviors [12, 13]. Two recent systematic reviews concluded the association between the neighborhood food environment and dietary intake was weak and inconsistent [31, 32]. This area of research has been criticized for reliance on less rigorous study designs (e.g., cross sectional studies) and limitations in measurement of diet (i.e., under- and overreporting are significant problems with several measures of diet, particularly food frequency questionnaires [83]) and the food environment [84]. In this study, it was hypothesized that mediation effects of home availability of fruits and vegetables and moderation effects of impact of weekly stressful events would contribute to greater understanding of the food environment and fruit and vegetable consumption, but mediation and moderation effects were not found. Researchers should continue to identify mediators and moderators that may explain how the environment is related to dietary intake so that interventions and public policies have the desired impact.

A comparison of the methods used in this study with others that found an association between neighborhood availability of food stores and diet may highlight areas for future research. In this study, neighborhood was operationally defined as a 0.5 mile radius around subjects' residence, but fruits and vegetables purchased for the home may have come from stores outside of this boundary. In other studies among multiethnic adults, probability of having a healthy diet decreased as density of supermarkets within a *1 mile* radius of home [23] or a census tract (>0.5 mile from home) [25] decreased. Moreover, women in this sample may have purchased fruits and vegetables for the home from other types of food retail outlets compared with grocery stores or supermarkets, such as restaurants. In another study, across multiple ethnic groups, takeout restaurants were a popular source of fruits and vegetables purchased for the home [63], and, in another study, adults who perceived fruits and vegetables as available in restaurants reported greater self-efficacy for consuming fruits and vegetables compared with those who did not perceive fruits and vegetables to be available in restaurants [28]. Last, two very large recent studies (one longitudinal and one cross-sectional) provided evidence to suggest that neighborhood food store availability may be a stronger determinant of fast food consumption compared with fruit and vegetable consumption [29, 30]. Future research should examine a greater range of food retail outlet types, other components of the diet besides fruits and vegetables (e.g., fast food), and larger radius around the home to determine how the neighborhood food environment relates to the home food environment and diet.

Strengths of this study include a large diverse sample, objective measurement of neighborhood food stores, and control of potential confounding demographic variables in analyses. However, use of self-report measures (subject to bias) and the fruit and vegetable screener (less valid and reliable compared with more intensive measures of diet such as 24 hour dietary recalls) may be considered limitations. Healthy African American and Hispanic or Latina women, who do not engage in physical activity regularly, were recruited for this study; therefore, results are generalizable only to women who meet these criteria.

5. Conclusion

African American and Hispanic or Latina women do not generally meet dietary guidelines for fruit and vegetable consumption putting them at risk for related chronic diseases like diabetes and heart disease. Ecologic models posit environmental factors contribute to individual behaviors like diet. Results showed home availability of fruits and vegetables and impact of weekly stressful events were unique and significant determinants of fruit and vegetable intake. Neighborhood availability of grocery stores and supermarkets was not related to home availability of fruits and vegetables or fruit and vegetable intake, and impact of weekly stressful events was not a moderator for any associations. Future interventions should target the home environment and impact of weekly stressful events to promote increased fruit and vegetable consumption. Future research should measure a broader range of neighborhood environment and dietary variables with greater precision and rigor to determine the extent to which and how the neighborhood environment is related to the home food environment and diet. Last, the mechanisms for the association between impact of weekly stressful events and diet should be further explored.

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Research Article

Overweight and Obesity among Palestinian Adults: Analyses of the Anthropometric Data from the First National Health and Nutrition Survey (1999-2000)

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Background. A cross-sectional survey was designed to provide a baseline data on the prevalence and distribution of overweight and obesity and their associations among adults in Palestine. *Methods*. A random representative sample of 3617 adults aged 18–64 years was collected between October 1999 and October 2000. *Results*. The prevalence of overweight was 35.5% in women and 40.3% in men, obesity was 31.5% in women and 17.5% in men. Adults aged 45–54 years old were significantly more likely to be obese (29.2% in men and 50.2% in women) or overweight (48.1% in men and 37.2% in women). When compared with women, men showed significantly more normal BMI level (40.5% versus 31.6%; $P < 0.05$). Cut-off points for a high waist circumference and high waist-to-hip ratio identified 57.8% and 47.2% of the population, respectively, to be at an increased and high risk for cardiovascular disease. Sociodemographic factors (age, sex, educational level, and marital status) were also found to be significantly related to BMI. *Conclusion*. Obesity and overweight are enormous public health problems in Palestine. Population-based research at the national level to investigate the social and cultural factors associated with high prevalence of overweight and obesity among Palestinian adults should be implemented.

1. Introduction

Obesity and the related health risks have been noted to be an epidemic problem worldwide [1], especially in developing countries [2, 3]. Within the Eastern Mediterranean Region, an increasing prevalence of overweight has been recorded [4–6] and has been noted to be at *"an alarming level"* [7]. The factors leading to this widespread increase in obesity have been suggested to include economic growth, modernization, westernization of lifestyles (including foods higher in fats and decrease in exercise levels), and the globalisation of food markets [8–12], with women being suggested to be especially at risk [13, 14].

Palestine is currently divided into the West Bank, a 5,800 km^2 area located along the northwest border of Jordan, and Gaza, a 365 km^2 strip of land on the Mediterranean coast, northeast of Egypt [15]. The Central Intelligence Agency (CIA) world factbook reports there to be 2.5 million Palestinians residing in the West Bank and 1.5 million in the Gaza Strip [16]. 5.8% of the population of the West Bank and 31.3% of the population of the Gaza Strip live in refugee camps. Women of reproductive age (15–49 years of age) are estimated to 838,555 (45.1%) of the total number of the females in 2005 and constitute 22.3% of the total population, out of which 292,480 (43%) in Gaza Strip represent 17.2% of the total population and 543,075 in West Bank (46.4%)

[17]. The population is relatively young: in mid-2005 the Palestinian Central Bureau of Statistics reported 18% of the population to be under 5 and 46% to be under 15 years old. Due to this, the Palestinian population is expected to grow dramatically to 7.4 million by 2025 [17]. The socioeconomic situation is relatively poor with nearly 40% of Palestinians being considered chronically food insecure [18].

Palestine is not an exception regarding obesity. A study of an urban Palestinian population found 49% of women and 30% of men to be obese [19], and a later study including Palestinians in rural West Bank found 37% obesity levels for women and 18% amongst men [20]. Among adolescents, a study taking place at the national level in both West Bank and Gaza found the prevalence of overweight for both genders ($n = 12{,}847$; 6,099 boys and 6,748 girls) was 16.5% (13.3% overweight; 3.2% obese); off these, 20.4% were boys and 13.0% were girls [21]. Previously, Abdeen, Greenough, Shaheen, and Tayback (2003) conducted the first national representative study with objective measurement of height and weight for assessment of obesity prevalence in Palestinian children, finding relatively low prevalence of overweight (14.9%) and obesity in children (5.9%) under 59 months [22]. Since then problems with Palestinian children's eating, dieting, and physical activity have been reported warranting further study [23].

Due to the increasing challenges to the health of the Palestinian population in the occupied Palestinian territory, the national health plans have recognized the need to tackle the existence of obesity-related diabetes, cardiovascular disease (CVD), and certain types of cancer [24]. However, some factors hinder the public health planning from creating intervention and control programs for these diseases. These factors include the inadequacy of the societal and health care system reflected in the lack of cooperation between the Ministry of Health and civil society organizations, non-governmental organizations, international organizations, and private sector who should all adopt prevention as a national priority and work towards a common goal [25]. One other major impediment to the improvement of the Palestinian health intervention system is the continuing military occupation with all its consequences (checkpoints, the separation wall, and many other fences and barriers to movement) which have detrimental effects on the ability to deliver good health care [26–28], as well as the continued focus needed on emergency health care needs, the growing poverty, and unemployment faced by Palestinians [20]. In accordance with the country's nutrition policy, national priorities in research encompassed the identification of the problem of overweight among the Palestinian population and its geographical, sex, and socioeconomic distribution [29].

This paper presents the results of the first national health and nutrition survey (FNHANS) using objective anthropometric measurements, regarding obesity prevalence in the adult Palestinian population residing in the West Bank and Gaza. The objective of the study was to (i) provide baseline and reference data on the prevalence and distribution of overweight and obesity, using different anthropometric measurements (height, weight, waist, and hip circumferences) in adult Palestinians and (ii) to analyze the association between BMI, waist circumference (WC), and waist-to-hip ratio (WHR) measurements with socio demographic variables (educational level, region, area of residency, marital status, and family income), physical activity and smoking.

2. Method

2.1. Procedure. Palestinians residing in the West Bank including East Jerusalem and Gaza regions were selected at random to participate in the study. The sample for this study was based on the health survey (HS) frame provided by the 1999 Palestinian Central Bureau of Statistics (PCBS) [30]. The frame consists of data on each primary sampling unit (PSU), each of which is composed of 100 housing units. The sample was selected using a stratified three-stage cluster sampling design. For data stratification, the population localities in each of the 16 administrative governorates in both regions, 11 in the West Bank and 5 in Gaza Strip, were divided into two strata: urban and rural. For this survey, each locality with ≥2000 inhabitants or more as revealed by the 1997 Palestinian Population and Housing Census was considered "urban". The remaining localities were considered "rural". In the first stage of sampling 234 PSUs, 142 in the West Bank and 92 in Gaza Strip were selected. These units were distributed across governorates according to each unit's weight in terms of the number of households it contains. The PSUs were selected using probability proportionate to size with a systematic selection procedure. In the second stage, the equal secondary sampling units were selected (20 and 17 households per PSU in West Bank and Gaza, resp.). In the third stage, one eligible adult was selected per dwelling.

In total, 3,702 adults were eligible to participate in this study. The total number of respondents completed the survey questionnaire was 3,617 with response rate of 97.7%. Of the 3,617 questionnaire, 212 female participants were excluded for being pregnant as well as 27 of physically disabled participants, and those who did not fall within the targeted age group (18–64) were also excluded since BMI calculations would be affected. The final sample for this analysis comprised 3378 participants, with a mean of 35.6 ± 11.2 years. Of them 1725 (51.07%) were men and 1653 (48.93%) were women.

2.2. Data Collection. A pilot study in one urban and on non-urban primary sampling unit cluster took place in September, 1999. The data collection period was between October 1999 and October 2000. Data on food intake, health, and lifestyle, physical activity, attitudes to food and health and anthropometry were collected using a previously validated survey instruments. Questionnaires were checked for completeness, accuracy, and bias at two levels prior to data entry, by field supervisors in the field and by data entry staff at the Al Quds Nutrition and Health Research Institute in Jerusalem.

2.3. Anthropometric Measurements. For each participant, four anthropometric measures were taken in the following order; height, weight, waist circumference (WC), and hip circumference (HC). All measurements were performed according to World Health Organization (WHO) guidelines [31] by well-trained ten males and ten females under the supervision of two health professionals who have public health background and previous experience in performing anthropometric measurements. Height and weight were measured in light clothes without shoes. Height was measured using a coil spring tape measure, and a fixed wood angle was placed on the wall to mark the top of the head. If two measurements differed by >0.4 cm, a third measurement was taken. Weight was measured using a portable analogue Soehnle scale (Soehnle-Waagen GmbH and Co. KG, Wilhelm-Soehnle-Straße 2, D-71540 Murrhardt/Germany) (maximum measurement 130 kg, level of accuracy 0.5 kg) placed on a noncarpeted floor. If measurements differed by >1 kg, a third measurement was taken. For waist circumference measurement, participants were asked to stand erect, to breathe normally, and to relax the abdomen. Circular tapes were used in direct contact with but not compressing the skin. This measure was taken at the midpoint of the subcostal margin of the rib cage and the highest point of the iliac crest.

The hip circumference was measured with participants standing erect with their arms by their sides and with their feet together. The measure was taken to the nearest millimetre with circular tapes placed around the hip, at the level of the greater trochanter (when possible, in direct contact with but not compressing the skin; when not possible, with light and tight contact with clothing). At least two measurements were taken for both waist and hip circumferences to improve accuracy. Both waist and hip circumferences were registered in the database, and waist-to-hip ratio (WHR) was then calculated (by dividing waist values by corresponding hip values), as an indicator of fat distribution.

The BMI cut-offs for overweight and obesity categories, as well as the waist circumference cut-off for increased cardiovascular health risk, were the ones proposed by the WHO [31, 32]: for BMI, underweight <18.5; normal weight 18.5–24.9 kg/m^2; overweight 25.0–29.9 kg/m^2; obesity I 30.0–34.9 kg/m^2; obesity II 35.0–39.9 kg/m^2; obesity III ≥40 kg/m^2. Two risk categories of waist circumference were used to identify participants who were at an increased risk (men >94 cm, women >80 cm) or a high risk (men >102 cm, women >88 cm) for metabolic diseases [33]. A high risk of cardiovascular disease was also assessed using cut-off points for waist-to-hip ratios (WHR) defined as >0.95 for men and as >0.80 for women as used by other authors [34].

Age was categorized into five groups (18–24, 25–34, 35–44, 45–54, and 55–64 years) while education was categorized as 0–8 years; 9–11 years and ≥12 years of education. Income was categorized as below average (<300 JD/month) and above average (>300 JD/month; 1$ = 0.7 JD). Participants were asked about their smoking and physical activities: "do you now smoke?" (yes or no); "have you ever smoked?" (yes or no); "over the past year, have you regularly engaged in physical activity, lasting for 20 minutes or more, causing rapid breathing and perspiration?" (yes or no).

2.4. Ethical Issues. All participants gave their written informed consent to participate. The protocol for the first national health and nutrition survey (FNHANS) (1999-2000) was approved by both the Ministry of Health and the Al-Quds University Ethics Committees.

2.5. Statistical Analysis. All statistical analyses were carried out using SPSS version 13 (2004 edition, SPSS Inc., Chicago, IL, USA). The mean and standard deviation (SD) were calculated for weight, height, BMI, WC and HC, and WHR. As all measurements were normally distributed, independent t-tests and one-way analysis of variance (ANOVA) were used to test for significant differences in mean anthropometric measurements between gender and age groups. Significance was defined as $P < 0.05$ except where otherwise stated. Survey weights were applied to obtain population level estimates. When ANOVA tables identified significant differences between age groups and lifestyle factors, post hoc tests were employed to identify which groups were significantly different. Equality of variance was assessed using Levene's test and that determined which post hoc test to use. For groups of equal variance, significant differences between groups were tested using the Scheffe post hoc test (unless otherwise stated). Cross-tabulation identified the percentage of participants in each of the BMI categories and the percentage of participants in the defined risk categories for WC and WHR, which were expressed as percentages. Significant differences between age groups and gender were tested using Chi-square analysis. Multiple regression analysis was performed to estimate BMI variation as dependent variable, and several sociodemographic variables as independent variables. These included age, gender, education, marital status, smoking, physical activity, diabetes, and hypertension. Prevalence odds ratios (ORs) and their 95% confidence intervals (CIs) were calculated.

3. Results

Table 1 summarised the results of anthropometric measurement for both men and women within the five age groups. Of the final sample for the analysis of this paper (3378 participants), BMI was obtained for 100% and WHR 99.3%. For almost all of the anthropometric variables, for both males and females, significantly higher values ($P < 0.05$) were observed in both the 45–54- and 55–64-year-old age groups when compared with the other three age groups. Height was an exception given that there was a small but statistically significant ($P < 0.05$) decline across these age groups.

Men were generally about 13 cm taller than women, and the difference was constant across age ranges. In men, the majority of the anthropometric measurements did not significantly increase further in the 55–64-year-old age group, compared with the younger age groups, with the exception of the BMI ratio. These measurements were significantly greater ($P < 0.05$) in the 45–54-year-old men. A slight decrease in weight and height measurements occurred after 55 years of age in men, and these were the only measurements that

Table 1: Mean anthropometric measurement and SD in Palestinian adults according to sex and age: findings of the first national health and nutrition survey (FNHANS) 1999-2000.

Age Group		Male						Female					
		Weight (Kg)	height (m)	BMI (kg/m^2)	WC (cm)	HC (cm)	WHR	Weight (Kg)	Height (m)	BMI (kg/m^2)	WC (cm)	HC (cm)	WHR
18–24	Mean	72.30	1.73$_{cde}$	24.13	81.10	93.70	0.87	61.40	1.60$_{e}$	24.08	78.30	96.40	0.82
	SD	13.10	0.08	3.80	14.50	15.80	0.09	10.20	0.07	3.77	13.40	15.80	0.09
	N	268	268	268	268	268	268	284	284	284	284	284	284
25–34	Mean	75.60$_{a}$	1.72$_{de}$	25.53	87.60$_{a}$	98.60$_{a}$	0.89$_{a}$	68.00$_{a}$	1.59$_{a}$	26.81$_{a}$	87.10$_{a}$	105.20$_{a}$	0.83
	SD	13.00	0.07	4.06	13.60	12.30	0.11	12.80	0.06	4.85	12.20	11.30	0.08
	N	580	580	580	580	580	580	539	539	539	539	539	539
35–44	Mean	78.5$_{ab}$	1.72$_{e}$	26.62$_{ab}$	92.0$_{ab}$	101.7$_{ab}$	0.91$_{a}$	73.10$_{ab}$	1.59	29.03$_{ab}$	93.20$_{ab}$	109.00$_{ab}$	0.86$_{ab}$
	SD	13.50	0.07	4.16	13.80	12.00	0.10	14.70	0.08	5.39	13.30	13.80	0.13
	N	555	555	555	555	555	555	443	443	443	443	443	443
45–54	Mean	81.40$_{ab}$	1.70	27.95$_{abc}$	96.30$_{abc}$	102.6$_{ab}$	0.94$_{abc}$	78.2$_{abc}$	1.59	31.08$_{abc}$	98.30$_{abc}$	112.60$_{ab}$	0.88$_{ab}$
	SD	14.30	0.07	4.22	15.40	13.90	0.08	14.40	0.07	5.51	15.00	15.60	0.08
	N	216	216	216	216	216	216	239	239	239	239	239	239
55–64	Mean	78.70$_{a}$	1.67	27.97$_{abc}$	95.90$_{ab}$	102.80$_{a}$	0.93$_{abc}$	77.5$_{abc}$	1.58	31.15$_{abc}$	100.8$_{abc}$	113.5$_{abc}$	0.89$_{abc}$
	SD	13.6	0.08	4.22	16.60	14.10	0.08	15.00	0.07	5.49	16.30	16.20	0.12
	N	106	106	106	106	106	106	148	148	148	148	148	148
Total	Mean	**76.90***	**1.72***	**26.12**	**89.60**	**99.60**	**0.90***	**70.50**	**1.59**	**27.94***	**90.10***	**106.50***	**0.85**
	SD	13.60	0.07	4.25	15.00	13.40	0.10	14.50	0.07	5.53	15.30	14.90	0.10
	N	1725	1725	1725	1725	1725	1725	1653	1653	1653	1653	1653	1653

*Denotes significant differences found between men and women for each of the mean anthropometric measurements at $P < 0.001$.
[abcde]: Different superscripts within a column denote significant differences between age groups at $P < 0.05$.

Table 2: Age-adjusted partial correlation coefficient among anthropometric measures in Palestinian adults: findings of the first national health and nutrition survey (FNHANS) 1999-2000.

	Females (n = 1653)		Males (n = 1725)		
	Weight	BMI	Waist	Hip	WHR
Weight	—	.872**	.669**	.577**	.282**
Body Mass Index (BMI)	.908**	—	.654**	.548**	.292**
Waist Circumference (WC)	.734**	.729**	—	.795**	.502**
Hip Circumference (HC)	.719**	.715**	.800**	—	-.096-**
Waist/Hip ratio (WHR)	.195**	.194**	.461**	-.108-**	—

All coefficients significantly different to zero ($P < 0.05$). **Correlation is significant at the 0.01 level (2-tailed). WC: waist circumference in cm, HC: hip circumference in cm, BMI: body mass index in kg/m^2, and WHR (Waist-to- Hip Ratio).

were not significantly higher in the 55–64-year-old age group compared with the 25–34 and 35–44 age groups. In women, all of the anthropometric measurements, with the exception of height, were significantly greater ($P < 0.05$) in the 45–54 year old age group. For all age groups combined (18–64 years), weight and height values were significantly higher ($P < 0.001$) for men than for women while waist and hip values in females had significantly higher values (Table 1).

Table 2 presents pairwise partial correlation between weight, BMI, WC, and HC, and WHR was investigated, after controlling for age. These anthropometric measurements strongly correlated in both sexes ($n = 3378$), suggesting that measures of obesity based on these parameters will provide comparable information.

The percentage of the population in the different BMI categories is given in Table 3. For the total population ($n = 3378$), 1.5% was underweight (BMI < 18.5 kg/m^2), 36.1% were in the normal range (BMI = 18.5–24.9 kg/m^2), 38.0% were overweight (BMI = 25.0–29.9 kg/m^2), and 24.4% were obese (BMI ≥ 30 kg/m^2). The majority of the obese participants (17.2%) were in class I obesity (BMI = 30.0–34.9 kg/m^2) and 1.6% were morbidly obese (BMI ≥ 40 kg/m^2). The data shows that 57.8% of men and almost 67% of women were either overweight or obese with 17.5% of men and 31.5% of women in the obese category. The difference in prevalence of obesity between men and women was particularly large in the older age groups (45–54 and 55–64 years), where the ratio of prevalence of obese women to obese men was approximately two (50.8% versus 29.2%). For all participants aged 25–64-years-old ($n = 2826$), men ($n = 1457$) had a higher prevalence in the normal and overweight BMI category ($P < 0.05$) while women ($n = 1369$) had a higher prevalence of obesity. The percentage of the total population in the normal category (BMI = 18.5–24.9 kg/m^2) decreased significantly ($P < 0.001$) with increasing age. Conversely, in the overweight and obese categories, the percentage increased significantly with age ($P < 0.05$). Only in females in the overweight category did this decrease significantly in the 55–64-year-old age group. The prevalence of underweight (BMI < 18.5 kg/m^2) demonstrated a very different pattern (Table 3) with the highest prevalence of underweight in the first two age groups (18–24 and 25–34 years) in both sexes. The prevalence of underweight was higher in males (1.7%) than females (1.4%).

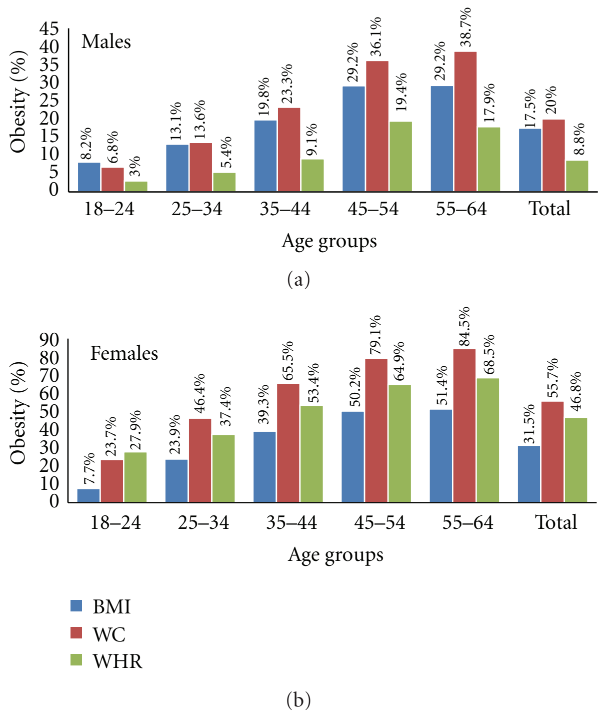

Figure 1: Prevalence of obesity as yielded by BMI, WC, and WHR, in Palestinian adults by gender: findings of the first national health and nutrition survey (FNHANS) 1999-2000. BMI (body mass index ≥30 kg/m2), WC (waist circumference ≥102 cm in men and ≥88 cm in women), and WHR (waist-to-hip ratio ≥1 in men and ≥ 0.85 in women).

Figure 1 shows the distribution of obesity in the study population based on BMI, WC, and WHR. The three measurements appear to provide different prevalence of obesity across genders. In men, BMI and WC showed an increase with age. WHR provided the lowest prevalence estimate while WC provided the highest prevalence estimate in all age groups. In women, BMI, WC, and WHR prevalence estimates showed an increase with age. Overall, using WC provided the highest prevalence of obesity in men (20.0%) and WHR the lowest (8.8%), while WHR (46.8%) and WC (55.7%) yielded the highest prevalence of obesity in women and BMI (31.5%) the lowest.

TABLE 3: Percentage of adults in each BMI category, increasing risk for CVD as defined by waist circumference and WHR according to sex and age group: findings of the first national health and nutrition survey (FNHANS) 1999-2000.

Gender	Age groups	*n*	BMI categories: Underweight (<18.5)	Normal (18.5–24.9)	Overweight (25.0–29.9)	Obese† ≥ 30	Class I (30.0–34.9)	Class II (35.0–39.9)	Class III ≥ 40	*n*	Waist circumference: Normal risk M: <94 cm F: <80 cm	Increased risk M: >94 cm F: >80 cm	High risk M: >102 cm F: >88 cm	*n*	WHR increased Risk: Normal risk M: <0.95 F: <0.80	Increased risk M: >0.95 F: >0.80
Male	18 –24	**268**	3.4	62.3	26.1^{bcde}	8.2^{cde}	6.7	1.5	0.0	**265**	83.4^{bcde}	9.8^{cd}	6.8^{cde}	**265**	87.9^{cde}	12.1^{cde}
	25–34	**580**	2.4	46.0	38.4^{a}	13.1^{ade}	10.7	2.2	0.2	**574**	70.0^{acde}	16.4	13.6^{cde}	**574**	84.0^{cde}	16.0^{cde}
	35–44	**555**	1.1	35.1^{ab}	44.0^{a}	19.8^{ab}	16.4	2.9	0.5	**550**	53.5^{abd}	23.3^{a}	23.3^{abde}	**549**	70.1^{ab}	29.9^{ab}
	45–54	**216**	0.0	22.7^{ab}	48.1^{a***}	29.2^{ab}	22.7	5.6	0.9	**216**	38.0^{abc}	25.9^{a}	36.1^{abc}	**216**	59.7^{ab}	40.3^{ab}
	55–64	**106**	0.0	19.8^{ab}	50.9^{a*}	29.2^{ab}	21.7	6.6	0.9	**106**	43.4^{ab}	17.9	38.7^{abc}	**106**	61.3^{ab}	38.7^{ab}
	18–64	**1725**	**1.7**	**40.5*****	**40.3*****	**17.5**	**14.1**	**3.0**	**0.4**	**1711**	**61.1**	**18.9**	**20.0**	**1710**	**75.7**	**24.3**
Female	18–24	**284**	2.5	63.7^{bcde}	26.1	7.7^{bcde}	6.7	1.1	0.0	**283**	53.4^{bcde}	23.0^{de}	23.7^{bcde}	**283**	46.3^{bcde}	53.7^{bcde}
	25–34	**539**	2.2	38.4	35.4	23.9^{acde}	17.8	5.4	0.7	**539**	24.1^{acde}	29.5^{cde}	46.4^{acde}	**537**	35.4^{acde}	64.6^{acde}
	35–44	**443**	0.7	20.5^{ab}	39.5	39.3^{ab**}	26.2	8.8	4.3	**438**	13.0^{ab}	21.5^{be}	65.5^{abde}	**438**	23.7^{abd}	76.3^{abd}
	45–54	**239**	0.4	12.1^{ab}	37.2	50.2^{ab***}	28.0	16.3	5.9	**239**	9.2^{ab}	11.7^{ab}	79.1^{abc}	**239**	14.2^{abd}	85.8^{abd}
	55–64	**148**	0.0	9.5^{ab}	39.2	51.4^{ab**}	26.4	18.2	6.8	**148**	8.8^{ab}	6.8^{abc}	84.5^{abc}	**146**	13.0^{ab}	87.0+
	18–64	**1653**	**1.4**	**31.6**	**35.5**	**31.5*******	**20.4**	**8.3**	**2.8**	**1647**	**22.6**	**21.6**	**55.7**	**1643**	**29.1**	**70.9**
Total	18–24	**552**	2.9^{cde}	63.0^{bcde}	26.1^{bcde}	8.0^{bcde}	6.7	1.3	0.0	**548**	67.9^{bcde}	16.6^{b}	15.5^{bcde}	**548**	66.4^{cde}	33.6^{cde}
	25–34	**1119**	2.3	42.4acde	37.0^{a}	18.3^{acde}	14.1	3.8	0.4	**1113**	47.8^{acde}	22.7^{ae}	29.5^{acde}	**1111**	60.5^{cde}	39.5^{cde}
	35–44	**998**	0.9^{a}	28.7^{abde}	42.0^{a}	28.5^{abde}	20.7	5.5	2.2	**988**	35.5^{abde}	22.5^{e}	42.0^{abde}	**987**	49.5^{abde}	50.5^{abde}
	45–54	**455**	0.2^{a}	17.1^{abc}	42.4^{a}	40.2^{abc}	25.5	11.2	3.5	**455**	22.9^{abc}	18.5	58.7^{abc}	**455**	35.8^{abd}	64.2^{abd}
	55–64	**254**	0.0	13.8^{abc}	44.1^{a}	42.1^{abc}	24.4	13.4	4.3	**254**	23.2^{abc}	$11.4b^{c}$	65.4^{abc}	**252**	33.3^{abc}	66.7^{abd}
	18–64	**3378**	**1.5**	**36.1**	**38.0**	**24.4**	**17.2**	**5.6**	**1.6**	**3358**	**42.2**	**20.2**	**37.6**	**3353**	**52.8**	**47.2**

†Obese group consists of all three classes of obesity (i.e. BMI ≥ 30 kg/m^2). M: male, F: female. $^{*}P < 0.05$, $^{**}P < 0.010$, $^{***}P < 0.001$: denotes significant difference between men and women of same age groups and BMI category. [abcde]Different superscripts within a column denote significant differences between age groups at $P < 0.05$.

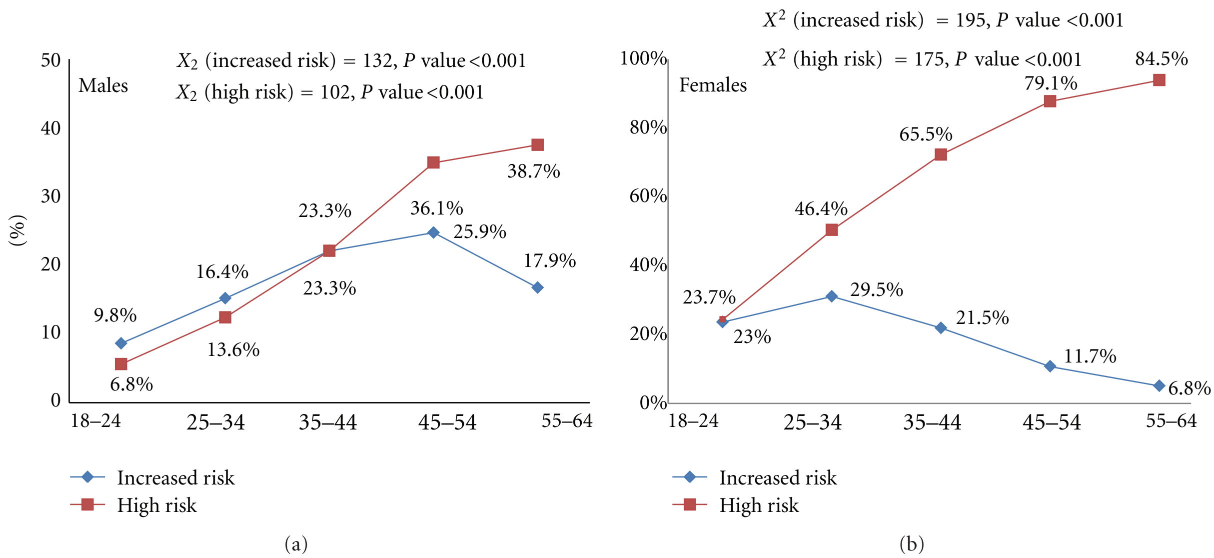

FIGURE 2: Prevalence of increased risk and greatly increased risk associated with high waist circumference by gender and age group: findings of the first national health and nutrition survey (FNHANS) 1999-2000.

WC and WHR are also presented in Table 3, where the data are expressed as a percentage of the population at varying levels of risk for cardiovascular disease as previously defined [22]. In both males and females, the percentage of participants in the risk categories increased with increasing age group for both WC and WHR. For the total population combined and for each gender, there was a significantly greater proportion as of age 25 years in the increased and high risk categories of WC, compared with 18–24-year-olds ($P < 0.05$). There was a particularly large increase between the 18–24-year-olds and 55–64-year-old age groups. Moving from the baseline age group category (18–24 years) to the last (55–64 years) increased the prevalence of obesity as estimated by WC and WHR by 5.7- and 3.2-fold, respectively, in men and by almost 3.6 and 1.6 times, respectively, in women. Similar to trends in BMI, significantly more men were in the normal risk category of WHR than women ($P < 0.001$), while significantly more women were in the increased risk category ($P < 0.001$). The percentage of both men and women in the increased risk category of WHR increased significantly with age up to 54-year age group ($P < 0.05$).

Figure 2 shows the prevalence of increased risk and greatly increased risk associated with high WC by gender and age group. Significant association ($P < 0.001$) was found between the prevalence of increased cardiovascular disease risk (and greatly increased cardiovascular disease risk) due to high WC and age interval groups.

Table 4 examines the association of anthropometric measures for overweight or obesity with demographic and lifestyle factors. Results from logistic regression analysis have shown that certain factors *(marked in bold)* remain strongly associated with overweight or obesity, namely: educational level, family income, marital status, smoking, and location of residence in the West Bank. Higher educational level was significantly associated with lower risk of overweight or obese among women for the two estimates, (BMI-OR (95% CI) = 0.66 (0.48–0.90); WHR-OR (95% CI) = 0.72 (0.54–0.95)) while the opposite is true among men WHR-OR (95% CI) = 1.34 (1.00–1.79). Married individuals were more likely to be overweight and obese (for men, OR (95% CI) = 1.54 (1.11–2.14), for women, OR (95% CI) = 1.92 (1.39–2.64) than single individuals. West Bank residents were at higher risk than Gaza with WHR-OR (95% CI) = 1.48 (1.11–1.98) for men and 0.76 (0.59–0.99) for women.

4. Discussion

Excess body fat is well documented as being a risk factor for numerous chronic conditions such as diabetes, hypertension, hyperlipidaemia, and cardiovascular diseases [35]. Studies of anthropometric measures among children within Middle Eastern countries have been conducted [22]; however studies of adult populations are limited, with weight and BMI being the most common indicators which have been used to assess overweight and obesity prevalence [19, 20].

This paper presents the results of the first national survey of its kind in Palestine which clearly shows that more than sixty percent of the Palestinian population between 18 and 64 years old are overweight (38.0%) or obese (24.4%). This highlights the emergence of noncommunicable diseases and their risk factors as major contributors to the burden of ill health in the Middle East, particularly among urban populations.

This study shows significant difference ($P < 0.001$) between the mean BMI for both males (26.12%) and females (27.94%). Females ($n = 1653$) within the study population showed a significantly higher prevalence of obesity than males ($n = 1725$) in all age groups except for those aged 18–24 years old. The results also showed that middle age

Table 4: Age-adjusted odd ratios (95% confidence interval) for being overweight or obese based on body mass index, waist circumference, and waist-to-hip ratio, with demographic and lifestyle factors in Palestinian adults by gender.

	Male			Female		
	BMI ≥25 OR (95%CI)	WC ≥0.9 OR (95%CI)	WHR ≥0.95 OR (95%CI)	BMI ≥25 OR (95%CI)	WC ≥0.8 OR (95%CI)	WHR ≥0.85 OR (95%CI)
Educational level						
0–8 Y	Reference	Reference	Reference	Reference	Reference	Reference
9–11 Y	1.33(0.98–1.80)	1.41 (0.23–8.81)	1.19 (0.84–1.68)	0.84 (0.61–1.17)	0.50 (0.02–10.22)	0.84 (0.63–1.13)
≥12 Y	1.25 (0.97–1.62)	1.06 (0.25–4.42)	**1.34 (1.00–1.79)***	**0.66 (0.48–0.90)***	0.37 (0.03–5.39)	**0.72 (0.54–0.95)***
Region						
Gaza	Reference	Reference	Reference	Reference	Reference	Reference
West Bank	1.14 (0.89–1.47)	2.94 (0.71–12.15)	**1.48 (1.11–1.98)***	0.96 (0.71–1.28)	5.88 (0.51–67.52)	**0.76 (0.59–0.99)***
Area of residency						
Rural	Reference	Reference	Reference	Reference	Reference	Reference
Urban	**1.29 (1.01–1.63)***	0.24 (0.03–2.05)	1.09 (0.84–1.42)	1.08 (0.82–1.44)	0.78 (0.07–8.97)	1.14 (0.89–1.46)
Marital status						
Not married	Reference	Reference	Reference	Reference	Reference	Reference
Married	**1.54 (1.11–2.14)***	1.19 (0.21–6.66)	1.01 (0.68–1.51)	**1.92 (1.39–2.64)***	3.05 (0.38–24.16)	1.22 (0.90–1.64)
Family income						
Average and below	Reference	Reference	Reference	Reference	Reference	Reference
Above average	0.86 (0.69–1.08)	**5.49 (1.10–27.36)***	0.98 (0.76–1.27)	1.03 (0.79–1.33)	11.50 (0.81–163.14)	0.86 (0.68–1.08)
Physical activity						
Not active	Reference	Reference	Reference	Reference	Reference	Reference
Active	0.87 (0.60–1.26)	1.04 (0.98–1.1)	1.10 (0.72–1.69)	1.55 (0.88–2.71)	1.23 (1.13–1.35)	0.80 (0.48–1.34)
Ever smoked						
No	Reference	Reference	Reference	Reference	Reference	Reference
Yes	**0.76 (0.60–0.95)***	1.37 (0.40–4.76)	1.25 (0.97–1.62)	0.63 (0.38–1.03)	1.06 (0.97–1.15)	0.77 (0.49–1.21)

was the period of life where the highest prevalence of overweight/obesity was found. This pattern was expected for the age range of 18 to 55 years old and was similar to other large-population-based studies [24, 29]. The female/male ratio for obesity (1.8) was also found to be similar with those in Saudi Arabia (1.7) and Israeli Arabs (1.8) but higher than several other Middle Eastern countries, such as Israel (1.2) and Lebanon (1.3). Furthermore, as previously reported this increase was found to be more dramatic in urban areas than rural [4, 29, 36, 37].

The steeper BMI-age gradient in the current study was due both to a steeper weight-age gradient as well as less variation in mean heights of comparable age groups. The increase in body weight with age has been attributed to increasing sedentary lifestyle, and the lower heights among older age groups is said to be due to younger cohorts achieving better growth potential because of better nutrition [38]. Furthermore, the larger increases in body weight with age could mean that the changes in physical activity, diet, and lifestyles that are associated with aging have greater negative impact on this group of women. Alternatively this could be due to limited exercising facilities or opportunities for practicing healthier lifestyles within this population group.

The correlation of indices of overall and central obesity is highly suggestive of an association between increased overall obesity (as measured by BMI) with increased visceral fat (WC in this case). We found that mean WC, more than WHR, increased with age in both genders. Similar results were reported in the urban adult population of Israel [37] and Saudi Arabia [4]. It is likely therefore that BMI and WHR provide different measures of almost the same phenomenon.

Visceral fat is more metabolically active than subcutaneous fat and hence may be more deleterious to health [39]. Studies have found a strong association between visceral fat and cardiovascular risk factors [40]. WC is a practical measure of intra-abdominal fat mass [41], and recommendations have been formulated to use it in the identification of people in need of intervention for cardiovascular risk reduction [33, 42, 43]. Many studies have considered WC to be the best anthropometric measurement to determine abdominal obesity-related risks contributing to future cardiovascular disease (CVD) [44, 45]. Another study identified a high correlation between WC and BMI and suggested this could imply that WC is not only an indicator of abdominal adiposity but also overall obesity [46]. While other studies have suggested WHR to be a superior predictor of CVD risk because it includes a measurement of hip circumference, which is inversely associated with dysglycaemia, dyslipidaemia, diabetes, hypertension, CVD, and death [47–49], much debate to determine which of the two (WC or WHR) is the better measurement tool to assess risks on CVD. But it was agreed that both WC and WHR as being stronger predictors of all-cause mortality than BMI [50, 51]. Since BMI is used to measure the general adiposity, it is unable to distinguish between fat mass and lean mass, particularly for men and the elderly [52]. Finally, these two indices on their own, or in combination with BMI, could better capture the health risks of increased adiposity [53].

In Table 3, based on WC, approximately half of the sample is at a greater risk (increased risk and high risk combined 57.8%) of having at least one major risk factor for cardiovascular disease. The high-risk category (37.6%) corresponds with the level at which symptoms of breathlessness [54] and arthritis [55] may begin to develop due to overweight. The group of participants in the increased risk category must be discouraged from further weight gain and an increase in WC towards the high-risk category. In this study, WHR cut-off points indicated that approximately half of the population 47.2% was at an increased risk for cardiovascular disease risk factors which corresponds with other research results [56, 57]. WC seems to identify a greater proportion of the population that is above normal risk compared with WHR.

In men and women adults of Palestine, WC was strongly correlated with BMI ($r \approx 0.7$ in men and women, resp.) but showed moderate correlation with WHR (men $r = 0.50$; women $r = 0.46$), Table 2. These findings suggest that defining obesity on the base of WC may be an equally or more valid and useful method for use in epidemiological research and clinical practice than BMI or waist-to-hip ratio indices, though further research is needed to demonstrate this unequivocally.

Recently, there has been increasing emphasis, especially in Saudi Arabia, Bahrain, Egypt, Kuwait, Lebanon, and Tunisia, on determining the factors associated with obesity [42, 43, 58]. Food consumption patterns and dietary habits in Palestine and the surrounding Eastern Mediterranean Region have changed markedly during the past 4 decades [38, 59]. Data from the food balance sheet showed an increase in calories consumed during 1971–1997 in the countries of the Region, and a high percentage of these calories came from animal foods [60]. It is probable that the high consumption of foods rich in fats and calories and the sedentary lifestyle among most communities in this Region played an important role in the rise of obesity. This is particularly salient with regard to the shift from traditional foods to more westernized foods, which are characterized by high fat, high cholesterol, high sodium, and low fibre. Nevertheless, in-depth studies on this aspect are few, which mean there is a grave need for establishing a well-designed, community-based study in the Middle Eastern Region.

A review of the literature by Monteiro (2004) concluded that obesity in the developing world is not solely a disease of high SES groups. The risks of obesity within developing countries tend to shift towards the groups of lower SES as that country's GNP increases, and this occurs at an earlier stages of economic development among women over men [61]. As was found in this survey, the World Health Organization (WHO) MONICA (monitoring trends and determinants in cardiovascular disease) Project found that women with lower educational levels faced significantly higher risk of obesity [62] which is consistent with our results (Table 4). The higher levels of obesity among less educated Palestinian women could be attributed to the lower levels of awareness on the risks and health consequences associated with obesity, combined with the belief that fatness is considered culturally desirable in Arab countries.

Regular exercise, though not common practice in this study population, was much less reported by those women categorised as obese. This low physical activity could be attributed to the limited availability of exercising facilities for girls and women in Palestine. Similar findings were also noted in an Iranian study, where it was suggested that a less frequent engagement in leisure physical activity was due to social and religious reasons [63]. Overweight and obesity were found to be higher among married individuals compared with singles after adjusting for other confounding variables. It is hypothesised that marital status could place a heavy burden on those individuals to adjust their physiological rhythms for sleeping and eating, combined with having less time for physical activity along with exposure to other environmental factors [64, 65]. Furthermore, gender was treated as a stratifying variable for all analyses because of the different ways that men and women experience and are affected by marriage [66] and the different ways each gender perceives body weight [67]. More studies are required to examine the factors related to weight gain among married individuals.

Several study limitations must be considered. The cross-sectional design of this study limits any conclusions regarding causal relationships. It is also possible that there are other factors, such as home environment, body image, beliefs and attitudes, lack of health awareness, and cultural conditions, which may be linked with obesity but were not included within this investigation.

Despite these factors, the greatest strength of the current study is the use of a nationally representative sample rather than obese patients seeking medical care or weight loss treatment. In addition, the ability to examine within causal domains adds to the scant knowledge published in this area. Measured height and weight was also a strength that eliminated the chance of misclassification of respondents through self-report of body weight status. However, the data presented here are first-level analyses and require further investigation to formulate recommendations. It can be concluded from this national survey that obesity and overweight are enormous public health problems in Palestine. Within this population, the people at most risk of overweight and obesity are middle-aged (45–54 years old). This risk is especially alarming among Palestinian women.

Considering the global burden of this health problem, the Palestinian Ministry of Health should take the lead responsibility in creating a task force and provide an integrated and consistent proactive approach to addressing overweight and obesity. As well, it should be in charge of the implementation, monitoring, and evaluation of the National Strategy on Obesity in conjunction with all government departments, relevant bodies and agencies, and industry and consumer groups. In cooperation, all these departments and agencies should (1) target the young in the population with preventative strategies, to prevent them becoming the next obese generation, (2) define concrete actions for changing eating behaviours like the use of mass media to influence nutritional norms, practices, and personal choices, (3) provide culturally appropriate health education programs for promoting physical activity especially among Palestinian women, and (4) continuously monitor the numbers of overweight and obese individuals with a national register for obesity.

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Research Article

Targeting Policy for Obesity Prevention: Identifying the Critical Age for Weight Gain in Women

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The obesity epidemic requires the development of prevention policy targeting individuals most likely to benefit. We used self-reported prepregnancy body weight of all women giving birth in Nova Scotia between 1988 and 2006 to define obesity and evaluated socioeconomic, demographic, and temporal trends in obesity using linear regression. There were 172,373 deliveries in this cohort of 110,743 women. Maternal body weight increased significantly by 0.5 kg per year from 1988, and lower income and rural residence were both associated significantly with increasing obesity. We estimated an additional 82,000 overweight or obese women in Nova Scotia in 2010, compared to the number that would be expected from obesity rates of just two decades ago. The critical age for weight gain was identified as being between 20 and 24 years. This age group is an important transition age between adolescence and adulthood when individuals first begin to accept responsibility for food planning, purchasing, and preparation. Policy and public health interventions must target those most at risk, namely, younger women and the socially deprived, whilst tackling the marketing of low-cost energy-dense foods at the expense of healthier options.

1. Introduction

The World Health Organisation (WHO) estimates that globally 1.5 billon adults are overweight and 500 million are obese [1]. Almost 25% of Canadians are currently obese, with an estimated 1 in 10 premature adult deaths attributable directly to obesity [2]. Obesity rates in Nova Scotia have more than doubled since 1985 [3, 4]. With 20% of Nova Scotians classed as obese and a further 35% classed as overweight, the Provincial rate is substantially higher than the Canadian average of 16% and 32% for obese and overweight, respectively [5]. Further, overweight and obesity rates are higher in Nova Scotian women than men [3]. These trends have important implications for population health and health system planning.

Obesity is a serious public health issue. It is a risk factor for premature mortality from a number of causes, such as hypertension, coronary artery disease, and type 2 diabetes, as well as many types of cancer [2, 6].

While the causes of the obesity epidemic are simple in principle—an imbalance between energy consumption (diet) and energy expenditure (physical activity)—in reality the problem is complex and the result of an interaction between genetic, lifestyle, and environmental factors [7]. A greater understanding of policy options and of potential target populations for obesity prevention is therefore necessary.

Understanding the parameters of maternal weight status is of critical importance for a number of reasons. Maternal obesity is related to a significantly higher risk for complications during pregnancy, including a higher rate of delivery and surgical difficulties, hypertension, thromboembolism, and gestational diabetes which also contribute to fetal complications such as congenital malformations, macrosomia, and antepartum stillbirth [8, 9]. Furthermore, pregnancy often alters the weight gain trajectory of an individual by increasing the likelihood of postpartum weight retention if gestational weight gain is greater than the recommended range [10, 11]. This cycle may then be repeated with each additional pregnancy as increases in maternal body weight can occur with parity, further perpetuating the obesity epidemic [12]. Obese women are also less likely to breast-feed for mechanical as well as physiological reasons, removing a fundamental safeguard against long-term weight gain for themselves and their children [13]. These early life factors, among many others, make it more likely that the children of obese mothers will themselves be overweight or obese, or at greater risk of becoming overweight or obese adolescents and adults [14]. In particular, the relatively new concept of assortative weight gain suggests an important role of the mother in influencing body mass index (BMI) of daughters, with a weaker relationship seen between fathers and sons [14]. Studies have identified that women of childbearing age are at a particularly high risk of weight gain and future obesity [15]. Amongst this group, the highest risk has been identified in the 25–45 age range [16].

Identifying the target for policy approaches requires some consideration. For example, prevention of obesity in children is an important element of obesity prevention [17], but targeting children without also addressing parental obesity may not be an effective or viable solution. Therefore, targeting obesity prevention policies at childbearing women could offer a dual benefit—to both the mother and the child. However, information on the parameters of maternal weight status is limited, particularly in terms of identifying critical periods for weight gain.

The purpose of this study was therefore to identify the socioeconomic, demographic, and temporal trends of maternal prepregnancy bodyweight for Nova Scotian women. Specifically we analyzed changes in prepregnancy body weight of women giving birth in Nova Scotia between 1988 and 2006 to identity the critical window for excessive weight gain in this substantial cohort of women. Our overall aim was to understand how weight gain varies at different age points in order to understand better the role of lifecourse factors that influence obesity risk.

2. Materials and Methods

2.1. Data. Canada has no national surveillance system in place to assist in the identification of overweight or obese women giving birth. Therefore the development of evidence-based public health policy is problematic. The Canadian Perinatal Surveillance System (CPSS) [18] is the closest system and collects 27 health outcomes however height, weight, or waist circumference of the mother is not included. In Nova Scotia, the Atlee Perinatal Database (NSAPD) records information on pregnancy outcomes and was used to analyse trends in maternal prepregnancy weight. Ethical approval was obtained from the Research Ethics Board at the IWK Health Centre, Halifax, Nova Scotia.

The total female population of Nova Scotia in 2010 was approximately 485,000. The NSAPD represents a sizeable fraction of this Nova Scotian female population, with prepregnancy self-reported body weight from over 110,000 women, and a total of 196,209 individual deliveries, collected between January 1st 1988 and December 31st 2006. Of these deliveries 23,829 (12%) were excluded from this analysis, mostly because prepregnancy weight was not recorded but a very small number had no parity information recorded, resulting in a total analysis dataset of 110,743 women with 172,373 deliveries and prepregnancy body weight measurements. No other covariates beyond age and parity that are relevant to obesity risk were available in the NSAPD, although we were able to use the residential postal code for each woman to define urban/rural residence and assign an indicator of socioeconomic status from census information.

2.2. Outcome Measures. Self-reported prepregnancy body weight in kilograms (kg), taken from the standard provincial prenatal form used in Nova Scotia, was used as the principal outcome measure. For all women this information was collected at their first physician visit where their pregnancy was confirmed. This was used as a continuous and discrete variable; for the discrete comparisons, individuals were classified as underweight (<55 kg), normal weight (55–75 kg), overweight (>75–90 kg), or obese (>90 kg) using the same classifications developed by Robinson et al. in an analysis of body weight changes in the NSAPD [8]. Demographic variables analysed were age, by year and in six categories (<20, 20–24, 25–29, 30–24, 35–39, ≥40), parity, income decile (derived from census data), and location (urban versus rural residence).

2.3. Analysis. Descriptive statistics were used to explore temporal, socioeconomic, and demographic trends in body weight. Multivariate linear regression modelling of body weight was conducted for the following predictor variables: year of birth (of the offspring), mother's age (continuous, six categories), socioeconomic status (income deciles), and location (urban/rural). These data relate to prepregnancy body weight at specific pregnancies in a longitudinal cohort of women, and therefore the analysis was clustered on maternal identifier, and robust estimates of variance were used [19]. The overall significance of each regression model was assessed using the F-test; significance of individual coefficients was assessed through inspection of the t-statistic and the 95% confidence intervals (CIs) for the coefficients. Statistical analysis was performed using STATA 10 [20].

3. Results

Prepregnancy body weight was recorded for 172,373 deliveries to women resident in Nova Scotia between 1988–2006. There were very few deliveries (<0.1%) to women aged over 45 years in the cohort. Overall, the average age at first birth was 26 years, increasing from 25 years in 1988 to 27 years in 2006, highlighting the trend for women having babies later in life. Figure 1 shows the change in median body weight over time for primiparous and multiparous women, which represents a steep upward trend over the last two decades. Multiparous women were consistently heavier than primiparous women, and the difference in median body

Table 1: Linear regression modelling of body weight in relation to demographic factors (i) unadjusted, (ii) adjusted for parity, and (iii) adjusted for parity and all other variables.

Variable	Body weight (kg)		Unadjusted			Adjusted (parity)			Adjusted (all variables)		
	Mean	Median	Coefficient	95% CI	P	Coefficient	95% CI	P	Coefficient	95% CI	P
Year	—	—	0.53	0.51–0.55	<0.01	0.53	0.52–0.55	<0.01	0.53	0.51–0.54	<0.01
Age group					<0.01			<0.01			<0.01
<20	59.4	56.7	—	—		—	—		—	—	
20–24	65.2	61.2	5.84	5.57–6.12		5.70	5.42–5.98		5.42	5.13–5.70	
25–29	67.1	63.5	7.74	7.47–8.02		7.52	7.23–7.81		7.46	7.16–7.75	
30–34	67.2	63.5	7.86	7.57–8.14		7.57	7.26–7.89		7.27	6.94–7.59	
35–39	67.6	63.5	8.23	7.89–8.57		7.90	7.52–8.27		7.19	6.80–7.58	
≥40	68.0	64.4	8.62	7.99–9.25		8.24	7.58–8.90		7.06	6.39–7.72	
Income (SES)	—	—	−0.17	−0.20–−0.14	<0.01	−0.17	−0.21– −0.14	<0.01	−0.27	−0.30–−0.24	<0.01
Urbanicity					<0.01			<0.01			<0.01
Urban	66.0	62.6	—	—		—	—		—	—	
Rural	66.9	63.5	0.82	0.63–1.01		0.75	0.56–0.94		1.49	1.30–1.67	

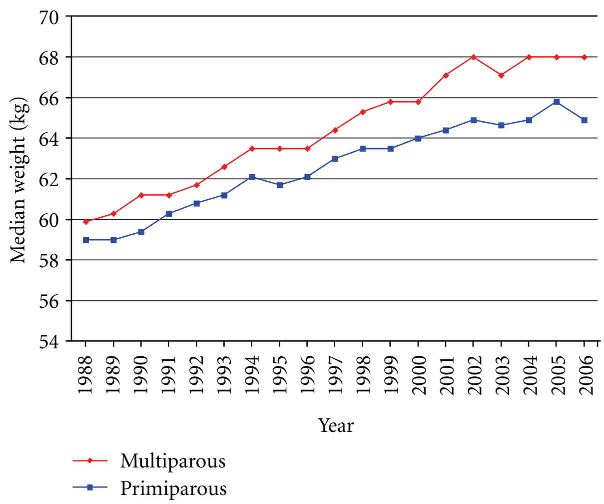

Figure 1: Median prepregnancy bodyweight, primiparous, and multiparous women, 1988–2006.

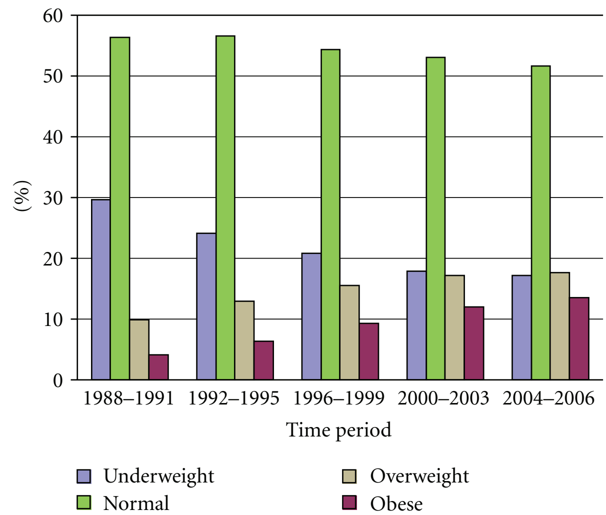

Figure 2: Percentage of women classified as underweight (<55 kg), normal weight (55–75 kg), overweight (>75–90 kg), and obese (>90 kg) by time period, 1988–2006.

weight between these groups showed evidence of widening in the latter years of the study. The percentage of individuals in each weight category by four-year time periods displays a clear trend, with notable increases in the number of overweight/obese women and a fall in the percentage of those women classed as underweight (Figure 2). During the first time period (1988–1991) the overweight and obesity prevalence was 14%, whereas by the final time period (2004–2006), the prevalence had increased to 31%. Extrapolating these percentages to the total adult female population of Nova Scotia in 2010 (485,000 women) the province had an estimated 150,000 overweight or obese women, compared to just 68,000 women overweight or obese if the 1988–1991 obesity rate still applied.

Table 1 shows the results from the linear regression modeling of body weight socioeconomic and demographic risk factors (adjusted and unadjusted). For continuous variables (year and income deciles), the coefficient represents the weight change (in kg) for every unit change in either year or income decile. For categorical variables the coefficient represents the weight change in kg for each category, compared to the mean weight in the baseline category (i.e., the coefficient for the constant). Body weight increased by 0.5 kg each year on average across the duration of the study period. In each age category women were between 6 kg and 8 kg heavier than the youngest age group of women aged <20 years, even after adjusting for parity. Although women aged >40 years of age were heavier than women in the younger age groups, the adjusted regression model (Table 1) suggested that weight differences in women in age categories older than 29 years were not markedly different and the largest increase in weight was in the 20–24 years group. Body weight declined by 0.17 kg for each increase in income decile, compared to

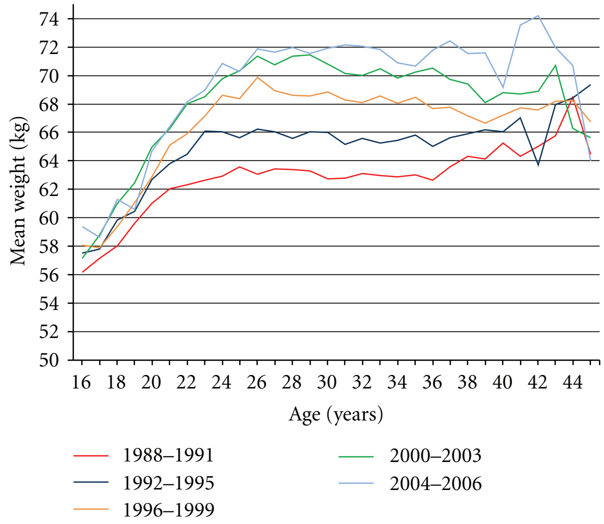

Figure 3: Change in maternal prepregnancy bodyweight by year of age and time period, age 16 to 45 years.

the baseline category representing the lowest income group. Women living in rural areas were also significantly heavier than women in urban areas, especially after adjustment for other variables in the model.

Figure 3 shows the change in mean maternal prepregnancy weight by year of age for ages 16 to 45 years by time period. For all time periods average weight increased steadily between ages 16 to 24 but from age 24 upwards weight increased more slowly until women were in their forties. The increase in mean body weight between ages 16 and 24 years was sharper in the later time periods compared to 1988–2001. The pattern in change in weight by year of age was similar for primiparous and multiparous women. Linear regression modelling of weight difference by year of age is presented in Table 2. The modelled weight difference is the weight change with respect to the weight at the baseline age 16 years. There was an increase of between 1 kg and 1.5 kg in weight with respect to the weight in each previous year of age until age 19. The largest increase in weight difference between each year of age (2.2 kg) was between ages 19 and 20 years. There was very little variation in weight difference after age 24 years of age, except for the much older ages, but the sample in these older ages was small, and the 95% CIs indicated generally that these findings were insignificant.

4. Discussion

The purpose of this study was to evaluate the socioeconomic, demographic, and temporal trends in obesity in women residing in the Canadian province of Nova Scotia to identify the critical period for weight gain. During the course of this study, body weight in this large sample of the female population increased significantly, and results showed similar socioeconomic and demographic correlates to obesity as seen from other studies [21–23]. Lower socioeconomic status and living in rural areas were associated significantly with higher body weights. The overall upward temporal trend for weight in Nova Scotian women echoes the increases in overweight and obesity rates over the past few decades worldwide [1, 24]. Although prepregnancy weight increased with age even after adjusting for parity, the highest weight increases were primarily in the younger women aged below 24 years of age. The largest single increase in weight by year of age was between 19 and 20 years (2.2 kg), and there was very little difference in mean prepregnancy weight in women aged between 26 and 40 years old. Although the heaviest women were generally aged over 40 years of age, the number of women in this age group was relatively small, as reflected in the wide confidence intervals in the regression modelling. Therefore, weight gain was highest for the younger women in the "transition age group" from adolescence into adulthood: the age when they will be taking responsibility for planning, purchasing, and preparing meals for the first time.

Over the course of this study overweight and obesity prevalence more than doubled from 14% in 1988–1991 to 31% in 2004–2006. These changes suggest that, in 2010, an estimated 150,000 women in Nova Scotia were overweight or obese, representing an additional 82,000 overweight/obese women compared to the number expected from observed rates of obesity two decades ago. Given the clear association of many health risks with obesity [24], this substantial increase in the overweight and obese population will have major implications for health service provision and utilization and healthy public policy [25].

The study data provide a much needed evidence base with which to support public health policy development and targeted public health interventions, information that is currently lacking in Canada due to the limited availability of surveillance data regarding maternal weight status. Our analysis suggests that the critical age for weight gain in this large cohort of women was in the younger age groups, and there was little change in mean weight of women beyond age 24 years. These trends are of importance to public health planning and policy since maternal prepregnancy overweight and excessive gestational weight gain are recognized as contributing factors to child obesity [26–28]. These findings have implications for the intergenerational transmission of weight gain and highlights the unique role that women of childbearing age may have as both a contributor to and a potential solution for the obesity epidemic [14]. Excessive weight gain before and during pregnancy, particularly when subsequently retained postpartum, influences the health of both mother and baby [10–12]. Excessive weight gained during an individual's early twenties carries with it a range of health risk factors, including cancer and other chronic diseases, that they will carry into middle and older age. Prevention efforts targeted at women preconceptually, particularly young adult women, may therefore be necessary to reverse these trends. However, this is not a group typically targeted for interventions to prevent weight gain.

The transition age between adolescence and adulthood is a time of increasing obesity, especially for specific racial/ethnic populations [29]. Our findings suggest that this age is critically important for obesity in women. The identification of this at risk age group provides an important focus for policy development and prevention intervention design.

Table 2: Change in maternal prepregnancy bodyweight (kg) compared to the reference weight by year of age, unadjusted and adjusted for parity and year of child's birth.

Age	Weight (kg)		Unadjusted		Adjusted	
	Mean	Change by year of age	Weight difference[1] (kg)	95% CI	Weight difference[1] (kg)	95% CI
16	57.3		—	—	—	—
17	57.8	0.5	0.5	−0.3–1.4	0.4	−0.5–1.2
18	59.4	1.6	2.2	1.3–3.0	1.9	1.1–2.7
19	60.6	1.2	3.3	2.5–4.1	2.9	2.1–3.7
20	62.8	2.2	5.5	4.7–6.3	4.9	4.1–5.7
21	64.3	1.5	7.0	6.2–7.8	6.2	5.4–7.0
22	65.1	0.8	7.9	7.1–8.7	7.0	6.2–7.9
23	66.0	0.9	8.7	7.9–9.5	7.9	7.1–8.7
24	66.6	0.6	9.3	8.5–10.1	8.7	7.9–9.5
25	66.7	0.1	9.4	8.6–10.2	8.7	7.9–9.5
26	67.2	0.5	10.0	9.2–10.7	9.3	8.5–10.1
27	67.1	−0.1	9.8	9.0–10.6	9.0	8.2–9.8
28	67.0	−0.1	9.8	9.0–10.5	9.0	8.2–9.7
29	67.3	0.3	10.0	9.2–10.8	9.0	8.2–9.8
30	67.2	−0.1	9.9	9.1–10.7	8.8	8.0–9.6
31	67.0	−0.2	9.7	9.0–10.5	8.4	7.6–9.2
32	67.2	0.2	9.9	9.1–10.7	8.5	7.7–9.3
33	67.4	0.2	10.2	9.4–10.9	8.6	7.8–9.4
34	67.2	−0.2	9.9	9.1–10.7	8.2	7.3–9.0
35	67.6	0.4	10.3	9.5–11.1	8.4	7.6–9.3
36	67.4	−0.2	10.1	9.3–11.0	8.2	7.4–9.1
37	67.8	0.4	10.5	9.6–11.4	8.5	7.6–9.4
38	67.6	−0.2	10.4	9.4–11.3	8.3	7.3–9.2
39	67.4	−0.2	10.1	9.1–11.1	7.8	6.8–8.8
40	67.4	0	10.1	9.0–11.2	7.8	6.7–8.9
41	68.5	1.1	11.2	9.9–12.5	8.7	7.4–10.1
42	68.2	−0.3	10.9	9.3–12.6	8.5	6.9–10.1
43	69.2	1	11.9	9.6–14.2	9.3	7.0–11.6
44	68.3	−0.9	11.0	8.3–13.7	8.1	5.4–10.9
45	66.2	−2.1	8.9	5.8–12.1	6.5	3.3–9.8
46	65.4	−0.8	8.1	1.7–14.6	5.8	−0.6–12.2
47	65.0	−0.4	7.7	0.2–15.3	4.5	−3.0–12.0
48	71.4	6.4	14.1	−3.1–31.4	9.9	−10.6–30.5
49	62.7	−8.7	5.4	−1.9–12.8	3.3	−5.0–11.6
50	77.5	14.8	20.2	4.3–36.1	17.7	2.5–32.9

[1] Weight difference compared to baseline weight at age 16 years.

Women at this transition age are generally characterised as newly independent and gaining responsibility for family shopping, food choices, and meal planning, but are typically not an age group targeted for intervention. At this age incomes are generally lower, and issues around food insecurity are likely to be heightened. Social and economic resources and food costs influence individual food choices, and energy-dense foods are typically the lowest cost option [30]. These foods contribute significantly to the obesity epidemic [30]. Many young adults, by virtue of socio-economic circumstances, are therefore vulnerable to the marketing of low-cost energy-dense and obesogenic foods. We suggest that policy to tackle the obesity epidemic is focused both at those most at risk—young women at the transition age—whilst also tackling the food supply industry. The food industry continues to promote and market the availability of low-cost energy-dense foods, at the expense of healthier options, which are generally more expensive [30]. By contrast, more costly but healthier options are much less appealing or practical to individuals living under economic constraints, experiencing food insecurity, and who may not have much experience in food preparation. Targeted education and supportive public policies may encourage individuals to perceive these types of products as more desirable, but the food industry needs to ensure that these foods are also affordable and readily available.

Weight reduction for obese and overweight people is inherently problematic, and such interventions are rarely successful within the limitations of our current health system [15]. Thus, it is crucial that public health strategies focus on prevention of excessive weight gain. These should promote an integrated approach to food, leisure, transport, and built environment policy and planning, developed in conjunction with public health strategies targeting at-risk individuals and at-risk communities. This approach requires the identification of critical at-risk age groups for weight gain, as identified in this study, in order to provide a focus for prevention interventions and targeted policy initiatives. Our findings of increased obesity in rural areas and the more socially disadvantaged communities suggest that these should also be the focus for targeted interventions and prevention activities.

The use of self-reported body weight in this analysis is a limitation, although given that body weight is often under-reported, this is likely to lead to an underestimation of the problem, making these findings all the more concerning. Further the NSAPD does not record height, and therefore it was not possible to calculate BMI, which is the usual indicator of obesity. However, maternal height distribution is unlikely to vary substantially between communities across Nova Scotia; therefore the use of the distribution of body weight as a surrogate for the distribution of obesity is reasonable and has been used elsewhere [8]. This study analysed change in body weight distribution over time (1988–2006), and in the absence of any substantial shifts in population height over short periods of time, there would be no advantage to using BMI since change in body size over time in the absence of changes in height is measured equally well by change in body weight.

These results relate to a subset of the population, women of childbearing age giving birth, derived from the NSAPD. However, this sample provides body weight data related to 172,373 deliveries (over 100,000 women) and is geographically representative of the whole female population. Therefore, the trends described in this study relate to a representative proportion of the Nova Scotia population, and, further, there is no reason to suspect that the body weight increases in this subset of the population have not been similarly experienced by other groups of women. In the absence of any alternative dataset of a comparable size and level of detail that is representative of the provincial female population, these data provide very valuable information for policy making and prevention initiatives.

5. Conclusions

Our findings add to the literature by clearly demonstrating the inexorable rise in body weight that has occurred in the last two decades in a subgroup of the population of childbearing age that precedes pregnancy. These findings support the targeting of prevention initiatives at younger age groups, as well as those from socially disadvantaged and rural communities. Younger women are at a transition age, newly independent, gaining responsibility for food choices and experiencing food insecurity, and therefore extremely vulnerable to the marketing efforts of a food industry which promotes the consumption of low-cost energy-dense foods over and above healthier but more costly options. However, this age group is not a traditional focus for health promotion and we suggest that policy options need to go beyond promoting healthy eating for individuals to tackling the food supply industry and its overemphasis on obesogenic foods. Our findings offer insight of relevance to public health planners and policy makers and suggest that obesity prevention initiatives aimed at women of childbearing age, both before and afterconception, may hold promise to deal with the consequences of the obesity epidemic, whilst also supporting strategies to deal with the causes.

Conflict of Interests

The authors declare that there is no conflict of interests.

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Research Article

Fast Food Consumption and Food Prices: Evidence from Panel Data on 5th and 8th Grade Children

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Fast food consumption is a dietary factor associated with higher prevalence of childhood obesity in the United States. The association between food prices and consumption of fast food among 5th and 8th graders was examined using individual-level random effects models utilizing consumption data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K), price data from American Chamber of Commerce Researchers Association (ACCRA), and contextual outlet density data from Dun and Bradstreet (D&B). The results found that contextual factors including the price of fast food, median household income, and fast food restaurant outlet densities were significantly associated with fast food consumption patterns among this age group. Overall, a 10% increase in the price of fast food was associated with 5.7% lower frequency of weekly fast food consumption. These results suggest that public health policy pricing instruments such as taxes may be effective in reducing consumption of energy-dense foods and possibly reducing the prevalence of overweight and obesity among US children and young adolescents.

1. Introduction

The incidence of obesity increased rapidly among children and adolescents in the United States over the last few decades. In 2007-08, obesity prevalence (with body mass index (BMI) greater than or equal to the 95th percentile of the CDC growth chart) was 19.6% for children 6 to 11 years of age and 18.1% for adolescents aged 12 to 19 years [1]. Parallel to the rising prevalence of obesity among children and adolescents, there was a rapid rise in the consumption of, and total energy intake derived from, food away from home, particularly at fast food restaurants [2, 3]. Consumption of at least one serving of fast food per day was reported by 30.3% of children and adolescents in 1994–1998 [4]. Fast food restaurants were found to be an important source of food away from home among children aged 2 through 17 years; the percentage of total calories derived from food consumed at fast food restaurants rose from 2% in the 1977-78 period to 9% during the 1994–96 period [2]. The increased proportion of total caloric intake derived from fast food has been variously attributed to bigger portion sizes, increased convenience, taste, accessibility, and affordability [3, 5–7]. Furthermore, the frequency of fast food consumption was reported to be rising with age among children ages 9 through 19 as their consumption decisions become more independent of parental influences [6, 8].

Fast food consumption has been associated with higher total caloric intake, higher total fat and sodium intake, poorer nutrient and vitamin intake, higher BMI, and increased likelihood of obesity [4, 9–13]. An increase in fast food intake during the transition period from adolescence to adulthood was linked to greater weight gain [14]. In addition, obesity itself has been shown to track from childhood to adulthood [15]. Potentially modifiable determinants of childhood eating behaviors and food choices include environmental and contextual factors, such as the availability of healthy food, promotion of appealing and convenient foods, and variations in food prices [16, 17]. Food prices, in particular, have been shown to be key determinants of consumption [18–23] and therefore may be good candidates for effective policy intervention aimed at improving dietary patterns among children and adolescents.

A systematic review of time series and household survey studies on price elasticity of demand for food found that consumption of food away from home was more responsive to price changes than any other food category with a 10% increase in price associated with a 8.1% reduction in consumption [24]. A limited number of studies on price sensitivity among children and adolescents found mixed evidence on the association between prices and intake of high-fat energy-dense foods. One such study using data from the 1994–1998 Continuing Survey of Food Intakes by Individuals (CSFII) found that higher fast food prices were associated with lower fast food consumption for children aged 2–9 years and adolescents aged 10–18 years although the association was not statistically significant for the adolescent sample [16]. Using data from a high school cafeteria, another study found that a 10% increase in the price of higher-fat foods (French fries, cookies, and cheese sauce) and a 25% reduction in the price of lower-fat foods (fresh fruit, low-fat cookies, low-fat chips, and cereal bars) did not substantially alter revenue, suggesting that consumption patterns shifted towards healthier foods [25]. A vending machine price study found low-fat snack price reductions of 10, 25, and 50 percent corresponded to increased sales of 9, 39, and 93 percent, respectively, among both adolescents and adults [26]. A recent study by Sturm and Datar [27] using a single cross-section of 5th graders found a positive relationship between the price of fast food and intake. However, the authors indicated that this result was not robust and disappeared in alternative specifications potentially due to the correlation between fast food and meat prices in the data.

Linking food price to fast food consumption is important given that a number of recent studies have found statistically significant negative associations between fast food prices and the prevalence of overweight among children and adolescents [28–33]. The link between fast food prices and consumption helps to establish that the observed negative association between fast food prices and obesity operates through fast food consumption and is not due to unobserved confounding factors. Therefore, we expanded on prior studies by using a longitudinal individual-level random effects estimation model, which controls for unobserved individual factors, to examine the relationship between children's fast food consumption and prices of fast food and food at home. Economic contextual factors including median household income and availability of fast food restaurants at the zip code level were included in the analysis to further control for confounding factors. We also examined whether price responsiveness differed across a number of subpopulations.

2. Methods

2.1. Data. This study drew on two waves of individual-level data (5th graders in 2004 and 8th graders in 2007) from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K). Trained evaluators assessed children in their schools, collected information from their parents over the telephone, and contacted teachersand school administrators to complete the questionnaires. Information on the frequency of fast food consumption was self-reported by the children, anthropometric variables such as height and weight were measured by the evaluators, home environment and school characteristics were self-reported by parents, teachers, and school officials. The outcome of interest was child fast food consumption, which was comprised of how many times in the past 7 days the child ate a meal or snack from a fast food restaurant such as McDonald's, Pizza Hut, Burger King, Kentucky Fried Chicken, Taco Bell, Wendy's, and other similar establishments. The responses given by the children were converted from a categorical scale to a numerical scale using midpoints to facilitate analysis.

The contextual data consisted of food prices from the American Chambers of Commerce Researchers Association (ACCRA), fast food outlet density data from Dun and Bradstreet, and median household income from the Census 2000. Food price indices were computed from the ACCRA Cost of Living Index reports, which contain quarterly information on prices in the United States, and which were matched to each child for each year based on the closest zip code match available using the child's home zip code identifier. An index of fast food price was computed using three food items in the ACCRA data, which includes a McDonald's Quarter-Pounder with cheese, a thin-crust regular cheese pizza at Pizza Hut and/or Pizza Inn, and fried chicken (thigh and drumstick) at Kentucky Fried Chicken and/or Church's Fried Chicken. In order to compute the price index of food at home, a basket of grocery items was utilized, which included meats (steak, ground beef, fried chicken, and tuna), fruits and vegetables (potatoes, bananas, lettuce, sweet peas, peaches, and frozen corn), dairy products (half gallon of whole milk, a dozen eggs, margarine, and parmesan cheese), and soft drinks. Both price indices were weighted based on expenditure shares provided by ACCRA derived from the Bureau of Labor Statistics (BLS) Consumer Expenditure Survey. All prices were deflated by BLS Consumer Price Index (CPI; 1982–1984 = 1). In addition to the price data, a number of economic contextual variables, including the Census median household income and fast food restaurant density were merged to the restricted geocoded version of ECLS data at the zip code level to account for differences in neighborhood characteristics. The median household income data for each zip code was obtained from the Census 2000. Information on fast food restaurant outlet density was obtained by year and zip code from the Dun and Bradstreet (D&B) business list data at the primary 8-digit SIC code level for categories of "fast food restaurants and stands" and "chain and independent pizzerias" but not coffee or ice cream shops.

The basic controls consisted of standard individual and household characteristics including age, gender, race (white, African American, Hispanic, other race, and more than one race), mother's highest level of education completed (less than high school, high school, some college, bachelor's degree or more), family income (categories consisting of income below \$20,000, \$20,001–\$35,000, \$35,001–\$50,000, \$50,001–\$75,000, \$75,001–\$100,000, and \$100,001 and above), degree of urbanicity (urban, suburban, and rural), and an indicator for the year. Two variables indicating the number of times per week a child ate breakfast and dinner with parents were included to account of unobservable characteristics such as the importance the parents place on children's food consumption patterns. Number of hours of television watched per week was included to control for lifestyle behaviors. All data analysis for this project was conducted using STATA 11.0 [34]. This study was approved by the Institutional Review Board at the University of Illinois at Chicago.

2.2. Empirical Model. Children's food consumption may be influenced by a number of economic contextual factors, including food prices. Changes in relative prices of different food products are expected to influence the relative demand for these products. Consumption of fast food will have own-price effects from fast food prices, and cross-price substitution effects from prices of other foods (such as food at home).

A model of children's fast food consumption of the following form was estimated:

$$\begin{aligned} \mathrm{FFCons}_{ist} = {} & \delta_0 + \delta_1 \mathrm{FFprice}_{st} + \delta_2 \mathrm{FHprice}_{st} + \delta_3 \mathrm{FFrest}_{st} \\ & + \delta_4 \mathrm{MHinc}_s + \delta_5 X_{it} + \delta_6 D_t + v_i + w_{ist}, \end{aligned} \tag{1}$$

where $\mathrm{FFprice}_{st}$ and $\mathrm{FHprice}_{st}$ were indices of fast food and food at home prices for geographic area s at time t, respectively, for which we also controlled for the average distance of the price match. FFrest_{st} measured the per capita availability of fast food restaurants for geographic area s at time t. MHinc_s, was the median household income in geographic areas. X_{it} was a vector of individual and household characteristics for individual i at time t. The characteristics in the vector X_{it} included gender, race/ethnicity, highest level of schooling completed by mother, parental income, urbanicity indicators, number of days per week child ate breakfast with parents, number of days per week child ate dinner with parents, and number of hours per week child watched television. D_t was a dummy variable for the survey year. δ were the parameters to be estimated, v_i was the constant individual-specific error, and w_{ist} was a standard error term.

To take advantage of the longitudinal nature of data, an individual-level random effects model was estimated to provide a weighted average of the between and within estimates where v_{it} and the independent variables were assumed to be uncorrelated [35]. We tested this assumption based on a Hausman test [36] which indicated that a random effects model was appropriate. Further, we conducted functional form comparisons and determined that a linear form of individual-level random effects model was more appropriate than count data forms. The Poisson goodness-of-fit and the likelihood ratio tests indicated that the Poisson distribution was not suitable for this sample. The point estimates from the linear random effects models were comparable to binomial count models; however, the latter models did not permit the use of clustering and reporting of robust standard error due to the limitation in the statistical software. Further, previous work also examined the distribution of these outcomes and estimated them using linear OLS [37].

Sensitivity analysis was conducted to assess the robustness of the fast food price estimates to exclusions of additional contextual variables. The data showed (not shown in tables) that the frequency of fast food consumption was significantly higher ($P \leq 0.01$) for children who were male, African American, low-income, and frequent television viewers compared to their counterparts. It is likely that these individuals with greater frequency may be more price sensitive, given that their overall expenditure on fast food would be greater than those with less frequency. Thus, we expanded our analysis to estimate models by various subgroups across gender, race, parental income, and child television usage. Further, given that previous research found that adolescents with body mass index (BMI) in the upper tail of the distribution was more responsive to fast food prices [30], we also estimated models separately by overweight status.

3. Results and Discussion

3.1. Descriptive Statistics. The basic summary statistics are shown in Table 1. The average weekly frequency of fast food consumption by the 5th and 8th graders was roughly 2.5 times in the past week. Among the household characteristics, about half (50.2%) of the sample was female. Additionally, about 66.5% were White, 9.2% were African American, 15.2% were Hispanic, 2.2% defined themselves as multiple races, and 6.9% were of another race. On average, more than one-half of the children (63.6%) had mothers who completed some college or more; about 23.7% of children had mothers whose highest level of education completed was high school. Approximately, 10.6% of children lived in families with parental income below \$20,000, and 38.4% lived in families with income above \$75,000. Nearly 67.3% of the households were from urban residential areas, while 13.4% were from suburban areas and 19.3% were from rural areas. Among the economic contextual factors, the average fast food price was \$2.66 while the average price of food at home was \$1.19 (based on the 1982–1984 deflated price indices). On average, the median household income at the zip code level was \$47,560. Finally, there were approximately 3.6 fast food restaurants per 10,000 capita per zip code.

3.2. Longitudinal Regression Analysis. Table 2 presents the regression estimates of childhood fast food consumption using an individual-level random effects model. Higher fast food prices were statistically associated with lower childhood fast food consumption. A one-standard deviation increase in the price of fast food (a \$0.17 increase) was associated with a reduction in fast food consumption of approximately 0.09 times per week based on the coefficient estimate that a one-dollar increase in the price was associated with an approximate decline of 0.53 in the weekly frequency of fast food consumption. Measured as a price elasticity (the percentage change in consumption associated with a one-percent change in price), the estimates corresponded to a price elasticity of -0.57, suggesting that a 10% increase in price of fast food was associated with a reduction in weekly consumption by 5.7%, as shown in Table 3. The results from sensitivity analyses presented in Table 3 show that the relationship between fast food prices and consumption was generally robust to the exclusion of the various other contextual factors. The association of the price of fast food increased slightly by

Table 1: Summary statistics.

	Mean (SD)
Outcome variable	
Number of times fast food consumed in past 7 days	2.468 (3.955)
Price measures	
Price of fast food ($1982–84)	2.662 (0.168)
Price of food at home ($1982–84)	1.185 (0.136)
Contextual factors	
Median household income in $10,000 ($2000)	4.756 (1.838)
Fast food restaurants per 10,000 per capita	3.598 (3.000)
Individual, household and local area characteristics	
Female	0.502 (0.500)
Male	0.498 (0.500)
White	0.665 (0.472)
African American	0.092 (0.290)
Hispanic	0.152 (0.359)
Other	0.069 (0.253)
More than one race	0.022 (0.147)
Mother completed less than high school	0.127 (0.332)
Mother completed at least high school	0.237 (0.426)
Mother completed at least some college	0.335 (0.472)
Mother completed bachelor's degree or more	0.301 (0.459)
Parental income 0–20 K	0.106 (0.307)
Parental income 20 K–35 K	0.152 (0.359)
Parental income 35–50 K	0.159 (0.366)
Parental income 50–75 K	0.199 (0.399)
Parental income 75–100 K	0.168 (0.374)
Parental income 100 K+	0.216 (0.412)
8th grade round (year = 2007)	0.513 (0.500)
Household residence urban	0.673 (0.469)
Household residence suburban	0.134 (0.341)
Household residence rural	0.193 (0.394)
Days per week eat breakfast with parents	3.497 (2.399)
Days per week eat dinner with parents	5.287 (1.752)
Hours of television child watches weekly	21.94 (15.18)

Notes: $N = 11,700$. SD = standard deviation.

about 20% (elasticity of −0.69 versus −0.57) when all other contextual factors were excluded from the model.

The results for the remaining contextual factors were consistent with expectations. Higher median household income was associated with lower fast food consumption: a $10,000 rise in median household income lowered fast food consumption by 0.13 times per week. Greater availability of fast food outlets measured as outlets per capita was associated with higher frequency of fast food consumption. Higher prices of food at home were associated with higher frequency of fast food consumption although the estimate was not statistically significant.

3.3. Subgroup Analysis. Table 4 shows that consumption among males was more responsive to increases in the price of fast food, which was expected given that they were more frequent fast food consumers than were females. We also found greater fast food price sensitivity among children from lower-income households, but the estimates were not statistically significant. The estimations across ethnicities show that the price of fast food was important and statistically significant for White children but not for African American or Hispanic children despite the fact that minority children consumed fast food more frequently. This suggests minority children's preferences for fast food may be influenced by factors other than food prices. Children who frequently watched television (nine or more hours per week) were found to be more price sensitive than their counterparts. This suggests that higher fast food prices might reduce their consumption to a greater extent, which is important given television watching in general is associated with childhood obesity [38, 39] and fast food ads are the most prevalent food ads seen on television by children and adolescents [40]. Finally, we also found stronger price sensitivity among children who were already overweight (BMI greater than or equal to 85th percentile of the CDC growth chart), perhaps because when they consumed from fast food restaurants they purchased more calories. Additionally, there were also significant differences across the subgroups in their response to the other contextual factors. Fast food consumption by children from low-income households was more strongly influenced by zip code level median household income and fast food restaurant outlet density compared to children from high-income households. Furthermore, the protective (reducing) effect of the higher median household income on fast food consumption was 3-times-greater for African American and Hispanic minority children than for white children and also greater for more frequent television viewers.

4. Conclusions

Policymakers continue to consider a number of potential public health policy interventions aimed at reducing the negative health implications from the increasing rates of obesity prevalence among children and adolescents in the United States. Public health policy may help to reduce obesity prevalence in children and adolescents by utilizing mechanisms that improve diets through the influence of food prices. Children and adolescents often have disposable income and are able to make independent meal selections when food is not purchased for them directly by their parents [3]. In particular, adolescents were estimated to have spent $159 billion in 2005 [41]. More specifically, the third highest spending category for this age group after beauty/apparel and videogames/electronics was restaurants [42, 43]. Since children are less likely to understand the nutritional and health implications of their high caloric consumption patterns, this age group is more likely to be potentially influenced by prices as opposed to health consequences as they may have high rates of time preference [44]. Thus, this study aimed to describe the relationship between fast food and food at home prices and fast food consumption among children in 5th and 8th grade using a nationally representative panel dataset. The results based on longitudinal estimation methods suggested

Table 2: Longitudinal regression estimates for individual level random effects model of the determinants of fast food consumption.

	Consumption of Fast Food	(SE)
Price measures		
Price of fast food	−0.527**	(0.241)
Price of food at home	0.175	(0.401)
Contextual factors		
Median household income	−0.131***	(0.021)
Fast food restaurants	0.025**	(0.013)
Individual, household and local area characteristics		
Female	−0.267***	(0.079)
African American	1.932***	(0.022)
Other	0.231	(0.141)
Hispanic	0.627***	(0.139)
More than one race	0.331	(0.242)
Mother completed high school	−0.221	(0.176)
Mother completed some college	−0.350**	(0.170)
Mother completed bachelors or more	−0.625***	(0.175)
Parental income 20–35 K	−0.635***	(0.207)
Parental income 35–50 K	−0.784***	(0.194)
Parental income 50–75 K	−0.825***	(0.195)
Parental income 75–100 K	−0.913***	(0.192)
Parental income 100 K+	−0.776***	(0.192)
8th grade round (year = 2007)	−0.787**	(0.362)
Household residence is suburban	0.165	(0.123)
Household residence is rural	−0.085	(0.120)
Days per week eat breakfast with parents	−0.053***	(0.016)
Days per week eat dinner with parents	−0.054**	(0.023)
Hours of television child watches weekly	0.014***	(0.004)

Note: regressions include a full set of age dummy variables and average distance between closest ACCRA city and ECLS-K zip code. Standard errors (SE) are reported in parentheses and are robust and clustered at the home zip code level. **significance at 5%; ***significance at 1%. $N = 11,700$.

Table 3: Longitudinal regression estimates for individual-level random effects model of the determinants of fast food consumption and price elasticity of consumption, by alternate model specifications.

	Fast food price coefficient estimates	Fast food price elasticity
Model 1: full specification as shown in Table 3	−0.527** (0.241)	−0.565** (0.258)
Model 2: model 1 without median household income	−0.563** (0.240)	−0.603** (.257)
Model 3: model 1 without fast food restaurant density	−0.548** (.243)	−0.586** (0.260)
Model 4: model 1 without median household income and fast food restaurant density	−0.589** (0.242)	−0.630** (0.259)
Model 5: model 4 without price of food at home	−0.644*** (0.198)	−0.689*** (0.211)

Notes: the regression models include all variables shown in Table 2 and those described in the notes of Table 2. Standard errors are reported in parentheses and are robust and clustered at the home zip code level. **significance at 5%; ***significance at 1%. $N = 11,700$.

that pricing policies in the form of taxes may be an effective tool for reducing fast food consumption. The fast food price elasticity of consumption of −0.57 indicated that this age group was sensitive to price variations such that a ten percent increase in price was associated with a 5.7% reduction in weekly fast food consumption. This estimate is in the mid- to lower-range of estimates of price elasticity of demand for food away from home [24].

Earlier studies suggested that pricing mechanisms may have the strongest impact on those individuals who were in the upper tail of the BMI distribution [30]. Consistent with these previous findings, this study found that that price of fast food had a stronger association with consumption among overweight children. We also found a number of sub-populations who were more frequent fast food consumers to be relatively more price sensitive. This suggests that pricing policy instruments such as fast food taxes might be particularly effective in reducing fast food consumption among frequent consumers and those at risk for overweight. This is important given that previous research had showed

Table 4: Longitudinal regression estimates for individual level random effects model of the determinants of fast food consumption, by sub groups.

	Price of Fast Food	Price of Food at Home	Fast Food Restaurant Outlet Density	Median Household Income
Full sample	−0.527** (0.241)	0.175 (0.401)	0.025** (0.013)	−0.131*** (0.021)
By gender				
Female	0.070 (0.345)	−0.783 (0.555)	0.022 (0.012)	−0.146*** (0.028)
Male	−0.190*** (0.351)	1.163** (.056)	0.039 (0.026)	−0.108*** (0.030)
By income				
0–35 K	−0.627 (0.610)	1.223 (0.991)	0.074 (0.043)	−0.285*** (0.084)
36–75 K	−0.407 (0.443)	−0.284 (0.647)	0.035 (0.024)	−0.139*** (0.041)
75 K+	−0.534 (0.292)	0.046 (0.433)	0.016 (0.011)	−0.076*** (0.019)
By weight status				
Overweight	−0.787** (0.391)	0.944 (0.703)	0.080*** (0.029)	−0.170*** (0.038)
Nonoverweight	−0.397 (0.332)	0.083 (0.482)	0.007 (0.011)	−0.118*** (0.025)
By race				
White	−0.844*** (0.239)	−0.065 (0.368)	0.039*** (0.012)	−0.081*** (0.018)
African American	0.172 (1.389)	−2.360 (2.066)	0.063 (0.070)	−0.228 (0.133)
Hispanic	0.073 (0.741)	0.893 (1.143)	0.022 (0.064)	−0.210*** (0.069)
By TV viewing				
9 hours or more per week	−0.595** (0.261)	0.229 (0.435)	0.028** (0.014)	−0.140*** (0.023)
Less than 9 hours per week	1.050 (0.617)	−0.794 (0.870)	−0.028 (0.028)	−0.080 (0.042)

Notes: the regression models include all variables shown in Table 2 and those described in the notes of Table 2. Standard errors are reported in parentheses and are robust and clustered at the home zip code level. **significance at 5%; ***significance at 1%.

that adolescents who were overweight were less likely to compensate for their fast food meals by properly adjusting their energy intake downward throughout the remainder of the day [45].

The results from this study were subject to a number of limitations. First, the fast food consumption data were self-reported total number of days per week consumed, not actual amounts of consumption (e.g., caloric intake). Second, the ACCRA price data had a number of limitations, which included that the data were only collected in a limited number of cities and metropolitan statistical areas, the data were based on establishment samples that reflect a higher standard of living, and they did not always sample the same cities continuously and hence the data were not fully comparable over time. Third, the outlet density count measures were subject to count error and we were limited to using SIC codes which may have classification errors. Fourth, this study was only able to assess the contextual variables at the zip code level due to data limitations in the availability of more proximate geographic identifiers in the ESLS-K data.

Despite these limitations, the results from the individual-level random effects model in this paper suggested that higher fast food prices were associated with lower frequency of children's fast food consumption. Therefore, public health policy interventions such as taxes may be effective in reducing consumption of fast food and possibly reducing the prevalence of overweight and obesity among children. Given that the price effects were stronger among children who were male, white, overweight, and frequent television viewers, additional studies based on longitudinal data are needed to develop the evidence base with regard to the potential effectiveness of pricing interventions among various groups of children to help improve food consumption patterns, overall diet, and health outcomes that may possibly translate into healthier outcomes later in adulthood.

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Research Article

Is Field of Study or Location Associated with College Students' Snacking Patterns?

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Objective. To compare on- and off-campus snacking patterns among college students pursuing degrees in health-related fields (HRFs) and nonhealth-related fields (NHRFs). *Materials and Methods*. Snack frequency questionnaire, scales measuring barriers, self-efficacy, and stage of change for healthy snacking, and a snack knowledge test (SKT). *Participants*. 513 students, 46% HRFs, and 54% NHRFs. The students' mean ± SD BMI was 24.1 ± 4.3 kg/m^2 (range 14.6 to 43.8), and 32.2% were overweight/obese. *Results*. Softdrinks (on-campus), lowfat milk (off-campus), and sports drinks were popular among HRFs and NHRFs. Cost and availability were barriers to healthy snacking, students felt least confident to choose healthy snacks when emotionally upset, and 75% (65%) of HRFs (NHRFs) self-classified in the action stage of change for healthy snacking. The HRFs scored higher on the SKT. *Conclusions*. Neither location nor field of study strongly influenced snacking patterns, which featured few high-fiber foods.

1. Introduction

The United States is currently experiencing an epidemic of overweight [1], defined as a body mass index (BMI) between 25.0 and 29.9 kg/m^2, and obesity, defined as a BMI of 30.0 kg/m^2 or greater [2]. Among the groups showing an increased incidence of excess adiposity are college students [3]. Currently, there are an estimated 16.6 million young people aged 18 to 24 enrolled in US colleges and universities, [4] and it is estimated that 26% of Caucasian and 50% of African American college students are either overweight or obese [3]. Additionally, an estimated 33% of US college students have a total cholesterol level above 200 mg/dL, about 20% have HDL cholesterol concentrations below 40 mg/dL, and another 15% to 21% have prehypertension [5]. These trends are of concern to health care providers because ample clinical and epidemiological evidence links BMIs of 25.0 or greater to hypertension, heart disease, type 2 diabetes mellitus, strokes, and some types of cancers [6]. Although these chronic diseases are generally manifested in older adults, Skelton and coworkers [7] and Shaw [8] noted that these conditions can originate during childhood and adolescence. Moreover, several authors [7–9] have observed that these developmental periods may be critical for weight gain. Thus, an objective of the federally sponsored Healthy People 2010 initiative [10] was to increase the proportion of college students who are at a healthy weight (BMI between 18.5 and 24.9), and the US Surgeon General's Call to Action [11] proposed that more policies and interventions promoting healthy dietary and physical activity habits be implemented to meet this objective.

Several investigators [12–15] have reported that snacks, defined as unstructured eating occasions between meals [16] contribute significantly to the daily caloric intake of adolescents and young adults, and that frequent consumption of energy-dense snack foods may be contributing to the increasing occurrence of overweight/obesity among college-aged individuals. This argument is strengthened by data documenting the widespread availability and large sales volume of energy-dense snack foods. For example, Farley and co-workers [12] conducted systematic observations of 1082 retail stores in 19 US cities to determine the availability of six categories of higher-calorie (i.e., high-fat, sugary) snack foods. They found that these products were available in 41% of the stores; the most common products were candy (33%), sweetened beverages (20%), and salty snacks (17%). Moreover, snack foods were sold in 96% of pharmacies, 94% of gasoline stations, 22% of furniture stores, 16% of apparel stores, and 29% to 65% of other types of stores. Additionally, Pineda and Kleiner [16] reported a significant increase in the consumption of candy, soft drinks, fruit drinks, French fries, cheeseburgers, and pizza by adolescents and young adults over the past 30 years. In this regard, Zenk and Powell [17] reported that US adolescents aged 12 to 19 spent approximately $159 billion on food, candy, and soft drinks in 2005 alone. Additionally, the snack industry publication Vending Times [18] reported that the sales of cold beverages and snack foods combined totaled $34.3 billion or 73% of vending machine sales in 2006. The findings reported by Nelson and Story [13] for US college students reflect these sales and consumption trends. These investigators inventoried the foods and beverages found in the dormitory rooms of 100 college students and reported that more than 70% of the students had salty snacks, desserts or candy, and sugar-sweetened beverages, while fewer students had lower-calorie beverages, fruits and vegetables, dairy products, tea/coffee, and pure fruit/vegetable juice. They also noted that the mean number of food and beverage items per student was 47 (range zero to 208), and that the average number of calories per dormitory room was 22,888.

The Transtheoretical Model (TM), originally used by Prochaska and Di Clemente [19] as a conceptual framework for the study of addictive behaviors, has since been used successful to identify correlates of healthy eating for use in clinical and educational settings [20–23]. In its expanded form, the TM consists of four dimensions, that is, the stages of change, the processes of change, situational self-efficacy, and decisional balance. The stages of change represent the temporal, motivational, and consistency constructs of behavior change. These stages are precontemplation (no thought is given to adopting a healthy behavior within the next six months), contemplation (serious consideration is given to adopting a healthy behavior within the next six months), preparation (the decision is made to adopt a healthy behavior within the next 30 days), action (the healthy behavior has been practiced for six months or less, and it requires considerable effort to maintain), maintenance (the healthy behavior has been practiced for longer than six months, and it requires less effort to maintain), and termination (the healthy behavior has become automatic).

The TM hypothesizes that individuals can transition from the preaction (precontemplation, contemplation, and preparation) to the action (action, maintenance, and termination) stages through cognitive and behavioral processes of change. The cognitive processes focus on gathering information about the unhealthy behavior, leading to an attitude change conducive to a positive behavior change. The behavioral processes involve adopting strategies that facilitate replacing an unhealthy with a healthy behavior. The situational self-efficacy dimension measures the degree of confidence to undertake a healthy behavior under different circumstances, and the decisional balance component examines perceived barriers and benefits to adopting a healthy behavior.

College students pursuing academic degrees in health-related disciplines (e.g., nursing science, dietetics, wellness, health education, community health, etc.) are likely to engage in counseling future clients about healthy lifestyle behaviors, including dietary strategies for long-term health maintenance. It would, therefore, be helpful for educators in these and other health-related disciplines to monitor the dietary habits of these students, including their snack selections, to determine whether they are setting the stage for modeling a positive or a negative dietary behavior before beginning their professional careers. Furthermore, since the snack choices available to college students when spending time on-campus may differ from those available to them when off-campus in terms of variety and nutrient composition, it would be useful to identify their snack choices in the context of place, to examine their degree of consistency in snack selection under different environmental circumstances. Thus, the aims of this study were to (1) compare the on- and off-campus snacking patterns (i.e., snack choices and frequency of consumption) for college students pursuing academic degrees in health-related fields (HRFs, and in other fields (NHRFs), (2) compare these student samples on the psychosocial correlates from the TM, that is, perceived barriers, situational self-efficacy, and stage of change, (3) measure the students' knowledge concerning the nutritional characteristics of healthy snacks, and (4) identify associations between the students' snacking patterns and the psychosocial correlates from the TM. Several authors [21–23] have found that health promotion interventions are more effective if they are tailored to the target audience, which requires an assessment of the psychosocial correlates that may hinder the desired dietary change.

2. Materials and Methods

2.1. Participants and Recruitment. Convenience sampling was used to recruit male and female undergraduates at high-traffic locations (i.e., student union, residence halls, dining rooms, outside the library) at a southeastern university. Participation was restricted to off-campus residents to increase the likelihood that the students would have access to a variety of off-campus commercial establishments where snack foods could be purchased, in addition to those located on-campus, to facilitate comparisons of on- versus off-campus snacking patterns. Recruitment was accomplished by one female and one male undergraduate student under the supervision of two nutrition professors. Given that off-campus residents frequent the university primarily on week days, recruitment took place on different days of the week (excluding weekends) and at different times of day to obtain a sample that closely reflected the demographics of the off-campus residents enrolled at the University during the time of data collection.

Informed consent was explained in a cover letter attached to each questionnaire, no incentives were offered for participation, and receipt of a completed questionnaire was interpreted as obtaining informed consent. Confidentiality of responses was insured by storing the questionnaires in a locked filing cabinet in the office of one of the investigators. This research was approved by the University and Medical Center Institutional Review Board at the study site.

2.2. Survey Questionnaire. Data were collected over a three-month period using an anonymous, self-administered questionnaire that was completed at the recruitment sites. The students' snack choices and frequency of consumption were assessed using a snack food frequency questionnaire (SFFQ) that was developed by the authors with guidance from the snacking literature [12–18]. This assessment method was used because it is relatively inexpensive to administer and process and requires a relatively low respondent burden [24]. Validity is difficult to establish for all dietary assessment methods, since obtaining the "gold standard" dietary information would involve continuous monitoring of study participants for 24 hours per day [24]. The term snack was defined in the questionnaire as a food or beverage that is consumed between meals [16]. The SFFQ contained 12 higher-calorie snacks (i.e., snacks that are higher in fats, oils, and caloric sweeteners relative to their protein, fiber, and micronutrient content) and their lower-calorie counterparts. Thus, on the SFFQ, snacks were listed as follows: regular ice cream, low-fat/low-sugar ice cream, regular chips, lower-fat chips, regular yogurt, lower-fat/lower-sugar yogurt, regular soft drinks, diet soft drinks, regular cookies, lower-fat/lower-sugar cookies, and so forth. Ten additional higher-calorie and seven additional lower-calorie snacks were also included. The higher-calorie and lower-calorie snacks were scrambled throughout the SFFQ rather than listed in pairs to minimize the occurrence of an expectation bias. The columns of the SFFQ were labeled Snack, Location, and How Often Do You Eat This Snack? Next to each snack food under the column labeled Location were the terms Residence and On-Campus, and the students were instructed to estimate how often they consumed each snack at these two locations. The temporal categories listed under the How Often column were Never, Once a month, Two to three times a month, Once a week, Twice a week, Three to four times a week, Five to six times a week, Once a day, Twice a day, and Three or more times a day. The students estimated how often they consumed each snack on- and off-campus by filling in the bubble under the most appropriate column. These SFFQ data do not, however, indicate whether the snacks consumed on- or off-campus were purchased at these locations.

The students rated the perceived importance of 11 potential barriers to healthy snacking on- and off-campus on a five-point scale where 1 meant not at all important and 5 meant very important. Six of the barriers focused on practical concerns, two on awareness of healthy snacks, and three focused on internal cues. These barriers, developed by the authors with guidance from the literature [21–23] had an overall Cronbach's alpha coefficient of 0.85 (average interitem correlation = 0.121) for the off-campus and 0.84 (average interitem correlation = 0.114) for the on-campus locations, respectively.

The students' situational self-efficacy to consume healthy snacks was assessed using modified versions of the subscales developed by Ôunpuu and co-workers [21]. The negative/affective subscale (seven items) describes circumstances associated with emotional upset, the positive/social subscale (four items) describes social/celebratory situations, and the difficult/inconvenient subscale (six items) describes circumstances where accessing healthy snacks would be challenging. Each item was rated only once, regardless of where the students snacked, using a five-point scale where 1 meant not at all confident and 5 meant very confident. The Cronbach alpha coefficients for the present sample were 0.90 for the negative/affective, 0.85 for the positive/social, and 0.84 for the difficult/inconvenient subscale. The students' readiness to eat healthy snacks was assessed only once, regardless of where the snacking occurred, using Prochaska's descriptors of the stages of change for adopting a healthy behavior [19]. This framework has been validated in several dietary studies where the aim was to classify participants according to their motivation to adopt a healthy eating behavior [25–28].

The students' knowledge of healthy snacks was measured using a 14-item snack knowledge test (SKT) developed by the authors. The first eight items consisted of a list of nutrient descriptors, and the students circled yes or no to indicate whether the descriptors were characteristic of healthy snacks. These items were followed by six multiple-choice questions that asked the students to identify the snack that possessed the nutrient characteristic specified in the stem of the questions, with each stem followed by three answer choices.

The questionnaire concluded by asking the students to respond to four attitudinal items concerning their snack choices and to provide demographic information. The first attitudinal item asked the students to assess their perceived overall healthfulness of the snacks they typically consumed by circling either mostly unhealthy, some unhealthy/some healthy, or mostly healthy. The second item assessed the extent to which the students agreed with the following statement: "My current snack choices could have an influence on my physical health in the years to come." The response options for this item were arranged along a five-point Likert scale. The students were also asked to indicate the type of influence they thought their current snack choices could have on their physical health in the years to come, by circling either mostly unfavorable, no influence, mostly favorable, or no opinion. Lastly, the students were asked whether they would be interested in learning more about how to choose and prepare healthy snacks, and if so, to circle (from a list of seven sources) their preferred sources for receiving this information. The demographic items elicited information about sex, race/ethnicity, year in school, self-reported height and weight (used to calculate BMI), and field of study.

2.3. Pilot Test. The questionnaire was pilot tested and revised based on input from 20 undergraduates who did not participate in the final study. Accordingly, sports drinks were added to the SFFQ, and the list of potential information sources about healthy snacking was expanded to include the campus newspaper and radio station. Face and content validity of all measures were determined by a panel of three nutrition professors experienced at questionnaire design and familiar with the snacking literature and with the psychosocial correlates that were measured.

2.4. Statistical Analyses. Data were analyzed using the Statistical Package for the Social Sciences version 13.1 (SPSS Inc, Chicago, IL, USA) and the Statistical Analysis Systems version 9.1 (SAS Institute, Cary, NC, USA) software packages. Frequency counts, means, and percents were obtained on data from the SFFQ, on the psychosocial correlates, and on attitudinal and demographic items. The ten temporal categories listed on the SFFQ were collapsed into three categories to more succinctly report the students' snacking patterns. These categories were lower frequency (1 to 3 times a month), moderate frequency (1 to 4 times a week), and higher frequency (5 times a week to 3 or more times a day). The percentage of students who consumed each snack at the higher frequency was calculated separately for the two student samples at each location.

Data from the SFFQ were also used to calculate on- and off-campus snack quality indexes (SQIs), following the approach used by Schunk and co-workers [20]. These indexes were based on the energy density and frequency of consumption of each snack listed on the SFFQ. Accordingly, the quality of a snack was based on its approximate nutrient density, that is, the estimated amount of macro and micronutrients relative to the estimated caloric content. Thus, the higher quality (healthier) snacks were those that had a higher nutrient density, that is, they contained greater amounts of protein, fiber, vitamins, and minerals relative to their content of fats, oils, and caloric sweeteners. Conversely, the lower-quality (less healthy) snacks were those that had a lower nutrient density, that is, they contained lower amounts of the macro- and micronutrients relative to their content of fats, oils, and caloric sweeteners. For example, when calculating the SQIs, regular ice cream and regular chips were classified as less healthy snack choices, while low-fat/low-sugar ice cream and low-fat chips were classified as healthier choices. These lower-quality snacks are regarded as less healthy choices because, if consumed frequently, they can contribute to unwanted weight gain [12–15].

Calculation of the SQIs also took into account the frequency of consumption of each snack appearing on the SFFQ. In computing the SQIs, zero points were assigned to each healthier snack that was consumed once a month, one point if consumed 2 to 3 times a month, two points if consumed once a week, three points if consumed twice a week, 4 points if consumed 3 to 4 times a week, 5 points if consumed 5 to 6 times a week, 6 points if consumed once a day, 7 points if consumed twice a day, and 8 points if consumed 3 or more times a day. These point allotments were reversed when scoring the less healthy snacks.

SQI scores were expressed as a percentage of the maximum possible score. The percentage of the maximum possible SQI score was multiplied by the proportion of lower-calorie snacks in the students' diet to differentiate between students who consumed fewer versus more higher-calorie snacks (i.e., snacks low in nutrients relative to their caloric content). The resulting SQI scores were, therefore, reported on a scale ranging from zero to 100 points. Using this scoring system, higher SQI scores are associated with snacking profiles comprised of lower-calorie snacks eaten at higher frequencies and/or higher-calorie snacks eaten at lower frequencies. Snacks that were calorie-free (e.g., bottled water, black coffee, unsweetened tea, and diet soft drinks) were not included on the SFFQ, and snacks that were listed on the SFFQ but that the students never consumed were excluded from the calculation of the SQIs. In summary, the SQIs were intended to serve as rapid assessment measures to characterize the overall healthfulness of the students' snack choices rather than as precise measures of the energy and nutrient content of their snack choices. A similar scoring system was previously used by the authors to characterize the healthfulness of the dietary patterns of adolescents [24]. Moreover, Brunt et al. [29] noted that global measures such as the SQI used in the present study can be more informative for assessing the healthfulness of a diet than methods that focus on a single nutrient, food, or food group.

Wilcoxon-matched pair analysis was performed to identify significant differences between self-efficacy subscale scores on- and off-campus, and the Mann-Whitney independent samples test was used to compare the HRF and NHRF students on their mean SQI and SKT scores, and on their mean perceived barriers and situational self-efficacy subscale scores. Pearson's chisquare was used for comparing distributions of Likert scale responses between HRF and NHRF students. In scoring the 14-item SKT, one point was allotted for each correct and zero points for each incorrect answer.

Spearman correlation analyses were performed to identify associations between the SQI scores and body mass index (BMI), between the SQI scores and SKT scores, and between the SQI scores and the self-efficacy and perceived barriers subscale scores. Statistical significance was $P < 0.05$.

3. Results

3.1. Participant Characteristics. Completed questionnaires were received from 513 college students, of whom $n = 236$ (46%) were HRF students and $n = 277$ (54%) were NHRF students. The gender distribution among the HRF students was 68 males and 168 females (29% : 71%), and among the NHRF students was 124 males and 153 females (45% : 55%). The race/ethnicity distribution among HRF students was 80% white, 15% African-American, 2% Hispanic, 1% Asian-American, and 2% from other groups: among NHRF students, it was 76% white, 13% African-American, 4% Hispanic, 2% Asian-American, and 5% from other groups. Regarding academic classification for the overall sample, 33% were first- /second-year students and 67% were third- /fourth-year students. The mean ± SD BMI for HRF (NHRF) students was 23.8 ± 4.2 (24.3 ± 4.4) kg/m^2, and the proportion of overweight/obese students for HRF (NHRF) was 30% (35%); neither of these differences was statistically significant.

3.2. Snack Choices and Snack Quality Index (SQI) Scores. The HRF students consumed a median of two daily snacks when off-campus and one when on-campus, while the NHRF students consumed a median of three daily snacks when off-campus and one when on-campus. For the off-campus location, the three snacks consumed at the higher frequency by the greatest proportion of the HRF students were sports drinks (35%), low-fat milk (34%), and fresh vegetables (31%). The corresponding findings for the on-campus location were regular chips (7%), regular soft drinks (7%), and sports drinks (6%). The snacks consumed at the higher frequency by the greatest proportion of the NHRF students when off-campus were regular cheese (31%), sports drinks (29%), and low-fat milk (29%), while the corresponding findings for the on-campus location were regular soft drinks (8%), sports drinks (7%), and regular cheese (6%).

Among all students, the 3 lower-calorie snacks consumed at the higher frequency at their off-campus residence by the highest proportion of students were low-fat milk (32%), fresh fruit (32%), and fresh vegetables (29%); the corresponding ranking for on-campus was fresh fruit (6.8%), fresh vegetables (5.5%), and sports drinks (5.5%). In contrast, the 3 higher-calorie snacks consumed at the lower frequency at their off-campus residence by the highest proportion of students were high-calorie cottage cheese (96%), high calorie pudding (97%), and cheese puffs (88%); the corresponding ranking for on-campus was high-calorie cottage cheese (99%), high-calorie pudding (97%), and high-calorie popcorn (97%).

A self-evaluation of the perceived quality of their snack choices revealed that 5% of the HRF and 10% of the NHRF students regarded their snack choices as mostly healthy, while 31% of the HRF and 22% of the NHRF students perceived their choices as mostly unhealthy. Additionally, 82% of the HRF and 81% of the NHRF students agreed/strongly agreed that their current snack choices could have an influence on their physical health in the years to come, and 16% of the HRF and 19% of the NHRF students characterized this influence as mostly unfavorable. A majority (90%) of the HRF and NHRF students wanted to learn more about healthy snacking, preferably through the internet (57%), fliers (49%), and newspaper articles (36%).

The mean ± SD off-campus SQI scores for the HRF and NHRF students were 24.7 ± 5.6 points and 23.6 ± 5.5 points, respectively (Mann-Whitney chisquare = 6.188, DF = 1, P = 0.013). There was no significant difference in the mean on-campus SQI scores (21.4 ± 8.7 points versus 21.2 ± 9.3 points) for the HRF and NHRF students, respectively. Additionally, correlations between BMI and the off-campus SQI scores (Spearman $r = -0.097$) and between BMI and the on-campus SQI scores (Spearman $r = -0.093$) for the sample as a whole were small and not statistically significant.

3.3. Perceived Barriers, Situational Self-Efficacy, and Stage of Change for Healthy Snacking. The mean importance ratings for the barriers to healthy snacking shown in Table 1 indicate that the barriers perceived as most important on- and off-campus for the HRF and NHRF students related to cost, availability, and cravings.

Comparisons of the mean barriers subscale scores for the HRF and NHRF students revealed that significant differences were found only on the internal cues subscale and the awareness subscale, both on- and off-campus, with the NHRF students scoring significantly higher on both subscales.

Regarding situational self-efficacy to choose healthy snacks, the HRF students were least confident when experiencing negative emotions, more confident in positive/social situations, and most confident when accessing healthy snacks was difficult/inconvenient. In contrast, NHRF students were least confident when experiencing negative emotions, more confident when choosing healthy snacks was difficult/inconvenient, and most confident in positive/social situations (Table 2).

Comparisons of the mean self-efficacy subscale scores showed that the HRF students scored significantly higher on the difficult/inconvenient subscale (Mann-Whitney chisquare = 16.879, DF = 1, $P < 0.001$) and on the negative/affective subscale (Mann-Whitney chisquare = 6.187, DF = 1, $P = 0.013$).

Regarding their readiness to choose healthy snacks, a significantly higher percentage of HRF than NHRF students self-classified in the action stages (75% versus 65%, resp., $P = 0.013$).

3.4. Knowledge of Healthy Snacks. Table 3 shows the percent of correct answers and the summary statistics for the 14-item SKT. The mean ± SD score for the overall sample was 12.2 ± 2.0 points (range 0 to 14 points) out of a possible 14 points, or 87.4%. The majority (74%) of the students correctly answered the eight yes/no questions concerning the nutrient characteristics of healthy snacks, and 25% correctly answered the six multiple-choice questions requiring them to identify the snacks having the nutrient descriptors specified in the stem of the questions. The HRF students had a higher mean SKT score (12.4 ± 2.0 points) compared to the NHRF students (12.1 ± 2.0 points), although this difference was not statistically significant. The only significant correlation between SQI and SKT scores applied to the HRF students, for whom the off-campus SQI scores showed a small but significant association with their SKT scores (Spearman r = 0.149, $P = 0.024$).

An item analysis showed that of the 91.4% of the students who knew that low in trans fat is a characteristic of healthy snacks, 93% were also able to identify French fries as the snack with the highest amount of trans fat. However, while 95.2% of the students knew that high in fiber is a characteristic of healthy snacks, only 42.1% correctly identified popcorn as a high-fiber snack.

3.5. Relationships between SQI Scores and Psychosocial Correlates. The only significant correlations between the SQI scores and the perceived barriers subscale scores occurred among the HRF students, for which the off-campus SQI

Table 1: Mean importance ratings of barriers to healthy snacking on-campus and off-campus for 513 college students.

Subscale or item[a] (Stem: please rate each possible barrier to eating healthy snacks according to how important it is to you personally...)	Perceived Importance on-campus			Perceived Importance off-campus		
	HRF[b] ($N = 236$)	Sig[c]	NHRF[b] ($N = 277$)	HRF[b] ($N = 236$)	Sig[c]	NHRF[b] ($N = 277$)
Practical concerns subscale (mean of 6 items)	2.6 (0.9)	ns	2.6 (0.9)	2.5 (0.8)	ns	2.7 (0.9)
Practical concerns individual items[d]						
Too expensive	3.4 (1.5)	ns	3.4 (1.6)	3.0 (1.3)	ns	3.2 (1.4)
Not readily available	3.2 (1.5)	ns	3.2 (1.4)	3.1 (1.3)	ns	3.1 (1.3)
Take too long to prepare	2.6 (1.4)	ns	2.7 (1.4)	2.9 (1.2)	ns	3.0 (1.3)
Difficult to transport	2.3 (1.4)	ns	2.4 (1.5)	2.2 (1.3)	ns	2.4 (1.4)
My friends do not eat healthy snacks	2.0 (1.3)	ns	2.2 (1.3)	2.1 (1.3)	ns	2.3 (1.3)
Boy/Girlfriend does not eat healthy snacks	1.9 (1.4)	ns	2.1 (1.3)	2.0 (1.3)	ns	2.2 (1.4)
Internal cues subscale (mean of 3 items)	2.4 (1.1)	**	2.7 (1.0)	2.5 (1.0)	**	2.7 (1.0)
Internal cues individual items						
Do not satisfy the craving I have	2.6 (1.4)	**	3.1 (1.4)	2.8 (1.4)	**	3.2 (1.3)
Either not sweet enough or salty enough	2.2 (1.2)	ns	2.4 (1.2)	2.4 (1.2)	ns	2.5 (1.2)
Do not give energy I need	2.3 (1.4)	ns	2.4 (1.4)	2.3 (1.3)	ns	2.5 (1.4)
Awareness subscale (mean of 2 items)	2.1 (1.3)	*	2.3 (1.2)	2.1 (1.2)	*	2.3 (1.1)
Awareness individual items						
Do not know how to choose healthy snacks	2.1 (1.4)	ns	2.2 (1.3)	2.1 (1.3)	*	2.3 (1.3)
Do not know where to find healthy snacks	2.2 (1.4)	ns	2.5 (1.4)	2.1 (1.3)	ns	2.2 (1.2)

[a] Each item was rated on a 5-point scale, with 1: least important and 5: most important.
[b] HRF: health-related fields; NHRF: nonhealth-related fields. Data reported as "mean (standard deviation)."
[c] Statistical significance for HRF versus NHRF, ns: not significant ($P \geq 0.05$); $^*P < 0.05$; $^{**}P < 0.01$.
[d] Items within each subscale are ordered from highest to lowest mean score based on off-campus means for NHRM.

Table 2: Mean Ratings on situational self-efficacy subscales for eating healthy snacksfor 513 college undergraduates.

Item or total subscale [a] (Stem: please rate how confident you are in your ability to eat a healthy snack under each of the following circumstances)	HRF[b] ($N = 236$)		Sig[c]	NHRF[b] ($N = 277$)	
	mean	SD		mean	SD
Negative Affect Subscale (mean of 7 items)	**2.9**	**0.9**	**	**2.6**	**0.9**
When I am depressed or down	2.6	1.1	**	2.4	1.1
When I have had an argument	2.9	1.1	**	2.4	1.1
When I have had a tough day	2.8	1.1	**	2.5	1.1
When I am angry	3.0	1.1	*	2.7	1.2
When I am anxious	3.1	1.2	*	2.8	1.2
When I feel frustrated	2.9	1.1	**ns**	2.7	1.1
When I feel bored	2.7	1.3	**ns**	2.8	1.3
Positive/Social Subscale (mean of 4 items)	**3.1**	**1.0**	**ns**	**3.2**	**1.0**
When with friends at party	2.9	1.3	*	3.0	1.2
At happy celebrations with friends	3.2	1.3	*	3.2	1.2
While eating out with friends	3.2	1.2	**ns**	3.2	1.2
While at picnic/barbeque	3.1	1.2	**ns**	3.1	1.2
Difficult/Inconvenient Subscale (mean of 6 items)	**3.2**	**0.8**	**	**2.9**	**0.9**
When less healthy snacks available	2.8	1.1	**ns**	2.7	1.1
When I need to prepare myself	3.5	1.3	*	3.4	1.3
When eating healthy is too much trouble	2.7	1.0	**ns**	2.5	1.0
When eating healthy means I prepare	3.2	1.2	*	3.1	1.2
When substituting unhealthy with healthy is a pain	2.9	1.1	*	2.8	1.0
When eating less healthy is more convenient	3.0	1.1	**ns**	2.9	1.2

[a] Each item was rated on a 5-point scale, with 1: least confident and 5: most confident.
[b] HRF: health-related fields, NHRF: nonhealth-related fields.
[c] Statistical significance for comparison of HRF and NHRF, ns: not significant ($P \geq 0.05$); $^*P < 0.05$; $^{**}P < 0.01$.

Table 3: Frequencies of correct and incorrect responses, and overall summary statistics, from 513 college undergraduates on the snack knowledge test.

	Correct answer	HRF[a] (N = 236) % Correct	Sig[b]	NHRF[a] (N = 277) % Correct
Part I stem of question: which is a characteristic of a healthy snack?				
High in fiber	Yes	96.4	**ns**	94.3
Low in trans fat	Yes	92.9	**ns**	90.5
Low in cholesterol	Yes	97.3	**ns**	93.9
High in calories	No	97.3	*	92.8
Low in vitamins/minerals	No	96.4	**ns**	94.3
High in saturated fat	No	97.8	**ns**	95.4
Low in sugar	Yes	94.2	*	87.8
High in salt	No	98.7	*	94.7
Part II stem of question: which snack is . . .?				
Lowest in salt (among grapes, corn chips, light cheddar cheese)	grapes	93.9	**ns**	93.7
Highest in fiber (among French fries, popcorn, cottage cheese)	popcorn	40.0	**ns**	39.6
Highest in trans fat (among pretzels, French fries, apples)	French fries	91.7	**ns**	90.3
Lowest in cholesterol (among carrots, cheese pizza, whole milk)	carrots	94.4	*	88.8
Highest in saturated fat (among peaches in syrup, raisin bagel, cheese pizza)	cheese pizza	75.2	**ns**	73.9
Lowest in calories (among candy bar, potato chips, light yogurt)	light yogurt	93.9	**ns**	94.4
Overall Knowledge Test Summary Statistics (Mean ± SD)				
Part I (out of 8 possible points)		7.5 ± 1.4	**ns**	7.3 ± 1.6
Part II (out of 6 possible points)		4.9 ± 1.0	**ns**	4.8 ± 1.0
Total Score (out of 14 possible points)		12.4 ± 2.0	**ns**	12.1 ± 2.0

[a]HRF: Health-related fields, NHRF: Nonhealth-related fields.
[b]Statistical significance for comparison of HRF and NHRF, ns: not significant ($P \geq 0.05$); *$P < 0.05$; **$P < 0.01$.

scores correlated negatively with the internal cues subscale scores (Spearman $r = -0.246$, $P < 0.001$), and with the awareness subscale scores (Spearman $r = -0.172$, $P = 0.011$). The off-campus SQI scores for both student samples were significantly positively correlated with the overall self-efficacy scale scores (all three subscales); HRFs Spearman $r = 0.362$, $P < 0.001$, NHRFs Spearman $r = 0.295$, $P < 0.001$. However, no significant correlations emerged between the on-campus SQI scores and the overall self-efficacy scale scores. Additionally, statistically significant differences emerged between the mean off-campus SQI scores (20.6 ± 4.9 points versus 25.6 ± 5.2 points, Mann-Whitney chisquare = 95.798, DF = 1, $P < 0.001$) and between the mean on-campus SQI scores (19.0 ± 7.3 points versus 22.3 ± 9.4 points, Mann-Whitney chisquare = 24.911, DF = 1, $P < 0.001$) for the students who self-classified in the preaction or action stages, respectively, regardless of their field of study.

4. Discussion

The low mean on- and off-campus SQI scores reported for the HRF and NHRF students suggest unhealthy snacking patterns characterized by frequent consumption of energy-dense snacks. For example, fruits and vegetables were consumed at the higher frequency by less than one third of the HRF and NHRF students off-campus and by less than 10% of both samples on-campus, low-fat dairy foods were consumed at the higher frequency by approximately one third of the HRF and NHRF students off-campus and by less than 10% of both samples on-campus, and whole-grain products were consumed at the higher frequency by less than 10% of both samples at both locations. Regular consumption of energy-dense snacks by college students has previously been reported [12–14, 29]. Since such products can add a considerable number of calories to a daily diet [12–14], we hypothesize that the snacking patterns of the students in the present study may have contributed to the high prevalence (32.2%) of overweight/obesity reported for our overall sample. Our hypothesis is supported by the findings of an earlier study by Burger and co-workers [7] that examined the relationship between self-selected portion sizes and BMI in a college sample. These authors reported a strong positive correlation between BMI and consumption of large portion sizes for high-calorie foods and snacks. We acknowledge, however, that our self-reported anthropometric and dietary data may contain estimation and recall errors [30]. Additionally, the excess adiposity found in our sample may have been partly attributable to frequent consumption of high-energy meals and a sedentary lifestyle, neither of which was measured in this study.

Despite the low mean SQI scores earned by the HRF and NHRF students, three fourths of the former sample and two-thirds of the latter sample self-classified in the action stages of change for healthy snacking. Additionally, while the mean scores on the SKT reported for the two student samples reflect a good understanding of the nutrient characteristics of healthy snacks, the students' low SQI scores suggest a disconnect between acquired nutrition knowledge and its application when making snack choices. Hence, the low SQI scores, the high prevalence of overweight/obesity, and the possibility that some students misclassified themselves in the action stages suggest a need for health promotion programs that offer HRN and NHRN students opportunities to taste, purchase, and prepare healthy snacks. This need is underscored by the findings that approximately 30% of the HRF and approximately 20% of the NHRF students regarded their snack choices as mostly unhealthy, and that almost 20% of the students in both samples acknowledged that their current snack choices could have an unfavorable effect on their long-term health.

Snack preparation and tasting activities should offer college students the opportunity to taste a variety of healthy snacks, with the aim of motivating them to want to invest their limited time and money in purchasing and preparing such snacks. These tasting opportunities should feature palatable snacks that can be safely transported in a backpack and should be made using easy-to-follow recipes, and affordable, familiar ingredients. Emphasis should be placed on fiber-rich foods, given that small percentages of the HRF and NHRF students snacked on fresh fruits, vegetables, and wholegrain foods on- or off-campus. The most popular snack recipes could subsequently be offered to the students on-line, on fliers, and in the student newspaper, since these were the preferred media identified by the students for receiving information about healthy snacking. Our findings suggest that these students would be receptive to such activities, since almost 90% expressed an interest in learning more about healthy snacking.

Programs focusing on snack purchasing should teach college students how to make healthy snack choices from different kinds of food outlets, including vending machines, convenience stores, and grocery stores. One strategy would be to provide nutrition information at or near the point-of-purchase, given that Freedman and Connors [31] found that college students made healthier food purchases at on-campus convenience stores when nutrition information was available at the point of purchase. In particular, snack purchasing interventions should teach college students how to identify fiber-rich snack foods, given that half the students incorrectly identified the snack that was highest in fiber on the SKT. The most common response to this test item was cottage cheese rather than popcorn, suggesting that those students who answered this question incorrectly are misinterpreting the lumpy appearance of cottage cheese as an indication that this food possesses a high fiber content. Since high-fiber foods can help with weight management [32] and can assist in lowering LDL cholesterol [33], health promotion interventions focusing on healthy snacking should teach these young adults how to identify high-fiber foods and emphasize the potential health benefits of adding more of these foods to their diets.

Since greater proportions of the HRF and NHRF students consumed fresh fruits and vegetables and low-fat/fat-free milk off- campus than on-campus, it would be worthwhile to approach on-campus food vendors with suggestions about making these products more available and affordable, along with smaller packages of such popular snacks as popcorn, chips, cookies, and so forth. Making these products more accessible on-campus could help the students overcome their most important barriers to healthy snacking, that is, availability and cost, while making valuable contributions to their daily calorie and nutrient intakes [10, 32].

Snack tasting, preparation, and purchasing activities could be offered in introductory health and nutrition courses, during guided supermarket tours, at on-campus social gatherings, at student health centers, during athletic and wellness events, and at dining/residence halls. However, the finding that the students felt least confident to choose healthy snacks when they are emotionally upset suggests that affording these young people learning opportunities about healthy snacking may not suffice to produce desirable dietary change. Our findings suggest that interventions are also needed that teach college students techniques for enhancing their self-confidence to choose healthy snacks under unfavorable emotional and environmental circumstances. Regarding the impact of negative emotions on food selection, Locher and co-workers [34] reported that young adults often eat high-calorie foods for comfort when they are depressed, lonely, or bored. If motivational messages are to be a part of these interventions, Wilson [35] recommends that, for greater effectiveness, the following are to be considered: tailoring the message to the cognitive abilities of the audience; making the message relevant to the audience; wording the message clearly and specifically, with no distractions; delivering the message through a medium that allows for reflection and self-pacing rather than one that allows for little audience control; having the message delivered by a credible source; and using a spokesperson that shares characteristics with the audience.

This study has several noteworthy strengths and limitations. A key strength is that, including such psychosocial correlates as perceived barriers, situational self-efficacy, stage of change, and knowledge generates findings that permit nutrition and health educators to tailor interventions to the needs of specific student groups. The rapid assessment nature of the SQI makes its ease of use appealing, but validation of this tool with college samples is needed to enhance its usefulness.

The limitations of this study include the use of a convenience sample that prevents the generalizability of the findings, the use of the SQI as the single indicator of the healthfulness of the students' snacking patterns, the narrow geographic scope, and the self-reported nature of all measures. It is also acknowledged that not all instruments used in the study have undergone rigorous evaluation, and that the students who refused to complete the questionnaire may have differed from the participants on the demographic, behavioral, and psychosocial variables examined; however, the refusal rate was low (approximately one refusal for every ten who completed the survey). If other studies using validated snack frequency questionnaires similar to that used in the present study, probability samples, and a broader geographic scope corroborate our findings, future research should focus on developing and evaluating interventions and messages about healthy snacking for college students when spending time on-campus and at home. Previous research suggests that these educational efforts are more likely to produce the desired behavior change, that is, healthy snack selection, if these learning opportunities were tailored to college students in the preaction and action stages of change for healthy snacking [21–23].

5. Conclusions

In conclusion, there were few differences in the on and off-campus snacking patterns of the HRF and NHRF students. The most notable difference was the higher proportion of students consuming lower-calorie snacks such as low-fat milk and fresh fruits and vegetables off-campus compared to on-campus. However, at both locations, fruits and vegetables in any form, low-fat dairy foods, and whole grain products were consumed as snacks by small percentages of the students. These findings suggest a need for interactive programs that offer college students opportunities to taste healthy snacks, that teach them how to purchase and prepare such snacks for long-term health promotion, and that enhance their confidence to select these products under challenging emotional and environmental circumstances. Since the overweight/obese students are at risk of developing debilitating chronic diseases [5, 6], it is important that they recognize healthier snack options on- and off-campus and understand the unfavorable health implications of consuming high-fat, sugary snacks on a regular basis.

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Research Article

Local Context Influence, Activity Space, and Foodscape Exposure in Two Canadian Metropolitan Settings: Is Daily Mobility Exposure Associated with Overweight?

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It has become increasingly common to attribute part of the obesity epidemic to changes in the environment. Identification of a clear and obvious role for contextual risk factors has not yet been demonstrated. The objectives of this study were to explain differences in local overweight risk in two different urban settings and to explore sex-specific associations with estimated mobility patterns. Overweight was modeled within a multilevel framework using built environmental and socioeconomic contextual indicators and individual-level estimates of activity space exposure to fast-food restaurants (or exposure to visited places). Significant variations in local levels in overweight risk were observed. Physical and socioeconomic contexts explained more area-level differences in overweight among men than among women and among inhabitants of Montreal than among inhabitants of Quebec City. Estimated activity space exposure to fast-food outlets was significantly associated with overweight for men in Montreal. Local-level analyses are required to improve our understanding of contextual influences on obesity, including multiple influences in people's daily geographies.

1. Introduction

The obesity epidemic has been recognized as a major public health problem for over a decade [1]. Obesity has a substantial negative effect on longevity, reducing the lifespan of severely affected people by 5 to 20 years [2]. At the individual level, traditional explanations of obesity rely on three factors: metabolism, diet, and physical inactivity. In turn, these factors are influenced by genetic traits [3]. Genetics influences the individual predisposition but cannot directly explain the important increase in the prevalence of obesity prevalence over the past decades [3–5]. At the population level, this impact on life expectancy has important public policy implications [6]. In industrialized nations, groups with lower socioeconomic status (SES) are generally at greater risk of becoming obese. This is so particularly among women, for whom findings are relatively consistent [7]. Many studies controlling for individual SES also report an association between measures of the social or physical context and obesity [8, 9]. While it is theoretically sound and increasingly common in the published literature to attribute the obesity epidemic, in part, to changes in environmental context [10], current empirical evidence does not identify a clear and obvious role for contextual risk factors. There is an absence of agreement on how the built and social contexts should be measured and modeled, as well as the geographic scale at which local area studies should be done [10, 11]. Exposure to fast-food restaurants has been hypothesised to be a substantial influence on individuals' diet [12], but its association with overweight/obesity is unclear [13].

Many authors suggest further explorations at a local geographic scale in order to increase our understanding of contextual influences on obesity [14]. Indeed, the geographies of obesity/overweight appear to be more complex than might be interpreted from previous evidence [11]. Many literature reviews confirm the irregularity of associations between environmental indicators and weight-related outcomes (BMI, overweight, or obesity) [9, 13, 15–17]. An additional recommendation to resolve ambiguities in the role of contextual factors is to account for daily mobility patterns in analyses [14, 15, 18], as opposed to measurement based on residential location, in order to evaluate individuals' activity-space exposure to food environments [16] and, thus, not succumb to the "local or residential trap" [19, 20], that is, not considering environmental influences other than those located around one's residence [18].

In Canada's Province of Quebec, significant differences in overweight (BMI $\geq$25 kg/m^2) have been reported at the regional level after controlling for individual SES and lifestyle factors [21]. The differentials in variance between regions suggest that contextual influences might vary between regions and genders [22]. Put differently, these studies suggest that the level of influence of regional characteristics might vary between settings as well as between men and women.

The main objective of this study was to explore associations between a variety of contextual characteristics and the likelihood of being overweight in two urban settings, Montreal and Quebec City, and also to assess variation between men and women. Specifically, we aimed to (1) describe regional and sex-specific associations between overweight and contextual indicators of socioeconomic status, built environments and fast-food outlet exposure, and (2) compare associations obtained for a local residential-based indicator of fast-food exposure and an alternate measure based on individuals' activity space exposure, to evaluate whether accounting for daily mobility increases the strength of the association between fast-food outlet exposure and overweight.

2. Methods

Study Areas. This study compares the two urban areas of Montreal Island and Quebec City (Table 1). The former is the core of the largest metropolitan area of the province and is an important port-of-entry for immigration to Canada. It is culturally mixed, and its urban design characteristics vary considerably across neighborhoods [23]. The latter is the second largest metropolitan area of the province and is culturally very homogeneous. Quebec City also has a relative important variety in its urban design across neighborhoods but is among the Canadian cities with the highest ratio of highway kilometres per capita [24], estimated at 2.75 times Montreal's rate (Table 1). Both cities importantly differ in their urban structure: the classic monocentric model applies to Montreal, whereas Quebec City follows an axial pattern in land use due to historical and topographical reasons [25].

Both regions contain administrative geographical units consistent with notions of "neighborhood" and suitable for multilevel analyses [26]. In 2007, the Montreal Public Health Department purposely defined 111 geographic units covering the entire island of Montreal to shape interventions at the local level. Local stakeholders involved in the creation process characterized these units as natural sociologic areas [27]. These units are nested in turn within larger areas of local health and social services ($n = 29$) which were used as second-level units for nested analyses. In Quebec City, the 38 local units used in this analysis include the 36 official neighbourhoods of the city (2008), historically defined by city planners and citizens, and two additional units consisting of small peripheral areas (suburbs) located to the east (shore) and north of the city (mountains) of the city. These units all comprise an integer number of census dissemination areas from which selected contextual characteristics were drawn from the 2001 Canada census.

2.1. Data. Cycles 2.1 and 3.1 of the Canadian Community Health Survey (CCHS 2003, 2005) were combined for analyses. The Canadian Community Health Survey is a representative nationwide survey that collects individuals' socioeconomic and health-related information at the sub-provincial level from the year 2000. It relies on a large sample of respondents (approximately 130,000 per cycle), is designed to provide reliable estimates at the health region level, and has the central objective of supporting health-surveillance programs and public-health research [28]. Weights accounting for the sample plan, gender, and health region were used.

2.2. Outcome Variable. The outcome variable was a dichotomous indicator of overweight (BMI $\geq$25 kg/m^2) computed from self-reported height and weight provided by CCHS participants [1]. Underweight individuals (BMI $\leq$18.5) were removed from the sample in order to compare normal-weight individuals with those at risk for overweight-related diseases.

2.3. Individual-Level Variables. Table 1 summarizes information about SES and lifestyle for non-pregnant adults ($\geq$18 year old) of studied areas. Individuals with missing information were discarded from the analysis except for those missing income. Due to a relatively high occurrence of missing data (13%) on individuals' available income, a missing income variable was created.

We built an indicator estimating a respondent's exposure to fast-food restaurants based on the mobility patterns of travel-survey participants within the same territory. Computation of these variables is complex; a detailed description of the procedure is available elsewhere [18]. In summary, the creation of this estimated "activity space foodscape" (E-ASF) relies on a multiple-regression model using activity-location data from a travel-survey (Origin-destination survey 2003 in Montreal and 2001 in Quebec City) and a geocoded business registry (Tamec businesses registry 2003-2004). Kernel densities of fast-food restaurants and of all restaurants were computed for each city (geographic raster of 100 m^2

Table 1: Descriptive statistics for the Island of Montreal and Quebec City area.

		Montreal	Quebec
Study Area	Population (2001)[a]	1 845 137	564 277
	CCHS sample	3244	2334
	Average sample size by local area (neighbourhood)	112	71
	% of French as maternal language[a]	51.1	95.8
	% of visible minority[a]	21.1	1.8
	Highway km per 10 000 pers.[a-b]	2.44	6.71
		%	
Individual	Overweight (BMI $\geq$ 25)	45.4	43.8
	Obese (BMI $\geq$ 30)	14.2	12.1
	Gender (men)	47.3	43.6
	18–24 years old	12.1	13.8
	25–44 years old	40.2	35.3
	45–64 years old	31.2	35.9
	Over 65 years old	16.5	15.0
	No high school diploma	20.0	14.5
	High school of college diploma	50.9	62.1
	University degree	29.1	23.4
	Available income-low*	27.8	20.9
	Available income-high	59.9	65.9
	Missing income	12.3	13.2
	Average % fast-food (E-ASF-)[c]	18.7	33.0
Neighbourhood	Average % immigrant[a]	27.1	3.5
	Average % of single[a]	44.1	45.1
	Average % of less than 13 years of schooling[a]	15.7	11.8
	Average % who moved within the last year[a]	16.8	14.9
	Average % of single parent households[a]	21.8	18.0
	Average median income (CAN$)[a]	37676	43138
	Average dwelling density (km^2)[a]	2751	1289
	Average % of dwellings constructed before 1946[a]	21.5	13.4
	Avegage motorisation rate[c]	72.2	73.8
	Average number of four-way intersections (connectivity)[b]	26.4	16.1
	Average land use mix score (100 = equal land use; 0 = single land use)[b]	76.8	53.5
	Average % fast-food (O-NF-)[c]	20.2	38.6

Sources: CCHS 2003–2005 or a: Statistics Canada 2001; b: source DMTI Spatial 2005; c: Tamec businesses registry 2003-2004, OD survey 2001(Qc)-2003(Mtl), and CCHS 2003–2005.
*Less than 30 K$ for household of 1 or 2 individuals; less than 40 K$ for 3-4 individuals; less than 60 K$ for 5 individuals or more.

cells) thus transforming point data (restaurants) into a spatial continuum reflecting restaurants density unconstrained by neighborhood boundaries. Destinations of travel-survey participants were mapped above this continuum in order to estimate individuals' activity-space exposure to both kinds of restaurant. The index was constructed from individual information (age, gender, occupation, household type, household size) and local-area residential characteristics computed at the census tract level (street connectivity, motor-vehicle ownership rate, density of buildings constructed before 1946, education level, and immigration rate). This procedure was done separately for fast-food restaurants and for all restaurants (including fast-foods) to provide an estimate of density at any location. In order to provide an indication on the "relative availability" of fast-food restaurants, we further computed the proportion of fast-food restaurants on the density of all restaurants. This relative index was preferred to an absolute value of density since it provides a better approximation of the foodscape, that is, the food establishments' idiosyncrasy for a given area. For example, two individuals could be living in areas presenting the same density of fast-food outlets—say, 10 outlets per square kilometer—but in one case these could represent all available restaurants in the area (100% of restaurants are fast food outlets), and in the other case these could represent a fraction of all restaurants available. In such a scenario, even if fast-food outlet densities were equal in both places, one could argue that the person with no alternative would experience a higher (relative) exposure to fast-food outlets.

Separate models were calibrated for Montreal and for Quebec City to predict exposure to the proportion of fast-food outlet density. These models were then applied to the

CCHS participants to establish the actual E-ASF measures. In the context of this study, we used the E-ASF variable to estimate the proportion of fast-food restaurants to which an individual is exposed in his or her activity space, for a typical weekday.

2.4. Contextual Variables. Four contextual variables were computed for both settings at the local area (neighborhood) level (Tables 1 and 2). The objective neighborhood exposure to foodscape (O-NF) measure was based on the same information as the E-ASF indicator but differed in its spatial structure. It is a direct measure of the proportion of restaurants classified as fast-food restaurants [18] relative to all restaurants within a local unit.

The three other contextual variables were constructed based on a series of socioeconomic indicators (Canadian census 2001), built environment indicators (DMTI Spatial, 2005), and motor-vehicle ownership rate (origin-destination sur-veys). We conducted principal component analyses (PCAs) separately for each region (Montreal and Quebec), on each subset of variables. This procedure allows for including synthesized information on a series of correlated variables, with resulting PCA factors presenting uncorrelated indicator [29]. To allow comparability and give independence to the measurement scale, each indicator (x_c) was centered on the mean and reduced by its standard deviation, as shown in (1):

$$x_c = \frac{(x-\mu)}{\sigma}. \tag{1}$$

2.5. Statistical Analyses. Multilevel modeling is regularly used to study the role of context on the prevalence of obesity and other health disparities because it allows for the assessment of variation in health across small areas as a function of both composition (characteristics of the individuals within areas) and context (characteristics of the areas themselves), thus taking into account the dependent nature of individual observations within a specific area [30]. Multilevel logistic regressions were used to investigate relations between individual and contextual indicators and overweight [31]. A three-step procedure was performed to evaluate (1) the contribution of each contextual indicator and the ASF estimates on the individual's odds of being overweight as well as (2) the level-2 variance, given here as the magnitude of the territorial variance of overweight. All models control for survey cycle.

The first step simply enabled estimating whether there was a significant ($P < 0.05$) territorial variation of overweight where β_0 is the overall mean probability expressed on the logistic scale and is the area-level residual, no covariates included (null model, formula (2)):

$$\log it\left(\pi_{ij}\right) = \beta_0 + u_{0j}. \tag{2}$$

In the second step we added individual socioeconomic and demographic variables: age, education level, and available income (SES model, formula (3)):

$$\log it\left(\pi_{ij}\right) = \beta_0 + \beta_n x_{ij} + u_{0j}. \tag{3}$$

This allows to estimate the second-level variance not explained by individual characteristics. The third step individually presents the strength of association for each contextual indicator and the ASF estimate as well as the remaining level-2 variance not explained by the complete model (Formula (4)), where the logit of the probability π of individual i in neighbourhood j is the sum of (1) the city-wide probability of being overweight (β_0), (2) the adjustment of n variables at individual level ($\beta_n x_{ij}$), (3) the selected variable at the second level ($\beta_1 x_{0j}$), and (4) the neighbourhood-specific differential of overweight probability (u_{0j}). This last parameter is important as analysis of its variance ($\sigma^2 u_0$) contributes to the interpretation of the contextual effect:

$$\log it\left(\pi_{ij}\right) = \beta_0 + \beta_n x_{ij} + \beta_1 x_{0j} + u_{0j}. \tag{4}$$

We then estimated the proportion of the removed variance (RV) at the second level by adding one contextual variable. This is done by separately adding each contextual variable to the individual SES model, and then computing the proportion of the level-2 variance, this specific variable removes from the SES model (formula (5)). Since the Social Diversity and Financial Insecurity (socioeconomic factors) derive from the same PCA, they were kept in the same model:

$$\mathrm{RV} = \frac{(\sigma^2 u_0 \text{ SES}) - (\sigma^2 u_0 \text{ context})}{\sigma^2 u_0 \text{ SES}}. \tag{5}$$

All regressions were estimated using the residual-iterated generalized least squares (RIGLSs) and the predictive quasi-likelihood (PQL) in MlwiN 2.17.

3. Results

Table 2 summarizes the PCA loading scores after Varimax rotation (read as a correlation coefficient). Although Montreal and Quebec City have different general characteristics, the same three components emerge from PCAs independently conducted in both cities. Subsequent parameter differences observed in the modeling of overweight cannot consequently be attributed to heterogeneity of these factors between cities. The PCA run on the socioeconomic indicators resulted in two factors (Eigenvalue > 1). The first factor, labeled *Social Diversity*, was mainly correlated with the proportion of people living alone and the proportion of recent movers. The second factor—*Financial Insecurity*—was correlated with the proportion of people with low education, a single parent households, and median area income. The third factor came from the PCA run on the built environment variables. Labeled *Centrality*, referring to urban city center structure, this factor was mainly correlated with the percentage of dwellings built before 1946, the dwelling density, the average rate of motor-vehicle ownership by household, and street-network connectivity.

Multilevel logistic regressions were then conducted independently for men and women in Montreal and Quebec City. Table 3 summarizes results for the three-step procedure for both cities and genders. The empty models indicated a larger significant area-level variance ($\sigma^2 u_0$) in Montreal for both

Table 2: Principal components loadings for the socioeconomic and physical environments in Montreal and Quebec City.

Area-level indicators		Social diversity		Financial insecurity		Centrality	
		Montreal	Quebec	Montreal	Quebec	Montreal	Quebec
Socioeconomic environment	% singles	**0.955**	**0.941**	0.129	0.137	—	—
	% 1 year mover	**0.968**	**0.949**	0.117	0.187	—	—
	% less schooling	−0.218	−0.03	**0.947**	**0.976**	—	—
	% single parents	0.442	0.533	**0.808**	**0.775**	—	—
	Median income	−0.487	−0.62	**−0.824**	**−0.73**	—	—
Physical environment	% old dwelling	—	—	—	—	**0.844**	**0.820**
	Dwellings density	—	—	—	—	**0.908**	**0.904**
	Motorisation rate	—	—	—	—	**−0.958**	**−0.98**
	Con nectivity	—	—	—	—	**0.935**	**0.933**
	Land use mix	—	—	—	—	0.069	0.532

men and women. In Quebec, the effect was slightly lower among women, whereas no significant territorial difference in overweight was observed among men. Models including SES variables (Step 2) indicated associations between overweight and age, education, and income for both men and women. The area-level variance fell substantially for men and women in Montreal. Step 3 presents the associations for the four contextual indicators as well as the E-ASF for fast-food density in a series of four models. This step allows the direct comparison of two sets of information: the indicators' relative strength with the odds of being overweight (OR) and their contribution to explaining the magnitude of the territorial variations. All these models hold the individual SES constant (Step 2).

3.1. Indicators' Relative Strength. Except for the Financial Insecurity factor, all indicators were significantly associated with overweight among men in Montreal. The strongest associations were observed for social diversity, where an increase of 1 standard deviation reduced the odds of being overweight by 35% (OR = 0.74) and the neighborhood-based fast-food proportion measure (OR = 1.34). The ASF, which estimates one's fast-food exposure according to personal mobility, was slightly less strongly associated than the O-NF. Associations found for women in Montreal tended to be weaker, and the activity-space-based fast-food density indicator was not significant. For women in Quebec City, only Financial Insecurity and the proportion of fast-food restaurants in the neighbourhood significantly predicted the odds of being overweight. Although no territorial variance was detected for men in Quebec City, the Centrality factor was significantly associated with overweight.

3.2. Territorial Variations Magnitude. The RV index presented in Table 4 indicates the percentage of the territorial variation (area-level variance) explained by the addition of a specific contextual indicator to the SES model. It varies importantly between cities and between men and women.

In Montreal, all level-2 indicators having a significant association with overweight explained an important component of territorial variation in overweight, ranging from 37% to 48% for men and from 25% to 35% for women, the most important influences being the O-NF and contextual SES, respectively, for both men and women. In Quebec, the explained variance was of a lesser magnitude. Fewer indicators associated with overweight together explained less than 25% of the territorial difference in women, whereas none of the variance was explained for men (0%). The ASF indicator importantly explained territorial differences only for men in Montreal (37.4%).

4. Discussion

The primary findings of this study are thus as follows (1) contextual influences on overweight vary significantly between the two urban regions surveyed, and (2) predicted activity-space-based fast-food exposures are significantly associated with overweight for some subgroups of the population but do not explain as much territorial variance as traditional residential-based neighborhood indicators.

With the exception of the male subsample in Quebec City, our models show relatively important and statistically significant territorial variations in the local-area odds of being overweight. This indicates that the prevalence of overweight is not equally distributed between territories except for men in Quebec. Accounting for individual-level SES, a large part of this variance was explained for Montreal but not for Quebec City, suggesting that Quebec City holds a more uniform population from the standpoint of SES.

Comparing the RV index for all models further reveals differences between regions (Table 4), confirming observations made for other Canadian studies that a contextual effect could also be found at the regional scale, above and beyond individual SES [32, 33]. Contextual variables explained a negligible component of the territorial influence in Quebec City, compared to that explained for Montreal. Among women in Quebec City, the most important factor was the proportion of fast-food restaurants in the neighborhood of residence which explained 22% of the variance. The same variable explained a similar proportion of the variance for women in Montreal (25%). However, the proportion of fast-foods outlets in the neighborhood were the weakest of statistically significant influences. Centrality and social factors (Social Diversity and Financial Insecurity)

Table 3: Three-step procedure estimating overweight among men and women in Montreal and Quebec City.

		Montreal								Quebec							
		Men				Women				Men				Women			
1- Null Model	*Area-Level Components*	Coeff.	S.E.			Coeff.	S.E.			Coeff.	S.E.			Coeff.	S.E.		
	Variance	0.216	*0.055*		*	0.277	*0.081*		*	0.004	*0.031*			0.184	*0.052*		*
2- Individual SES model	*Variables*	OR	(95% Cl)			OR	(95% Cl)			OR	(95% Cl)			OR	(95% Cl)		
	Age 18–24	1.00				1.00				1.00				1.00			
	Age 25–44	1.44	*0.79*	*2.62*		0.98	*0.71*	*1.36*		5.29	*2.91*	*9.59*	*	1.44	*0.79*	*2.62*	
	Age 45–64	2.19	*1.27*	*3.78*	*	2.78	*1.45*	*5.34*	*	6.89	*3.86*	*12.3*	*	2.19	*1.27*	*3.78*	*
	Age over 65	1.94	*0.95*	*3.95*		5.01	*2.75*	*9.12*	*	4.63	*2.28*	*9.41*	*	1.94	*0.95*	*3.95*	
	No HS degree	2.01	*1.04*	*3.89*	*	4.63	*2.25*	*9.54*	*	1.23	*0.77*	*1.96*		2.01	*1.04*	*3.89*	*
	College or HS	0.98	*0.52*	*1.82*		2.83	*1.54*	*5.20*	*	1.46	*1.07*	*2.00*	*	0.98	*0.52*	*1.82*	
	University degree	1.00				1.00				1.00				1.00			
	Low income	1.24	*0.86*	*1.79*		1.09	*0.78*	*1.52*		0.81	*0.55*	*1.18*		1.24	*0.86*	*1.79*	
	Missing income	0.93	*0.57*	*1.50*		0.98	*0.64*	*1.50*		0.90	*0.53*	*1.52*		0.93	*0.57*	*1.50*	
	High income	1.00				1,00				1,00				1.00			
	Area-Level Components	Coeff.	S.E.			Coeff.	S.E.			Coeff.	S.E.			Coeff.	S.E.		
	Variance $\sigma^2 u_0$	0.198	0.050		*	0.200	0.065		*	0.000	0.000			0.185	0.054		*
3-Independent models for contextual indicators	*Variables*	OR	(95% Cl)			OR	(95% Cl)			OR	(95% Cl)			OR	(95% Cl)		
	Social diversity	0.74	*0.64*	*0.86*	*	0.83	*0.70*	*0.98*	*	0.92	*0.84*	*1.01*		0.86	*0.72*	*1.02*	
	Financial insecurity	0.91	*0.77*	*1.07*		1.15	*0.98*	*1.36*		0.97	*0.88*	*1.07*		1.21	*1.03*	*1.43*	*
	Centrality	0.76	*0.65*	*0.89*	*	0.76	*0.65*	*0.89*	*	0.90	*0.82*	*0.99*	*	0.89	*0.73*	*1.10*	
	O-NF—% fast-foods	1.34	*1.14*	*1.56*	*	1.26	*1.06*	*1.49*	*	1.06	*0.96*	*1.16*		1.28	*1.09*	*1.51*	*
	E-ASF—% fast-foods	1.31	*1.12*	*1.53*	*	1.08	*0.88*	*1.32*		1.10	*0.99*	*1.21*		1.15	*0.97*	*1.37*	

Table 4: Territorial variance of overweight for men and women in Montreal and Quebec City.

Models	Montreal						Quebec					
	Men			Woman			Men			Woman		
	Coeff.	S.E.	RV	Coeff.	S.E.	RV	Coeff.	S.E.	RV	Coeff.	S.E.	RV
Individual SES	0.198	*0.05*	—	0.200	*0.066*	—	0	*0*	—	0.185	*0.054*	—
Social factors	0.118	*0.029*	40.4%	0.130	*0.056*	35.0%	0	*0*	0.0%	0.160	*0.049*	14.0%
Centrality	0.118	*0.035*	40.4%	0.131	*0.047*	34.5%	0	*0*	0.0%	0.190	*0.053*	−3.0%
O-NF—% fast-foods	0.104	*0.034*	47.5%	0.150	*0.052*	25.0%	0	*0*	0.0%	0.144	*0.045*	22.0%
E-ASF—% fast-foods	0.124	*0.039*	37.4%	0.185	*0.061*	7.5%	0	*0*	0.0%	0.159	*0.051*	14.0%

RV: Removed level-2 Variance; O-NF: Objective Neighbourhood Foodscape; E-ASF: Estimated Activity Space Foodscape.
Social factors: social diversity and financial insecurity.

also explained a large part of the variance (up to 35%). Contextual influences were definitely stronger for men in Montreal, where all contextual indicators explained over 40% of the territorial variance and reached 47.5% for the neighborhood proportion of fast-food outlets.

These observations indicate clear differences between Quebec City and Montreal. Whereas little between-area variance can be explained for Quebec City, almost 50% can be explained for Montreal by the addition of only one contextual indicator. Exploratory analyses (not shown) that simultaneously included several factors indicated important multicolinearity. As a consequence, these associations need to be interpreted with care. Although each indicator appeared to be individually associated with overweight, all indicators explained a similar portion of the observed territorial variance. Accordingly, the factors used could all reflect a similar construct, linked to some elusive effect that could be termed the "socio-urban-foodscape." This interpretation is dependent on the importance of the variance; however, a small variance at the area level does not necessarily mean a small impact on the outcome. This can be observed, for example, when a strong effect is uniformly distributed between areas. A more in-depth study using different methodologies including qualitative methods would be useful in teasing apart observed differences between Montreal and Quebec City [34].

Another appealing observation concerned the E-ASF indicator (estimated activity space to foodscape). As opposed to the other indicators which were computed based on geographical boundaries, therefore referring to a specific territory, the E-ASF is more properly a spatial variable, distributed in space but not constrained by boundaries. This distinction is important because this indicator is computed with exactly the same geographical information as O-NF and differs only in how exposure and spatial structure are being considered. Although it contains geographical contextual information, the E-ASF is an individual indicator (level-1) and must be analysed accordingly.

The E-ASF proportion of fast-food restaurants was observed to be significantly associated with overweight in just one model. An increase in this exposure by one standard deviation yielded a 31% increase in the odds of overweight for men in Montreal and explained 37% of the territorial variance observed. This suggests that exposures to multiple sites encountered during a single trip in an urban environment might influence overweightfor men in Montreal. This relationship was not apparent, however, for women, for whom where almost no territorial variance was explained by this indicator. Does this imply that men are more mobile than women and consequently more subject to destinations' characteristics? This is plausible, since other large studies observed that contextual effect on overweight is weaker among men than among women [35, 36]. Consequently, visited places (or places to which one is exposed) during daily activities might be an important feature to consider in analyses modeling overweight. Once again, we must be careful in interpreting this exposure to fast-food restaurants, since the strength of association and the proportion of explained variance is similar to other factors, at least for men. Although individually based, it has a stronger association to overweight than contextual indicators. Future studies should specifically aim at untangling place-based and individual-based indicators such as the proportion of fast-food restaurant.

This paper suggests for Montreal and Quebec City that residential-area characteristics explain an important component of the territorial distribution of overweight, and that mobility patterns and related exposures to food environments are important features to consider for men. Associations might differ significantly between genders because their interaction with the environment could be of a different nature. Not considering the regional settings and gender differences would obscure such results.

This study has a number of limitations. The cross-sectional design does not allow for the determination of causal effects. Although the CCHS offers individual-level health and lifestyle data of good quality, the self-reported information provided to derive the BMI and other indicators is subject to potential bias [37, 38]. Also, as we did not have information on CCHS participants' mobility pattern, we used estimates of activity space exposure to foodscape. This procedure could yield an imprecise estimate for some subsamples and multicolinearity with other contextual variables. However, these estimates were calibrated using travel survey information and were done in the same geographic location where the CCHS sample was drawn. Such an approach may offer promising avenues for exploring the relationship between health status and activity space and could be tested in other cities with different spatial structures.

From an intervention standpoint, this study confirms the important role of the multidimensional reality of the local context and also confirms that looking for a specific attribute in just one way might be misleading. Local context is nonetheless clearly implicated in the territorial distribution of overweight, but a variety of information suggests that interventions aiming at overweight management might need to differ between genders as well as between regions. We consequently recommend research that seeks to understand local and regional idiosyncrasies according to the socioeconomic built environment, and more specifically the foodscape, while accounting for mobility patterns, prior to implementing more-or-less generic interventions at the local level. A more in-depth study accounting for the interaction between individuals and local areas' characteristics might also be a promising avenue for increasing our understanding of the embodiment of environmental influences and how they get, in the end, under the skin [39].

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Research Article

Adolescent Weight Status and Related Behavioural Factors: Web Survey of Physical Activity and Nutrition

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Purpose. To identify whether non-overweight students were different from their overweight or obese peers with respect to diet, suboptimal meal behaviours, and physical activity using a self-administered web-based survey. *Methods*. 4097 adolescents living in Alberta, Canada completed Web-SPAN (Web Survey of Physical Activity and Nutrition). Students were classified as overweight or obese, and differences were described in terms of nutrient intakes, physical activity, and meal behaviours. *Results*. Non-overweight students consumed significantly more carbohydrate and fibre, and significantly less fat and high calorie beverages, and had a higher frequency of consuming breakfast and snacks compared to overweight or obese students. Both non-overweight and overweight students were significantly more active than obese students. *Conclusions*. This research supports the need to target suboptimal behaviours such as high calorie beverage consumption, fat intake, breakfast skipping, and physical inactivity. School nutrition policies and mandatory physical education for all students may help to improve weight status in adolescents.

1. Introduction

Obesity has been recognized as a significant public health challenge worldwide. The obesity epidemic is of concern in Canadian adolescents due to the dramatic increase in prevalence over the past 25 years [1]. Further, numerous health consequences of adolescent obesity exist including risk for cardiovascular disease, type 2 diabetes [2], and persistence of obesity into adulthood [3, 4]. Equally concerning are psychosocial consequences such as discrimination and teasing that may occur, which can have a long-term effect on self-esteem and body image [5]. Obesity presents an enormous burden to our health care system, estimated in the billions of dollars, which is only expected to increase with the dramatic rise in obesity prevalence [6].

Given the numerous consequences of obesity, surveillance systems and measurement tools are needed to determine the effectiveness of obesity prevention programs and interventions [7]. However, it is becoming increasingly difficult to collect relevant and geographically diverse information in a time- and cost-effective manner. Web-based methods of surveillance provide a cost-effective means to survey large numbers of participants concurrently throughout wide geographic areas. Access to hard-to-reach areas is enhanced, thus improving the ability to obtain a representative sample [8]. The Web Survey of Physical Activity and Nutrition

(Web-SPAN), a self-administered web-based survey for adolescents, has previously been validated [9]. However, Web-SPAN has not yet been used to determine the relationship between bodyweight status and health behaviours such as dietary intake and suboptimal meal behaviours. Therefore, this study provides the much-needed insight on how web-based methods of surveillance can be used to further our understanding of the factors that contribute to overweight/obesity in youth and will help inform intervention development and refinement.

Although several studies have examined the relationship between overweight/obesity and obesity determinants, few have utilized a web-based platform in order to capture this information. Previous studies have indicated that obesity is a complex condition involving individual/behavioural, environmental, and social factors. Further, it has been proposed that a basic imbalance of energy intake and energy expenditure leads to increased adiposity [10]. Specifically, individual behaviours such as increased consumption of high calorie foods (which include high calorie beverages) [1, 11–13], physical inactivity, and increased sedentary activity [14–16] have been identified as key factors contributing to the development of obesity.

Therefore, the purpose of this study was to use a web-based method of surveillance to investigate the current bodyweight status of Alberta adolescents and to identify whether non-overweight students were different from their overweight or obese peers with respect to macronutrient intakes, consumption of Other Foods (foods not included in Canada's Food Guide), suboptimal meal behaviours including breakfast skipping and consuming meals away from home, and physical activity levels. It was hypothesized that non-overweight students would have different intakes including lower intakes of fat and Other Foods, and a lower frequency of meal skipping and consuming meals away from home. Further, it was hypothesized that non-overweight students would be more active than their overweight and obese peers.

2. Methods

2.1. Participants. The Web Survey of Physical Activity and Nutrition (Web-SPAN) was a self-administered web-based survey of grade 7 to 10 students that assessed diet, physical activity, related meal behaviours (i.e., meal skipping and consuming meals away from home), and height and weight and is described below. All 59 public and separate school boards in the province of Alberta, Canada were selected for participation, which included schools in both rural and urban areas, public schools, Catholic schools, and private schools. Of these 59 school boards, 48 (81%) agreed to participate and an average of seven schools within each school board was randomly chosen and contacted after obtaining school board approval. Private schools (approximately 10% of all Alberta schools) were also included in the study and were selected to ensure that they were appropriately represented in the sample. These schools were initially stratified according to the five Alberta Education zones in the province (Calgary and South, Central, Edmonton and area, North Central, North) and were then randomly selected.

In total, 18,484 students were sent consent forms across 363 schools and 4981 adolescents agreed to participate in the study. However, participating students who signed on to the website but did not complete the survey ($n = 9$), and students with extreme values of BMI, total caloric intake, or physical activity levels based on outlier analyses (non-mutually exclusive outliers: BMI, $n = 35$; total caloric intake, $n = 24$; physical activity, $n = 14$; total outliers removed, $n = 71$) were excluded. BMI classification could not be determined on 804 students due to missing height and/or weight, thus they were excluded from the analyses. The final sample was 4097 students (boys = 1974; girls = 2123; mean age = 13.7 years) from 136 schools (37% school response rate) within 44 school boards (75% board response rate). Age and sex characteristics of our overall sample reflected the sampling frame of the provincial school population for grades 7–10: the mean age of our sample was 13.7 ($\pm$1.2) years versus 13.3 ($\pm$1.3) years for grade 7–10 Alberta school youth ($n \sim 130,000$), and the proportion of males in our sample was 48% versus 51% for the province. During data collection, students were free to end the survey at any time and were not required to answer every question in order to participate. Therefore, sample size varied throughout the analyses.

2.2. Measures

2.2.1. Web-SPAN. Web-SPAN was a self-administered web-based survey that was developed at the University of Waterloo and modified by researchers at the University of Alberta in order to include questions regarding meal behaviours (i.e., meal skipping and consuming meals away from home), self-efficacy, and physical activity. Students respond to electronic survey questions providing information on height, weight, dietary intake, physical activity, and other health behaviours. Web-SPAN has previously been validated [9] and has been described elsewhere [17–21].

2.2.2. Weight Status. Students provided self-reported height and weight. Body mass index (BMI) was calculated (weight [kilograms]/height [meters^2]), and students were categorized as overweight or obese using the International Obesity Task Force (IOTF) cut-offs [22]. Derived from adult BMI cut-off points (25 and 30 kg/m^2 for overweight and obesity, resp.), age and sex specific cut-off points for youth 2 to 18 years of age were extrapolated by placing these values (25 kg/m^2 and 30 kg/m^2) at 18 years of age where prevalence of overweight and obesity were matched. The IOTF cut-offs were used to determine overweight and obesity status based on the recommendation of Dietitians of Canada, the Canadian Paediatric Society, the College of Family Physicians of Canada, and the Community Health Nurses Association of Canada [23]. Among a subsample of 459 students in our study, Web-SPAN showed good agreement for self-reported height ($r = 0.88$) and weight ($r = 0.94$) when compared to measured height and weight [9].

2.2.3. Dietary Intake. As part of Web-SPAN, a 24-hour web-based dietary recall was administered to students to measure dietary intake using the *Food Behaviour Questionnaire* developed at the University of Waterloo [24] and modified by researchers at the University of Alberta [17]. Responding to the electronic survey questions, students reported all foods and beverages consumed during the previous day. To help students recall their intake, portion size images and cues regarding beverage intake were provided. The 24-hour recall component of the *Food Behaviour Questionnaire (FBQ)* has been validated using several methods and has been described previously [9]. Briefly, in comparison to a dietitian-administered 24-hour dietary recall, the *FBQ* showed good agreement for total energy and nutrient intakes [25], and compared to a 3-day food record, intraclass correlation coefficient values were within ranges reported elsewhere in the adolescent population [9].

A measure of diet quality was used to classify students into groups of poor (meeting minimum servings of 0-1 food group), average (2-3 food groups), or superior (all 4 food groups) diet quality using a food-based diet quality index [26] modified to reflect Canada's Food Guide to Healthy Eating (CFGHE) [27] foods [17]. The number of servings from each CFGHE food group [27] was calculated using data from the 24-hour dietary recall and included the following food groups: Grain Products, Vegetables and Fruit, Milk Products, and Meat and Alternatives. Foods that were not classified as CFGHE foods were categorized as Other Foods and further divided into the following subcategories: foods containing mostly sugar (e.g., candies), high salt/fat foods (e.g., potato chips), high calorie beverages (e.g., regular soft drinks), low calorie beverages (e.g., low calorie soft drinks), or high sugar/fat foods (e.g., pastries) based on Canadian Nutrient File definitions [28]. The CFGHE was subsequently revised and the new food guide [29] was released in early 2007. In spite of this, the 1992 CFGHE was the government recommendation during data collection and was also a component of Alberta school curriculum [30, 31]. Therefore, it was most appropriate to compare intakes to the 1992 CFGHE recommendations. Macronutrient intakes were assessed using ESHA Food Processor (version 7.9; Salem, OR) and the 2001b Canadian Nutrient File [28] database.

2.2.4. Suboptimal Meal Behaviours. Survey questions examining meal behaviours (i.e., meal skipping and consuming meals away from home) were comparable to questions developed for Project EAT (Eating Among Teens), a well-established survey instrument [32, 33]. Frequency of meal consumption was assessed by asking "How often do you usually eat?" followed by "breakfast," "lunch," "dinner," "morning snacks," "afternoon snacks," or "evening snacks" with response options of "Never," "On weekends only," "Less than half of the week (≤3 days/week)," "More than half of the week (≥4 days/week)," "Every day," and "Not answered." Frequency of consuming meals away from home was assessed by asking "How often do you eat meals or snacks prepared away from home?," with response options of "rarely or never," "once a month," "once a week," "2–6 times a week," and "once a day." The following locations were assessed: school cafeteria, fast food restaurant or take out, other restaurants, vending machines, snack bars, and convenience stores.

2.2.5. Physical Activity. A web-based version of the Physical Activity Questionnaire for Older Children (PAQ-C) was used to assess physical activity levels over the previous 7-day period. The PAQ-C was specifically designed for Canadian school-aged youth and includes components on physical activity during the school day as well as after school and weekend activity [34]. The questionnaire consists of 9 items which are used to calculate an activity score (scores range from 1.00 to 5.00). The PAQ-C has been shown to be a reliable [35] and valid [36] method to assess physical activity in youth. In addition, among a subsample of 411 students in our study, when compared to the paper-based PAQ-C, the web-based PAQ-C showed good agreement ($r = 0.70$) [9].

2.3. Procedures. School boards and schools were individually contacted by mail and followup phone calls were made to request permission to survey students. Parents and students received information letters, and parental consent was obtained using active consent. All students provided assent after signing on to the web-based survey. The anonymous 24-page survey took approximately 45 minutes to complete and was conducted during class time within the school day. Survey data were collected between January and November 2005 (except in July and August when schools were closed for summer). This research was approved by a university ethics board and by all participating school boards and schools.

2.4. Statistical Analyses. Overweight and obesity prevalence were analyzed using descriptive statistics. Four 2×3 multivariate analyses of covariance (MANCOVA) were used to evaluate the association between gender and BMI classification for the four sets of dependent variables: nutrient intakes, Other Foods categories, frequency of meal consumption, and location of meal consumption. Total caloric intake was used as the covariate for all four MANCOVAs. Univariate followups were completed on significant MANCOVA results for dependent variables. Prior to the MANCOVA analyses, the assumption of homogenous slopes [37, 38] was tested, and interactions indicated that the slopes differed among levels of the independent variables. Therefore, adjusted values were based on custom models which included these interactions for the following MANCOVA analyses: macronutrients, Other Foods, and frequency of meal consumption. Differences in physical activity levels and diet quality scores between non-overweight, overweight, and obese students were assessed using a 2×3 analysis of variance (ANOVA) for gender and weight status.

Statistical analyses were performed using the software program SPSS (version 15.0; SPSS Inc, Chicago, Ill). A criterion α-level of $P < 0.05$ was used for all statistical comparisons given the small effect sizes previously observed using Web-SPAN [17–20].

Table 1: Percentage of overweight and obesity, by gender, among adolescents aged 11 to 17 years*.

BMI Classification†	Total (n = 4097)	Boys (n = 1974)	Girls (n = 2123)
Overweight	15.1‡	19.0	11.4
Obese	6.0	7.5	4.6

*Four students were younger than age 11 due to mixed grade level classrooms.
†Classified according to the International Obesity Task Force cut-offs [22].
‡Prevalence expressed as a percentage.

3. Results

3.1. Weight Status. Observed percentage of overweight and obesity, by gender, are presented in Table 1. In total, 21.1% of students (26.5% boys; 16.0% girls) were considered overweight or obese.

3.2. BMI Classification and Nutrient Intakes. Multivariate F values for BMI classification (Wilks′ Lambda = 1.00, $F[8, 8134] = 3.46$, $P = 0.039$, $\eta_p^2 = 0.002$) were significant, while the interaction between BMI classification and gender was not significant (Wilks′ Lambda = 1.00, $F[8, 8134] = 0.59$, $P = 0.788$, $\eta_p^2 = 0.001$) for nutrient intakes. Univariate followup analyses for BMI classification indicated that non-overweight students consumed significantly more carbohydrate and fibre, and significantly less fat compared to both overweight and obese students. Significant differences did not exist between overweight and obese students, or for protein intakes between BMI classifications (Table 2).

No significance was observed for the main effect of BMI classification (Wilks′ Lambda = 1.00, $F[10, 8132] = 0.88$, $P = 0.552$, $\eta_p^2 = 0.001$) or the interaction between BMI classification and gender (Wilks′ Lambda = 1.00, $F[10, 8132] = 1.03$, $P = 0.417$, $\eta_p^2 = 0.001$) with Other Foods subcategories (MANCOVA). The results of comparisons between intakes from the Other Foods subcategories and BMI classification are presented in Table 2. Although significant differences were not observed based on the MANCOVA, significance was observed for high calorie beverages based on univariate analyses where non-overweight students consumed significantly less high calorie beverages compared to obese students. No significant differences were observed between BMI classification and diet quality (χ^2 [4] = 5.31, $P = 0.257$).

3.3. BMI Classification and Suboptimal Meal Behaviours. Significant main effects for BMI classification (Wilks′ Lambda = 0.99, $F[8, 6202] = 2.88$, $P = 0.003$, $\eta_p^2 = 0.004$), but not for the interaction between BMI classification and gender (Wilks′ Lambda = 1.00, $F[8, 6202] = 0.77$, $P = 0.627$, $\eta_p^2 = 0.001$) were observed when meal frequency was assessed using MANCOVA. Followup univariate analyses revealed that non-overweight students had a higher frequency of consuming breakfast and snacks compared to obese students. Non-overweight students also consumed snacks more frequently than overweight students. No differences were observed for lunch or dinner consumption (Table 3).

The association between BMI classification and gender with frequency of consuming meals away from home assessed using a MANCOVA did not reveal significant F values for BMI classification (Wilks′ Lambda = 1.00, $F[12, 7034] = 1.44$, $P = 0.140$, $\eta_p^2 = 0.002$) or the interaction between BMI classification and gender (Wilks′ Lambda = 1.00, $F[12, 7034] = 1.27$, $P = 0.227$, $\eta_p^2 = 0.002$) (Table 3).

3.4. Physical Activity. Significant differences were observed in physical activity levels between non-overweight and obese students, and between overweight and obese students ($F[2, 3669] = 15.78$, $P < 0.001$) based on ANOVA. Both non-overweight (2.92 ± 0.01 [SE], $P < 0.001$) and overweight students (2.89 ± 0.03, $P < 0.001$) were more active than obese students (2.66 ± 0.05). Differences were also observed between BMI classifications based on gender for both boys ($F[2, 1747] = 23.12$, $P < 0.001$) and girls ($F[2, 1919] = 3.07$, $P = 0.047$) when assessed using ANOVA. Both non-overweight (3.06 ± 0.02, $P < 0.001$) and overweight boys (3.00 ± 0.04, $P < 0.001$) were more active than obese boys (2.63 ± 0.06), while non-overweight girls (2.81 ± 0.02, $P = 0.048$) were more active than obese girls (2.70 ± 0.07).

4. Discussion

The purpose of this study was to investigate the overweight and obesity status of Alberta adolescents and to identify differences in nutrient intakes, meal behaviours, and physical activity levels between BMI classifications using a web-based survey. One in five students were considered overweight or obese. They had significantly different nutrient intakes, meal behaviours, and physical activity levels than non-overweight students, such that suboptimal behaviours (e.g., skipping breakfast) were more prevalent in students classified as overweight or obese.

Self-reported height and weight were used to calculate BMI and to further classify students as overweight or obese. Although measured height and weight are more precise and accurate than self-reported measurements, self-report is a useful method that offers researchers a time- and cost-effective method to survey a large number of participants simultaneously [24, 39–41]. Overweight and obesity rates in the current study were similar to the Alberta rates from the 2004 CCHS [1]. The 2004 CCHS revealed that Alberta youth had a significantly lower prevalence of overweight/obesity than the national average, therefore it was most appropriate to compare to provincial statistics [1].

The association between dietary fat and weight status in the literature is inconclusive. Several researchers have suggested that an increase in dietary fat intake can be correlated to an increase in body fat in children 4 to 11 years [42–44]. However, Gillis and colleagues [45] and Troiano et al. [46] did not observe the same effect. In the current study, both overweight and obese students consumed significantly more total fat compared to non-overweight students, suggesting a relationship between dietary fat intake and BMI classification. In addition, overweight and obese students

Table 2: Group differences in adjusted* nutrient intakes based on BMI classification†.

	BMI Classification‡ (mean ± SE)			F value	P value
	Non-overweight§	Overweight	Obese		
Nutrients (g) (n = 4080)					
Carbohydrate	284.09 ± 0.99^{a}	275.13 ± 2.25^{b}	$275.35 \pm 3.52^{b,c}$	8.88	$<0.001^{ab}$; 0.016^{ac}
Protein	79.66 ± 0.46	81.95 ± 1.04	79.09 ± 1.63	2.25	nsd
Fat	77.36 ± 0.36^{a}	79.95 ± 0.82^{b}	$81.14 \pm 1.29^{b,c}$	7.51	$0.004^{ab,ac}$
Fibre	15.14 ± 0.13^{a}	13.97 ± 0.29^{b}	$13.79 \pm 0.46^{b,c}$	9.86	$<0.001^{ab}$; 0.005^{ac}
Other food groups subcategories (servings/day) (n = 4080)					
Mostly sugar	1.01 ± 0.03	0.91 ± 0.06	0.99 ± 0.10	1.12	nsd
High salt/fat	0.62 ± 0.02	0.58 ± 0.05	0.64 ± 0.07	0.29	nsd
High calorie beverages	0.79 ± 0.02	0.84 ± 0.05	1.09 ± 0.09	5.73	nsd**
Low calorie beverages	1.25 ± 0.04	1.30 ± 0.08	1.33 ± 0.12	0.35	nsd
High sugar/fat	0.67 ± 0.02	0.61 ± 0.04	0.54 ± 0.06	2.96	nsd

BMI: Body Mass Index; g: grams; nsd: no significant difference; SE: standard error of the mean.
*Adjusted for total caloric intake (energy).
†Univariate analyses.
‡Classified according to the International Obesity Task Force cut-offs [22].
§Non-overweight refers to all non-overweight, non-obese students.
**Significance was not observed based on multivariate analysis, however, univariate analysis revealed significance between non-overweight and obese students (P = 0.003).
a,b,cDifferent superscript letters in each row indicate significant statistical differences.

Table 3: Group differences in suboptimal meal behaviours* based on BMI classification†.

	BMI Classification‡ (mean ± SE)			F value	P value
	Non-overweight§	Overweight	Obese		
Meal frequency** (n = 3114)					
Breakfast	4.25 ± 0.03^{a}	4.14 ± 0.06	4.02 ± 0.09^{c}	4.35	0.014^{ac}
Lunch	4.66 ± 0.02	4.64 ± 0.04	4.51 ± 0.06	2.95	nsd
Dinner	4.87 ± 0.01	4.89 ± 0.02	4.78 ± 0.04	2.83	nsd
Snacks	3.55 ± 0.02^{a}	3.31 ± 0.05^{b}	$3.25 \pm 0.08^{b,c}$	16.67	$<0.001^{ab,ac}$
Consuming meals and snacks away from home†† (n = 3529)					
School cafeteria	2.33 ± 0.03	2.35 ± 0.06	2.40 ± 0.10	0.27	nsd
Fast food/take out	2.31 ± 0.02	2.26 ± 0.04	2.19 ± 0.06	2.40	nsd
Other restaurant	2.05 ± 0.02	2.08 ± 0.04	2.06 ± 0.06	0.37	nsd
Vending machines	2.19 ± 0.02	2.16 ± 0.05	2.18 ± 0.08	0.22	nsd
Snack bars	2.25 ± 0.02	2.15 ± 0.05	2.17 ± 0.08	1.93	nsd
Convenience store	2.52 ± 0.02	2.51 ± 0.05	2.56 ± 0.08	0.20	nsd

BMI: Body Mass Index; nsd: no significant difference; SE: standard error of the mean.
*Adjusted for total caloric intake (energy).
†Univariate analyses.
‡Classified according to the International Obesity Task Force cut-offs [22].
§Non-overweight refers to all non-overweight, non-obese students.
**Meal frequency: never = 1, on weekends only = 2, less than half of the week (≤3 days/week) = 3, more than half of the week (≥4 days/week) = 4, every day = 5; snacks were averaged before analysis (morning snacks, afternoon snacks, evening snacks).
††Consuming meals and snacks away from home: rarely or never = 1, once a month = 2, once a week = 3, 2–6 times a week = 4, once a day = 5.
a,b,cDifferent superscript letters in each row indicate significant statistical differences.

had significantly lower intakes of carbohydrate and fibre compared to their peers. Although mean intakes of total fibre were well below the recommended Dietary Reference Intake (DRI) in all BMI categories, higher intakes were observed in non-overweight students, representing an improvement in fibre intake with decreasing BMI. Significant differences were not observed between BMI classification and diet quality; however, recent findings from the 2004 CCHS suggested that youth who consumed fruits and vegetables more frequently (five or more times a day) were less likely to be classified as overweight/obese [1]. However, it is worth noting that diet quality was very poor in all students, regardless of weight status, which could explain the lack of significance in results [17]. Further, the food-based diet quality index used in the present study did not determine when students exceeded their CFGHE recommendations, which may provide a better understanding of the relationship between diet quality and overweight/obesity.

Although results did not indicate significance for the consumption of Other Foods subcategories, univariate analysis revealed that obese students consumed significantly more high calorie beverages compared to non-overweight students. The relationship between high calorie beverages (e.g., regular soft drinks) and body weight is of interest due to the tremendous increase in soft drink consumption in the adolescent population. In the United States, data from the National Heart, Lung, and Blood Institute Growth and Health Survey assessed longitudinal changes in beverage consumption among adolescent girls. Girls were assessed initially at age 9 or 10 years and annually up until 19 years of age. Data from multiple 3-day food records indicated that regular soft drink consumption nearly tripled over the 10-year period. In that study, for every 100 grams of regular soft drinks consumed, BMI increased by 0.01 unit and average daily caloric intake increased by approximately 82 kilocalories [12]. A more recent Australian study indicated that schoolchildren aged 4 to 12 years who consumed greater intakes of high calorie beverages (i.e., fruit juice/drink, soft drink) were more than twice as likely to be overweight/obese [13]. A meta-analysis which examined the effects of soft drink consumption on nutrition and health revealed positive associations between soft drink consumption and body weight, although results varied depending on the methodology used to assess body weight [47].

Results of the present study indicated that non-overweight students had a higher frequency of consuming breakfast and snacks when compared to either overweight or obese students. Breakfast skipping is highly prevalent in the adolescent population, and consistent with previous reports, has been associated with increased prevalence of overweight [48]. Although snack consumption has been previously associated with higher intakes of Other Foods [49], the current results suggest that snacks may be associated with a lower BMI classification. Additional research that examines meal patterns may be helpful in clarifying the association between snack consumption and weight. Although significant differences were not observed between BMI classification and consumption of meals and snacks away from home, previous studies have found a positive association [50, 51]. This suggests that location alone may not be adequate to explain the relationship between meal behaviours and overweight/obesity. Information regarding the type (e.g., fried versus grilled, white versus whole wheat, whole versus skim milk, juice versus fruit) and quantity of the food consumed away from home may be necessary to provide a true understanding of the relationship between BMI classification and meal location. As well, in the current study, the frequency of family meals was not examined. Family meals may have provided a better understanding of BMI classification than consumption of meals away from home at independent locations.

Results from the current study indicated that both non-overweight and overweight students were more active than obese students. Further, differences were observed by gender where both non-overweight and overweight boys were more active than obese boys, and non-overweight girls were more active than obese girls. These findings are consistent with results from the 2004 CCHS which indicated that sedentary adolescent boys were more likely than active boys to be obese [1]. However, these results are dissimilar to other reports from the Canadian Health Measures Survey that utilized objective measuring devices for physical activity such as accelerometers [52]. In a study done by Thompson et al. [14], no significant differences were found in physical activity levels among BMI classifications.

A limitation of this study was the use of self-reported survey data. Although validated survey components were used, many adolescents experience recall bias, response bias, and underreporting of total energy intake which is known to occur in the adolescent population [53]. Strengths of this study include the large sample size, the use of validated questionnaires to assess behaviours, and the web-based methodology which facilitated access to a large number of students over a large geographic area. The survey also provided anonymity and privacy which have been shown to be important determinants of adolescents' decision to report honest answers [54]. Further, students were not aware in advance what day the survey was to be completed, therefore reducing reactivity.

5. Conclusions

In conclusion, this study examined the overweight and obesity status of Alberta adolescents and the associations between BMI classification and lifestyle behaviours including nutrient intakes, meal behaviours, and levels of physical activity using a web-based survey. Web-SPAN was a time- and cost-effective method that was used to assess health behaviours of adolescents throughout a wide geographic area, including hard-to-reach areas. Significant differences in intake, meal behaviours, and physical activity levels existed between BMI classifications. This research supports the need to target suboptimal behaviours such as high calorie beverage consumption, total fat intake, breakfast skipping, and low levels of physical activity in order to promote healthy weights in the adolescent population. Because behaviours established during adolescence have been shown to track into adulthood, it is important to target these behaviours during early adolescence. In Alberta, vending machines have been removed from many schools, and daily physical activity is mandatory in grades 1–9; however, this research supports the need to focus on older adolescents, including those in high school (grades 10 through 12). Additional nutrition education in schools may also help target suboptimal nutritional intakes such as high intakes of total fat and low intakes of fibre, by educating students on the importance of a healthy diet. Thus, priorities that aim to improve the whole school environment such as comprehensive school health which includes school nutrition policies, removal of vending machines, and mandatory physical activity may help to improve overall weight status in Alberta adolescents. Further, because diet quality was poor among all Alberta adolescents, regardless of weight status, priorities should be developed that target students in all grade levels in order to improve the overall health and well-being of all adolescents.

Conflict of Interests

The authors declare that they have no conflict of interests.

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