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Weight, Lifestyle, and Health during Pregnancy and Beyond

Guest Editors: Hora Soltani, Debbie Smith, and Ellinor Olander

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Editorial

Weight, Lifestyle, and Health during Pregnancy and Beyond

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Healthy weight and healthy lifestyle behaviours are considered as essential prerequisites for a successful pregnancy. The importance of maternal lifestyle including nutrition and physical activity in relation to the short- and long-term birth outcomes is increasingly featured in the literature [1–3]. Recently, more attention has been given to excessive gestational weight gain and obesity as they are shown to significantly increase risks of complications during pregnancy and birth as well as elevating the risk of obesity in the offspring [4, 5].

While many western countries are mainly facing the challenge of obesity, most developing countries suffer from a dichotomy of ill health, resulting from both undernutrition and a rising trend in obesity affecting mothers and their babies [6]. There is a growing appreciation of interventions including elements of health psychology and behaviour change techniques (BCTs) in supporting health professionals to guide mothers in adapting a healthy lifestyle. These are also used to inform and motivate mothers to improve lifestyle during pregnancy to achieve healthier birth outcomes.

This special issue includes 10 articles from various parts of the world, presenting research findings related to gestational weight management and behaviour change during and after pregnancy.

Five articles focused on gestational weight management. One study highlighted the relationship between first-trimester weight gain and overall gestational weight gain (GWG) as well as showing the impact of racial differences so that Latina women gained more weight during pregnancy than their White counterparts in the United States of America. This could offer interesting insights for developing GWG interventions sensitive to the needs of women in different BMI categories and ethnic backgrounds. Another study, using a qualitative approach, explored barriers to appropriate GWG and suggested a lack of sufficient knowledge about pregnancy weight gain goals and family pressures for "eating for two" as major obstacles in maintaining a healthy weight gain during pregnancy.

The other two studies in this category assessed attitudes and experiences towards weighing during pregnancy from women's and clinicians' perspectives. The former reported that majority of women did not express any objection to being weighed during pregnancy but they indicated that there is a state of confusion and distrust with antenatal weight management interactions. The latter article suggested that while many clinicians support routine weighing during pregnancy, there are certain barriers such as inadequacy in systems and resources and lack of sufficient evidence in benefits of routine weighing which should be considered before its implementation. The last study in this category analysed the existing literature and highlighted the importance of effective BCTs in achieving healthy dietary behaviours during pregnancy. This study showed that although the reporting on the use of BCTs is very poor in the existing literature, the most commonly used BCTs in support of gestational weight management in trials with some evidence of effectiveness include "feedback and monitoring," "shaping knowledge," and "goals and planning." Taken together, these five articles make important suggestions for future intervention development.

Related to the articles on gestational weight management were two articles on maternal obesity. Firstly, the association between neighbourhood poverty level at menarche and prepregnancy obesity for African American women was explored. Prepregnancy obesity was found to be higher in those women who had their first period when living in a neighbourhood where a large number of people lived below the federal poverty level. This study highlights the need to take a public health approach to maternal obesity and to look at women's lifespan and not just their pregnancy.

Secondly, maternal obesity is associated with higher risks of gestational diabetes mellitus (GDM), but how GDM is best diagnosed is currently debated. One included study examines how two different criteria may affect GDM prevalence. They audited the prevalence of Australian women with GDM using the International Association of Diabetes and Pregnancy Study Groups (IADPSG 2010) criteria compared to the Australian Diabetes in Pregnancy Society (ADIPS 1991). Results showed that 3.4–3.5% of women were diagnosed with GDM, with no difference between the two criteria.

Lastly, three articles focused on lifestyle behaviours during and after pregnancy. One study examined dietary habits in American pregnant women. Results suggested that only one in five women consume fish, potentially missing out on omega-3 which may benefit the mother and the foetus. Dietary behaviours in pregnancy and after birth were examined by ethnicity of the mother in another American study which found that fast food (associated with high saturated fat and salt intake) was eaten more frequently by Black women than White and Hispanic women in this study. These two studies together provide information for future intervention development regarding healthy eating in pregnancy.

Although there are health benefits to postnatal physical activity, women often struggle to regain fitness after birth and may not engage in physical activity. One of the included studies reports on the secondary outcome measures of a postnatal physical activity intervention designed using health psychology theory (Transtheoretical Model) and behaviour change techniques (including goal setting). No impact was found on women's body composition and well-being, and the authors report the need for further research in the area.

In summary, we believe the studies presented in this special issue make an important addition to what is known about healthy weight and lifestyle behaviours during and after pregnancy. Collectively, the findings show the need to take a public health approach and view the impact of women's weight and lifestyle through their circumstances, including sociocultural and demographic factors such as neighbourhood poverty and ethnicity. Likewise, some included articles show the need for interventions to be targeted at individual groups to enhance their implementation success and effectiveness.

Hora Soltani
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Research Article

Antenatal Weight Management: Women's Experiences, Behaviours, and Expectations of Weighing in Early Pregnancy

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The current emphasis on obstetric risk management helps to frame gestational weight gain as problematic and encourages intervention by healthcare professionals. However pregnant women have reported confusion, distrust, and negative effects associated with antenatal weight management interactions. The MAGIC study (MAnaging weiGht In pregnanCy) sought to examine women's self-reported experiences of usual-care antenatal weight management in early pregnancy and consider these alongside weight monitoring behaviours and future expectations. 193 women (18 yrs+) were recruited from routine antenatal clinics at the Nottingham University Hospital NHS Trust. Self-reported gestation was 10–27 weeks, with 41.5% ($n = 80$) between 12 and 14 and 43.0% ($n = 83$) between 20 and 22 weeks. At recruitment 50.3% of participants ($n = 97$) could be classified as overweight or obese. 69.4% of highest weight women ($\geq 30\,\mathrm{kg/m^2}$) did not report receiving advice about weight, although they were significantly more likely compared to women with BMI $< 30\,\mathrm{kg/m^2}$. The majority of women (regardless of BMI) did not express any barriers to being weighed and 40.8% reported weighing themselves at home. Women across the BMI categories expressed a desire for more engagement from healthcare professionals on the issue of bodyweight. Women are clearly not being served appropriately in the current situation which simultaneously problematizes and fails to offer constructive dialogue.

1. Introduction

The antenatal period is often considered to be an important opportunity for health promotion and guidance, offering the so-called "teachable moments" [1]. Usual antenatal care associated with normal pregnancy puts women into greater contact with health professionals [2], and it is thought that responsibility for their developing baby can be an important motivator for behaviour change [1]. Pregnancy-related physical changes can also be said to cause a renegotiation of women's identity towards functionality and mothering [3], explaining why women can become more perceptive to health education [4].

In the context of maternal obesity, the UK's National Institute of Health and Care Excellence (NICE) recommends that the main focus of weight loss lies in the periconceptual period and that during pregnancy a woman should receive advice on healthy lifestyles and weight *management* [5]. Weight gain during pregnancy and changes in shape can be considered both expected and healthy [6], and NICE does not recommend weight loss during pregnancy as it may pose a risk by impairing foetal nutrition [5]. However, the UK does not have any formal, evidence-based recommendations for amount of gestational weight gain, although a guidance range of 10–12.5 kg (22–26 lbs) is used by NHS England [7] and has been recommended by the Department of Health in the past [8]. In contrast the USA has specific recommendations for weight gain for different BMI groupings published in the Institute of Medicine's "Weight Gain During Pregnancy: Reexamining the Guidelines" [9]. Women with a BMI of 20–25 $\mathrm{kg/m^2}$ are advised to gain 11–16 kg during pregnancy, whereas women with obesity are recommended to limit weight gain to no more than 9 kg. Since the late 1990s regular weighing has not been encouraged in the UK [10] and the current NICE [5] advises weighing women only at booking (usually ~10 weeks of gestation), while a joint guideline from the Centre for Maternal and Child Enquires and the Royal College of Obstetrics and Gynaecology recommended follow-up weighing in the 3rd trimester only if the women has a BMI that can be classified as obese at booking [11]. Despite recent evidence that pregnant women with BMI 18–29.9 kg/m^2 found regular weighing to be acceptable and useful [12] and the observation that monitoring can be reassuring [13], there remain fears that this practice would draw (negative) attention to the body, fuelling body image problems [14], particularly among those with internalised weight stigma.

There is also a lack of detailed, evidence-based guidance for clinicians on *how* to achieve appropriate weight gain. NICE [5] recommends that practitioners adopt a patient-centred approach, asking women if they would like advice about their weight and if so when they would like to receive it. This assumes that weight and weight gain have already been defined by the practitioner and women as a topic in need of discussion, but no guidance is given as to how—or indeed whether—the practitioner should take responsibility for raising the issue.

This lack of guidance is positioned within a society that has a significant pro-thin bias [15] and substantial anti-fat attitudes [16]. Women may be increasingly concerned about weight gain during pregnancy [17] and aware of the health risks associated with higher weights [18], but this can be opposed by the general acceptance of the inevitability of gestational weight gain (as opposed to weight gain outside of pregnancy) which temporarily exempts women from adherence to ideal [3]. Taken together it is, therefore, not surprising that there is confusion, contradiction, distrust, and negative effects associated with antenatal weight management interactions—both on the part of practitioners and on pregnant women [19]—along with ambivalence among midwives who are considering both women-centeredness and risk management as priorities [20].

The current study—the MAnaging weiGht In pregnanCy (MAGIC) study—sought to examine women's experiences of routine antenatal weight management provision in Nottingham, where the prevalence of obesity in pregnant women is 20% higher compared to England as a whole [21, personal communication]. In addition to giving a perspective on local needs, this observational study extends previous research by recruiting a cohort of women in early pregnancy and collecting follow-up data (until 12 months postpartum) on a wide range of biological, psychological, social, and behavioural factors. This allows an examination of an objective weight measurement (at baseline) as a dynamic variable subject to individual, ongoing appraisal. It also allows consideration of how advice on weight is positioned alongside advice on diet and physical activity, as well as assessments of dietary and physical activity behaviour, through the whole antenatal and postnatal period. The current analysis uses quantitative and qualitative data collected at recruitment (baseline) only and aims to describe the sample's experiences, behaviours, and expectations of antenatal weight management in early pregnancy.

2. Materials and Methods

2.1. Ethical Approval. This study was approved by the NHS Health Research Authority (NRES Committee East Midlands) and Nottingham University Hospitals NHS Trust, Research and Innovation Department (12/EM/0267).

2.2. Sample and Recruitment. Women were recruited from the antenatal clinic at Queens Medical Centre (QMC, Nottingham University Hospitals NHS Trust) while waiting for either their "dating scan" (an ultrasound scan, usually between 10 weeks 0 days and 13 weeks 6 days, to determine gestational age) or their "18–20-week anomaly scan" (ultrasound screening for structural anomalies, normally between 18 weeks 0 days and 20 weeks 6 days), both of which are routine appointments for all women according to NICE antenatal care pathway [2]. Women aged 18 years or over and of any sociodemographic background, bodyweight, and parity were approached by a researcher and provided with information about the study. Once they had read the information and if they agreed to take part, written consent was obtained. No incentive was offered.

2.3. Measures. Participants completed a paper-based questionnaire collecting data on a number of social, physiological, psychological, and behavioural measures. The variables used in the current analysis were as follows. (1) Sociodemographics: participants self-reported their age, ethnicity, gestation and number of embryos of current pregnancy, and number of other children. In addition, participants self-reported their own and partner's (if applicable) occupation, which were coded using the Standard Occupation Classification 2010 and then classified using the National Statistics Socioeconomic Classification (rebased on SOC2010; NS-SEC) [22]. To assess the socioeconomic status of the household, the highest reported NS-SEC score was taken as the Household Reference Point. (2) Anthropometrics: measurements of weight and height were taken by trained researchers on calibrated equipment (Leicester Height Measure, Marsden, UK, and bathroom scales, Salter, UK). Body Mass Index (BMI) was calculated using the standard formula (kg/m^2) and classified using the World Health Organization's criteria (underweight <18 kg/m^2, recommended weight 18–24.9 kg/m^2, overweight 25–29.9 kg/m^2, and obese ≥30 kg/m^2) [23]. Participants were also asked to self-report their prepregnancy weight in stones and pounds or in kilogrammes and describe how this prepregnancy weight was measured with the options "bathroom scales," "measured on scales by a midwife, by GP, and at a hospital appointment," "I have guessed my weight," and "other." (3) Weight monitoring behaviour and advice: participants were asked to report whether they had been weighed and by which healthcare professional during their current pregnancy and whether they had received specific advice about their weight following being weighed. Open questions were asked to women to describe the advice received following being weighed and how they felt about being weighed and any subsequent advice. Participants also responded to the question "which statement best describes what you were doing at the moment?" with the options "trying to lose weight," "trying to keep my weight at the same level," "not trying to do anything about my weight," and "trying to put on weight." (4) Current shape concern and antenatal weight change expectations: shape concern was assessed using 7 items from the shape concern subscale of the Eating Disorders Examination Questionnaire Version EDE-Q [24]. The item "have you felt fat?" was omitted due to its multidimensionality and value-laden terminology. A summative score was calculated using the mean of all 7 items; scores ranged 0–6 with higher scores indicating more shape concern. Cronbach's alpha for the 7 items in the current sample was 0.91, indicating internal consistency [25]. Participants were also asked whether they expected their weight to change and if so in what direction and by how much. (5) Awareness of guidance and sources of information: participants were asked whether they were aware of the Department of Health's guidance around weight gain and if so what this was. Participants reported what they perceived to be the main sources of information around bodyweight, diet, and exercise, and an open question was asked to women to describe what they thought about sources of information available.

2.4. Data Analysis. Quantitative data were analysed using SPSS version 22 (SPSS Inc., Chicago, IL, USA). Data entry was conducted by three members of the research team and all data entry was double-checked by another member of the team. The dataset was inspected for univariate outliers and missing data. Normality of continuous variables was assessed using the Kolmogorov–Smirnov test, and appropriate parametric and nonparametric statistics were then used to describe the sample. Chi-squared and Kruskal-Wallis tests were used to investigate the relationship between weight classification at recruitment and receiving advice and shape concerns, respectively. These were followed by *post hoc* 2×2 chi-squared tests and Mann-Whitney U tests as appropriate. The relationship between shape concerns and amount of weight women expected to gain during pregnancy was analysed using Spearman's rank correlation. Qualitative data from open questions were subjected to an inductive, descriptive content analysis [26].

3. Results

3.1. Sociodemographics. The research team approached 786 women in clinic and 360 consented to participate, were weighed and measured, and took the study materials home with them. Questionnaires were returned by 193 women and these women were considered to be recruited onto the study. At recruitment the participants' age was normally distributed with a mean of 32.8 years (SD 5.2 yrs, min 18.9 yrs, and max 47.1 yrs). 86% (n = 166) of the sample self-identified with a white ethnicity, 94.6% (n = 181) were living in a household with at least the equivalent of one full-time salary, and 79.6% (n = 121) were living in a household with a Household Reference Point of 1-2 (data were missing on ethnicity and occupation for 4 and 2 participants, resp.).

Participants' self-reported gestation was between 10 and 27 weeks with 41.5% (n = 80) participants in weeks 12–14 and 43.0% (n = 83) in weeks 20–22. The majority were expecting a singleton (n = 177, 91.7%). 43.5% (n = 84) of the sample were primiparous, 40.9% (n = 79) had one child, and 15.5% (n = 30) had two or three children.

3.2. Anthropometrics. At recruitment participants' Body Mass Index (BMI) had a non-Gaussian distribution with a median of 25.1 kg/m^2 (IQR 6.5 kg/m^2, min 17.5 kg/m^2, and max 53.5 kg/m^2), and 50.3% (n = 97) of the sample could be classified as overweight or obese (Table 1). There were no significant differences in terms of recruitment BMI between participants and those 167 women consented but did not return the study materials (median 25.6 kg/m^2; IQR 7.4 kg/m^2, min 16.4 kg/m^2, and max 47.6 kg/m^2). Self-reported prepregnancy weights were available for 168 women and had a median of 22.8 kg/m^2 (IQR 5.5 kg/m^2, min 15.9 kg/m^2, and max 51.3 kg/m^2). Women were most likely to take measurements using bathroom scales (66.7%, n = 112) while 23.2% (n = 39) were based on measurements taken by a healthcare professional. Women had, on average, gained 0.26 kg/wk (IQR 0.34 kg/wk, min −1.05 kg/wk, and max 9.83 kg/wk) since conception.

Among the 168 women who had complete data on both variables, 54 self-reported a prepregnancy weight that could be classified as overweight or obese using measurements taken at recruitment (Table 1). However, 26 of the 114 women who self-reported a prepregnancy weight that could be classified as underweight or recommended weight were classified as overweight or obese using measurements taken at recruitment. Further analysis revealed that 20 of these 26 women were recruited at gestation 20–22 weeks (76.9%) and the remainder were recruited between 12 and 19 weeks.

3.3. Weight Monitoring Behaviour and Advice. 95.3% (n = 184) of women reported having been weighed by a healthcare professional during their current pregnancy, most commonly a midwife (n = 181). 29 of these 184 women (15.8%) reported that they had received specific advice about their weight (Table 2). There was a significant association between receiving advice and weight classification at recruitment ($\chi^2_{(2)}$ = 9.57, $p < 0.001$; the one woman with BMI < 18 kg/m^2 was removed from this analysis due to insufficient cell count). Women who could be classified as obese were significantly more likely to receive specific advice about their weight after being weighed, compared to women who could be classified as having a recommended weight ($\chi^2_{(1)}$ = 9.04, $p < 0.01$) or overweight ($\chi^2_{(1)}$ = 4.20, $p < 0.05$) at recruitment. Content analysis of the advice reported by participants who had received comments about weight from health professionals covered a range of themes, as did women's feelings about being weighed (Table 2).

40.4% (n = 78) of participants reported that they had weighed themselves during their current pregnancy, and the majority of these weighed themselves weekly or fortnightly (57.7%, n = 45). The majority of women reported that they were not trying to do anything about their weight at the moment (n = 142, 73.6%) while 19.2% (n = 37) were trying to keep the same weight. Women with a BMI at recruitment that could be classified as overweight or obese were significantly

Table 1: Body Mass Index (BMI) classifications of participants calculated using weight measured at recruitment and self-reported prepregnancy weight.

	BMI* calculated using weight measured at recruitment ($n = 193$)	BMI* calculated using self-reported prepregnancy weight ($n = 168$)
BMI < 18 kg/m^2	2 (1%)	7 (4.2%)
BMI 18–24.9 kg/m^2	94 (48.7%)	107 (63.7%)
BMI 25–29.9 kg/m^2	61 (31.6%)	33 (19.6%)
BMI ≥ 30 kg/m^2	36 (18.7%)	21 (12.5%)

*Both BMI calculations used height assessed at recruitment.

Table 2: Weight advice received by participants after being weighed, by BMI classification at recruitment.

	Weight advice received ($n = 29$)	Themes of feelings about being weighed and advice received* ($n = 26$)	Themes of weight advice received after being weighed* ($n = 27$)
BMI < 18 kg/m^2	1 (3.4%)	Embarrassed ($n = 1$)	Advised that BMI required consultant-led care ($n = 1$)
BMI 18–24.9 kg/m^2	13 (44.8%)	Grateful/happy ($n = 3$) Fine/did not mind ($n = 7$) Embarrassed ($n = 1$)	Advised that BMI is "low" ($n = 3$) Advised that BMI is "healthy" ($n = 3$) Recommended healthy diet ($n = 4$) Emphasised need for weight gain ($n = 2$) Emphasised need for monitoring ($n = 1$)
BMI 25–29.9 kg/m^2	4 (13.8%)	Very sensible ($n = 1$) Fine ($n = 1$)	Advised not to lose weight but maintain ($n = 1$) Recommended avoidance of "sugary & fatty" foods ($n = 1$)
BMI ≥ 30 kg/m^2	11 (37.9%)	Fine/did not mind ($n = 4$) Grateful/happy ($n = 4$) Shocked but reassured ($n = 1$) Sceptical of advice ($n = 1$)	Advised to maintain weight/avoid weight gain ($n = 3$) Recommended healthy diet ($n = 2$) Recommended exercise ($n = 1$) Recommended commercial weight loss organization ($n = 2$)

*Themes are not mutually exclusive, and some responses could not be coded as they did not provide a description of the specific advice received.

more likely to be trying to keep the same weight, compared to women with a BMI < 25 kg/m^2 ($\chi^2_{(1)} = 6.65$, $p < 0.05$). The two women who reported trying to lose weight both had a BMI at recruitment that could be classified as obese.

3.4. Current Shape Concern and Antenatal Weight Change Expectations. There was a significant association between BMI classification at recruitment and shape concerns ($\chi^2_{(2)} = 19.71$, $p < 0.001$). Women with a BMI at recruitment which could be classified as a recommended weight had significantly lower shape concern scores than women with a BMI which could be classified as overweight ($Z = -3.35$, $p < 0.01$) or obese ($Z = -3.85$, $p < 0.001$). There were no significant differences between women with a BMI which could be classified as overweight and obese (Table 3).

None of the women reported that they expected to lose weight during pregnancy while 1.6% ($n = 3$) expected no change in their weight, and 5.7% ($n = 11$) reported that they had no idea what to expect. 50.3% ($n = 97$) reported that they were expecting to gain weight but were not able quantify it, while 42.5% ($n = 82$) of the sample were able to quantify their expected weight gain (median 10.1 kg, SD 4.58 kg, min 2.27 kg, and max 22.23 kg; excluding one woman with multiple pregnancy who provided that data on this variable did not significantly alter the distribution). There was no significant association between those women who expected no weight change, weight gain (but not quantified), and quantified weight gain and BMI classification at recruitment. There was small, significant, positive correlation between shape concerns and amount of weight women expected to gain during pregnancy ($r_s = 0.34$, $p < 0.01$, and $n = 82$).

Table 3: Shape concern subscale scores by BMI classification at recruitment.

	Median	Interquartile range	Min	Max
BMI 18–24.9 kg/m^2	0.86	1.29	0.14	5.71
BMI ≥ 25–29.9 kg/m^2	1.71	1.86	0.14	5.00
BMI ≥ 30 kg/m^2	2.14	2.29	0.14	4.71

3.5. Awareness of Guidance and Sources of Information. 39.4% ($n = 76$) of the sample reported that they were aware of guidance around weight change during pregnancy, and 59 women reported that guidance recommended a weight gain of 11.3 kg (IQR 4.2 kg, min 2 kg, and max 19.1 kg). 80.8% of the sample reported that healthcare professionals were main sources of information, 79.3% print and online information, and 37.8% family and friends. Women's responses to the open question about what they thought about sources of information available ($n = 137$) were often lengthy (max 157 words). Women across the BMI categories were more likely to report that sources of information were adequate or good rather than insufficient, and the thematic content analysis revealed three themes: general adequacy, healthcare professionals' role, and lay sources (Table 4).

4. Discussion

This study reports the broad range of women's experiences, behaviours, and expectations of routine antenatal weight management provision in Nottingham. In line with the recommendations of the NICE [5] guidelines and similar to a small UK study by Brown and Avery [27], most women in the sample reported having been weighed in early pregnancy and by a midwife. It is, however, notable that a low proportion of women weighed reported having received advice after these measurements—even less than that observed by McDonald et al. [28]. Presumably practitioners are using the information to refer higher weight women to consultant-led care, and from an ethical perspective women should be aware of why these measurements are being taken and how it will be used to plan their care. However, NICE also recommended that women with a BMI over 30 should be referred to a dietitian or appropriately trained professional to receive personalised advice on healthy eating and physical activity. Although significantly more women of a higher weight received advice, excessive gestational weight gain can occur regardless of prepregnancy BMI classification. It has been suggested that midwives are optimally placed to deliver advice on gestational weight gain [29] and that as they deal with sensitive issues and women's anxieties as a core part of their role, they are very well equipped [12]. Indeed, NICE recommended discussion of how to achieve a healthy lifestyle during antenatal contacts for all pregnant women. However, other researches reveal that midwives fear offending and alienating women by discussing the issue early in the therapeutic relationship [30]. These are valid concerns due to the moralistic nature of weight, reports of stigma in antenatal settings [18, 30–32], and in the current sample women both of higher and lower weights were embarrassed. However, women in this sample who were weighed and received advice were generally not negative about the experience and more similar to the views expressed by women in research by Olander et al. [33]. The language employed by women in this sample could not be said to be overwhelmingly positive either—rather the tone was one of confirmation of something uncontroversial.

Taken together the majority of women in the sample (regardless of BMI) did not express any barriers to being weighed and as 40.8% reported weighing themselves at home on scales, there is some justification for providing women with an opportunity to take accurate measurements using reliable equipment under supervision. This phenomenon of self-monitoring has been reported elsewhere; for example, women who disengaged from an antenatal weight service cited confusion and disappointment about not being weighed regularly [34, 35] and reported self-monitoring in half of the sample of women which included those who exhibited both recommended and excess gestational weight gain. What is less clear are women's motivations for regular weighing. It is perhaps being used as a means to motivate behaviour as suggested by Daley et al. [12] but—due to the lack of agreed targets—it might also reflect women's scientific curiosity and fascination as to their new-found functionality [3]. This would explain the relatively low levels of shape concern seen in the sample, even among higher weight women. Tiggemann [36] describes that while body image might be a relatively stable construct, the importance vested in it is dynamic.

Considering the lack of dialogue between women in this sample and their practitioners, it is perhaps unsurprising that the majority are unable to recall the guideline expectations for weight gain used by NHS England and the Department of Health or what to expect during their own pregnancy beyond a sense that they will "gain weight." Those women who did have an expected weight gain that could be quantified varied widely but were, on average, consistent with 10–12.5 kg.

When asked about the advice generally available on weight, diet, and exercise, participants used more positive than negative comments. However, a deeper examination revealed several narratives. In line with previous work [18, 27, 32, 33, 35, 37], women did not feel that their weight or indeed diet and exercise were priorities for midwives and other healthcare professionals. In the current study practitioners detached from the subject by employing terminology such as "BMI" and actions such as "keep an eye on [your weight]." Women also reported that there were not ready opportunities to ask questions about "nonroutine" or "nonemergency" topics. This perhaps also accounts for the equal reliance on Internet sources as "main sources of information," despite the awareness of their limitations. Olander et al. [33], Arden et al. [31], and Brown and Avery [27] have also described how gaps in knowledge on weight can be filled using self-study.

For those who had accessed advice, there was frustration that it was too general, not personalised, and diet-focused. Women are not, therefore, perceiving the advice to be "practical and tailored" as recommended by NICE [5]. Similarly, Heslehurst et al. [38] described how dietary information was provided *ad hoc* and not linked to weight management, while Brown and Avery [27] report that many participants stated advice was brief and lacking in detail. Interestingly women of a higher weight reported that the advice they received was too idealistic and not supported by advice on process.

In contrast to those who want to be better informed, there are women who actively avoided information about weight, diet, and exercise. The issue of bodyweight was sometimes deemed to be not salient (at all or due to time at which it is received) and previously authors have reported women preferring to wait until after birth [34, 39]. Worryingly advice from practitioners was in some cases dismissed as unreliable and Arden et al. [31] also describe how women can lack trust in "official" advice. Others reported a wish to avoid potential negative emotions which once again speaks to the value-laden nature of bodyweight.

4.1. Strengths and Limitations. As with previous work in the UK (e.g., [31]), the current sample is not wholly representative of the population. It had twice the proportion of women from

Table 4: Participants' feelings about sources of information during pregnancy on weight, diet, and exercise, by BMI classification at recruitment.

Themes*	BMI < 18 kg/m^2 (n = 1)	BMI 18–24.9 kg/m^2 (n = 69)	BMI ≥ 25–29.9 kg/m^2 (n = 43)	BMI ≥ 30 kg/m^2 (n = 24)
General adequacy				
Generally fine/good/plenty		14 (20.3%)	11 (25.6%)	4 (16.7%)
Generally not sufficient		8 (11.6%)	4 (9.3%)	2 (8.3%)
Not salient in very early pregnancy	1		3 (7.0%)	
Not salient until postpartum				3 (12.5%)
Emphasis on diet, not weight			5 (11.6%)	
Too general/no guidelines		13 (18.8%)	4 (9.3%)	2 (8.3%)
Individualised advice preferred		6 (8.70%)		
To idealistic			1 (2.3%)	1 (4.2%)
No information on *how* to change			4 (9.3%)	1 (4.2%)
No information on *why* to change			2 (4.7%)	1 (4.2%)
Healthcare professionals role				
Do not appear concerned		3 (4.3%)	3 (7.0%)	1 (4.2%)
Information can be confusing/unreliable/conflicting			3 (7.0%)	3 (12.5%)
Have to ask/seek information		7 (10.1%)	6 (14.0%)	3 (12.5%)
More active engagement preferred		3 (4.3%)	1 (2.3%)	
Subject too personal for HCP		2 (2.90%)	2 (4.7%)	
Do not seek/avoid information		9 (13.0%)		4 (16.7%)
Lay sources				
Happy with information available via the Internet/apps/magazines/books		5 (7.2%)		
Information can be confusing/unreliable/conflicting		8 (11.6%)	1 (2.3%)	3 (12.5%)
NHS web resources good/reliable	1	8 (11.6%)	2 (4.7%)	
Better signposting required		1 (1.4%)		

*Themes are not mutually exclusive.

a household with an NS-SEC score of 1 or 2 compared to the census data for the East Midlands (<65 yrs) [40], and the average age of mothers (32.8 yrs) was also higher than the 30.0 years reported in the Office for National Statistics data [41]. However, the majority of women were recruited at 12–14 weeks of gestation and 20–22 weeks of gestation which reflects the function of the clinics recruited from (namely, the 10–12-week dating scan and 18–20-week anomaly scan), and higher weight women were represented at a level similar to that from national statistics (i.e., 50% overweight or obese at the start of pregnancy [41]). It is interesting to observe that higher weight women were not systematically deterred from participation due to the objective weight and height measurements taken by the researchers, but when taking into account participants' low body shape concerns it may be that women (across the BMI categories) with body image and weight concerns may be underrepresented. This limits the generalisability of the findings and it would be inappropriate to conclude that weighing is generally acceptable across the socioeconomic spectrum and in various ethnic identities. However, the findings do reveal an unmet need for engagement on the issue of bodyweight among some women across the BMI categories.

The uses of BMI categories to identify obesity, indicate risk, and decide upon care are controversial but are widely used in research and clinical practice. Measurements can be taken throughout pregnancy, from prepregnancy [42, 43] to the 3rd trimester [44]. The mismatch between BMI figures in Table 1, calculated using both the self-reported prepregnancy and measured recruitment weights, is possibly due to misreporting and/or gestational weight gain, and it is not possible with the current study design to separate out these potential influences.

5. Conclusion

The positioning of prepregnancy bodyweight and gestational weight gain as *problematic* in the national consciousness has for many years been encapsulated in guidelines such Department of Health, National Institute of Health and Care Excellence, and the Royal College of Obstetrics and Gynaecology. Indeed, the focus has intensified of late, most recently with comments from the Chief Medical Officer [45] who described obesity as the "biggest threat to women's health" and the subsequent media coverage. It is, therefore, unsurprising that the current study revealed a desire for engagement on the issue of bodyweight among some women across the BMI categories. However, the lack of specific guidelines, the lack of available support around process, and the reluctance of some practitioners to engage in this complex and value-laden topic are all barriers.

Women are clearly not being served appropriately in the current situation which simultaneously problematizes and fails to offer solutions. Given the weight of medical opinion that bodyweight should be an issue to be addressed during pregnancy, future work needs to move away from the current obstetric risk management framework to an empowerment approach [6] and build the capacity of practitioners to deliver individualised weight-related advice without prejudice. Arguably the antenatal period offers a unique opportunity to counter the current negative reductionist dialogue around weight gain with one that emphasises the body's capabilities. Specific behavioural guidelines and positive framed advice could be developed and applied in a flexible, nonjudgmental manner to offer reassurance and empowerment.

Competing Interests

The authors declare that they have no competing interests.

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Research Article

Predictors of Gestational Weight Gain among White and Latina Women and Associations with Birth Weight

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This study examined racial/ethnic differences in gestational weight gain (GWG) predictors and association of first-trimester GWG to overall GWG among 271 White women and 300 Latina women. Rates of within-guideline GWG were higher among Latinas than among Whites (28.7% versus 24.4%, $p < 0.016$). Adjusted odds of above-guideline GWG were higher among prepregnancy overweight (OR = 3.4, CI = 1.8–6.5) and obese (OR = 4.5, CI = 2.3–9.0) women than among healthy weight women and among women with above-guideline first-trimester GWG than among those with within-guideline first-trimester GWG (OR = 4.9, CI = 2.8–8.8). GWG was positively associated with neonate birth size ($p < 0.001$). Interventions targeting prepregnancy overweight or obese women and those with excessive first-trimester GWG are needed.

1. Introduction

Significant evidence ties gestational weight gain (GWG) to short- and long-term maternal and infant outcomes. To optimize maternal and child health, the Institute of Medicine (IOM) provides guidelines for GWG based on prepregnancy body mass index (BMI) [1]. Greater GWG is recommended for women with prepregnancy BMIs in the underweight (28–40 pounds (lbs), 12.7–18.1 kg) or healthy weight (25–35 lbs, 11.3–15.9 kg) range, with less GWG recommended for prepregnancy overweight (15–25 lbs, 6.8–11.3 kg) and obese (11–20 lbs, 5.0–9.1 kg) women. However, only 22 to 40% of women attain GWG within the recommended ranges [2–8], and women of lower socioeconomic status and racial/ethnic minority women have lower adherence to GWG guidelines [5, 9–11]. Among Latina women and depending on national origin, estimates of excessive GWG range from 36 to 51%, whereas estimates of insufficient GWG range from 17 to 30% [7, 9, 10, 12, 13].

Socioeconomic and racial/ethnic disparities in achieving recommended GWG are further compounded by higher pregnancy rates and greater odds of adverse birth-related outcomes among socioeconomically disadvantaged and racial/ethnic minority populations than their more affluent and White counterparts. The pregnancy rate of Latina women in the US is estimated to be two-thirds higher than that of non-Latino Whites [14]. Within the Latina population, nearly half of Caribbean Latina women experience GWG above IOM guidelines [9], and Puerto Rican Latinas are among women with the highest rates of low birth weight neonates [15] and preterm births [16], both predictors of infant mortality [17]. However, little is known about why adherence to guidelines is low among this population. Identifying and understanding factors driving racial/ethnic differences in

GWG are a priority to target maternal and child health disparities in this growing and at-risk population.

Given the numerous adverse health consequences of excessive and insufficient GWG for the mother and the offspring [1, 4, 18–21], understanding the risk factors for low adherence to IOM-recommended GWG and intervening in at-risk groups are of utmost importance. In targeting interventions, timing of GWG may be important. However, little is known about the influence of early GWG (e.g., first trimester) on overall GWG and other maternal and infant outcomes. A prospective study of a predominantly White female sample indicated that maternal weight change in the first trimester was a stronger predictor of birth weight than weight change in the second or third trimester [22]. However, research on early GWG among Latina women is lacking. The timing and extent of GWG may also be an important determinant of birth weight as well as other maternal and prenatal outcomes; thus, early identification of women who are at risk of excessive or inadequate GWG may be critical to guide the timing and content for intervention delivery to maximize maternal and prenatal health and reduce health disparities.

To address gaps in the literature, this study aimed to examine differences in predictors of gestational weight gain (GWG), assess the association of first-trimester GWG to overall GWG between non-Latina White and Latina women, and examine GWG status with birth outcomes. We hypothesized that women who were overweight or obese before pregnancy would have higher odds of GWG outside of IOM recommendations and that first-trimester GWG status (below, within, or above guideline) would positively correlate with overall GWG.

2. Methods

2.1. Participants and Setting. The study's targeted population included non-Latina White and Latina women who received prenatal care from private providers and hospital clinics (i.e., a resident clinic and a midwifery clinic). The study was conducted at Baystate Medical Center, a large tertiary care facility in western Massachusetts with an average of 4,300 deliveries each year, approximately 57% of them to Latina women (primarily of Puerto Rican origin).

2.2. Procedures. Identification of participants included two screening steps. First, electronic medical record database searches were performed for a retrospective cohort of women who had live deliveries (preterm or full-term) at the medical center from September 1, 2005, to August 31, 2006. Women with multifetal pregnancies, unknown ethnicity, and primary language other than English or Spanish were excluded. A total of 3,966 (of 4,300) patient records met these criteria. Based on estimates of adherence to IOM guidelines in other samples, a sample size of at least 400 women was required for adequate power analysis for the current study. Thus, the second screening step consisted of randomly selecting one quarter ($n = 1{,}016$) of eligible patient records, stratified by ethnicity (non-Latina White and Latina) and site of prenatal care (hospital clinics and private providers), for additional participant eligibility screening via paper medical chart review. A total of 445 records were excluded. Reasons for exclusion included missing data on prepregnancy weight ($n = 226$) or height ($n = 4$), missing dates of prenatal measurements ($n = 138$), no documentation of prenatal visits in the first trimester of pregnancy ($n = 296$), maternal history of gastric bypass ($n = 2$), or maternal diagnosis of pregestational diabetes ($n = 31$). Of excluded records, 60% were excluded for one criterion and 40% were excluded for two or more criteria.

A scannable medical record abstraction form was developed by the research team. The form included fields for recording participant demographics (date of birth, race/ethnicity, primary language, marital status, insurance type, parity, and employment status), psychiatric history (i.e., documented psychiatric diagnosis or use of psychiatric medication), height, and dates and measured weights at each prenatal visit. Three research assistants were trained in the process of data abstraction from paper medical records until 100% interrater reliability was achieved. Data from completed and cross-checked abstraction forms were scanned and were uploaded into a SAS database.

Data abstraction was performed from 2007 to 2008. During this time frame, revisions of IOM's GWG guidelines were anticipated and were available following data cleaning procedures and at the time of analyses. Thus, the investigative team decided *a priori* to utilize 2009 guidelines [1] in categorizing GWG measures (described below) with the goal of providing an estimate of likely nonadherence to new recommendations and associated outcomes. Additionally, the 2009 guidelines did not differ greatly from former guidelines yet offered the benefit of a recommended range of gain for obese women in contrast to the previously stated "at least 15 pounds (6.8 kg)" without an upper bound [17]. All study protocols and procedures were approved by the Baystate Medical Center Institutional Review Board and the University of Massachusetts Medical School Institutional Review Board.

2.3. GWG Measures. Height and prepregnancy weight were obtained from prenatal forms in participants' medical records. Customarily, height is measured by obstetric provider office staff and prepregnancy weight is self-reported by pregnant women at their first prenatal appointment. Prepregnancy BMI was calculated as weight (kg)/height squared (in meters) and categorized as follows: underweight ($\text{BMI} < 18.5\,\text{kg/m}^2$); healthy weight ($18.5\,\text{kg/m}^2 \le \text{BMI} < 25\,\text{kg/m}^2$); overweight ($25\,\text{kg/m}^2 \le \text{BMI} < 30\,\text{kg/m}^2$); and obese ($30\,\text{kg/m}^2 \le \text{BMI}$) [17, 23].

Gestational weight measures were routinely obtained by clinical staff as part of standard obstetric care appointments, as is customary. At each visit, women are weighed and their weight is recorded in prenatal health records, along with gestational age. Each participant's GWG status was determined based on prepregnancy BMI, gestational age, and weight gain at the time of the weight measure. For each prepregnancy weight status category, IOM-recommended trajectories of weight gain were defined (1) in terms of minimum and maximum total weight gain at week 13 (end of first trimester) and (2) for subsequent weeks in terms of minimum and maximum weight gain per week. Thus, for each week of gestational age, a minimum and maximum recommended weight gain were calculated.

First-trimester GWG status was determined using the last weight measure recorded during the first trimester. GWG status in the first trimester was assessed by comparing first-trimester GWG (calculated by subtracting pregravid weight from weight at the last first-trimester prenatal visit) to the IOM-recommended GWG range for gestational age at the last first-trimester prenatal visit. Similarly, GWG status at delivery was determined using weight measured from the last recorded prenatal appointment and was assessed by comparing total GWG (calculated by subtracting pregravid weight from weight at the last prenatal visit prior to delivery) to the IOM-recommended GWG range for gestational age at the last prenatal visit (the average period between the last prenatal visit and delivery is estimated at 6.6 days) [24]. GWG status was categorized as follows: inadequate or "below" if weight gain for gestational age was below the lowest value of the recommended range; appropriate or "within" if weight gain for gestational age was between the recommended range lowest and highest values; and excessive or "above" if weight gain for gestational age was above the highest value of the recommended range.

2.4. Outcome Measures. Gestational age at delivery was calculated based on best dates for estimated date of confinement (EDC). EDC is determined as per clinician evaluation considering concordance of the last menstrual period and first-trimester ultrasound [25] and documented on the medical record based on clinical care standards. Pregnancies delivered at < 37 weeks were categorized as preterm and those delivered at ≥ 37 weeks were full term. Neonate birth weight recorded by nursing staff at the time of delivery was abstracted from the inpatient record. Neonates were categorized as small for gestational age (SGA) and large for gestational age (LGA) if birth weight was <10th and ≥90th percentile, respectively, of 1999-2000 US national reference data for singleton gestations, accounting for gestational age and gender [26, 27]. Regardless of gestational age, low birth weight (LBW) was defined as < 2,500 grams [28] and high birth weight (HBW) or macrosomia as ≥ 4,000 grams [26].

2.5. Statistical Analysis. Descriptive statistics of the study sample stratified by ethnicity were conducted using Chi-square tests or Fisher Exact tests for categorical variables and t-tests for continuous variables. Estimated means and standard errors for total GWG were computed for each ethnic group and by prepregnancy weight status category within ethnic group, adjusting for gestational age at the last prenatal visit. Unadjusted associations of GWG status (below, within, or above IOM-recommended range) with participant characteristics were estimated using contingency tables and Chi-square tests. Adjusted associations of GWG status with participant characteristics were estimated using multinomial logistic regression models (within GWG guidelines as the outcome reference category) to allow for the possibility of associations that violated the proportional odds assumption (e.g., a positive association with both above and below GWG guidelines).

Potential effect modification by ethnicity was examined by stratifying contingency tables of GWG status with participant characteristics by ethnicity and by including interaction terms of ethnicity with other predictors in logistic regression models. Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit Chi-square statistic [29]. Infant outcomes were compared by GWG status for the entire group and by ethnicity using contingency tables, Chi-square tests, and logistic regression. Supplemental analyses included conducting backward elimination in the logistic regression analyses to assess whether results were similar after omitting irrelevant or redundant predictors and performing sensitivity analysis comparing results based on the 1990 IOM GWG guidelines versus the 2009 IOM GWG guidelines.

3. Results

The final analytic sample included 571 participants (47% White and 53% Latina). The majority of participants were single (64%) and unemployed (53%) and had public health insurance (64%) (Table 1). Less than half (46%) of women had prepregnancy BMIs within the healthy weight range, a quarter were obese, and more than half (58%) exceeded GWG recommendations at the time of delivery. Compared to White women, Latina women were younger and more likely to be single and unemployed, have public insurance, and have higher parity (p values < 0.05). White women had higher prevalence of documented tobacco and alcohol use, were more likely to have a documented psychiatric history, and were more likely to deliver LGA neonates than Latina women (p values < 0.05). No other differences by ethnicity were observed. A comparison by prenatal care site revealed that women receiving care in hospital clinics were more likely to be younger, unmarried, unemployed, and nulliparous, have public insurance, have a psychiatric history, and have lower levels of education than those receiving care in private clinics (p values < 0.01).

Average GWG adjusted for gestational age at delivery was 36.3 lbs (SE = 0.92) (16.5 kg (SE = 0.42)) for White women and 32.4 lbs (SE = 0.88) (14.7 kg (SE = 0.36)) for Latina women ($p < 0.0001$). Average GWG by prepregnancy weight status category were as follows: 37.9 lbs (SE = 2.3) (17.48 kg (SE = 1.0)) for underweight participants; 36.7 lbs (SE = 0.9) (16.6 kg (SE = 0.4)) for healthy weight participants; 35.3 lbs (SE = 1.2) (35.3 kg (SE = 0.5)) for overweight participants; and 28.0 lbs (SE = 1.2) (12.7 kg (SE = 0.5)) for obese participants. Across prepregnancy weight status categories, adherence to IOM GWG recommendations was poor among both ethnic groups, with only 27% gaining within recommended ranges. Ethnic differences in GWG status at time of delivery for the overall sample were observed, with Latina women less likely to gain in excess than White women ($p = 0.016$) (Figure 1). Latina women were more likely to gain within the IOM-recommended range than White women across all prepregnancy weight status categories, with the exception of the underweight category (among underweight participants,

Table 1: Sample characteristics of overall study sample and by ethnicity ($N = 571$).

Sample characteristics	All women ($n = 571$)		White non-Latina ($n = 271$)		Latina ($n = 300$)		p value
	N	%	N	%	N	%	
	Mean	SD	Mean	SD	Mean	SD	
Demographic factors							
Age category, N (%)							
Age 15–19	127	22.24	39	14.39	88	29.33	<0.001
Age 20–24	155	27.15	64	23.62	91	30.33	
Age 25–29	133	23.29	67	24.72	66	22.00	
Age 30–34	100	17.51	62	22.88	38	12.67	
Age ≥ 35	56	9.81	39	14.39	17	5.67	
Mean (SD)	25.35	6.40	27.09	6.52	23.79	5.88	<0.001
Marital status, N (%)							
Divorced	8	1.41	6	2.21	2	0.67	<0.001
Married	199	35.04	129	47.60	70	23.57	
Single	361	63.56	136	50.18	225	75.76	
Employment at onset of pregnancy N (%)							
Employed	266	46.83	153	56.67	113	37.92	<0.001
Not employed	302	53.17	117	43.33	185	62.08	
Parity, N (%)							
0	233	42.75	114	44.53	119	41.18	0.003
1	160	29.36	86	33.59	74	25.61	
2	89	16.33	39	15.23	50	17.30	
3 or more	63	11.56	17	6.64	46	15.92	
Behavioral factors							
Alcohol use, N (%)							
No	449	78.91	193	71.22	256	85.91	<0.001
Yes, past	112	19.68	74	27.31	38	12.75	
Yes, this pregnancy	8	1.41	4	1.48	4	1.34	
Tobacco use, N (%)							
No	392	68.89	172	63.47	220	73.83	0.016
Yes, past	67	11.78	34	12.55	33	11.07	
Yes, this pregnancy	110	19.33	65	23.99	45	15.10	
Prepregnancy weight categories (body mass index range), N (%)							
Underweight (BMI ≤ 18.4)	33	5.78	16	5.90	17	5.67	
Normal weight (BMI 18.5–24.9)	260	45.53	133	49.08	127	42.33	0.315
Overweight (BMI 25.0–29.9)	138	24.17	64	23.62	74	24.67	
Obese (BMI ≥ 30.0)	140	24.52	58	21.40	82	27.33	
Prenatal care factors							
Week gestation at the 1st prenatal visit	10.57	3.07	10.53	2.72	10.61	3.36	0.760
Gestational age at the last visit	35.76	5.39	35.68	5.84	35.83	4.96	0.740
Number of prenatal visits	9.78	3.24	9.84	3.36	9.72	3.14	0.656
Gestational age at delivery	38.97	5.87	38.87	6.91	39.06	4.76	0.705
Prenatal care site, N (%)							
Private	272	47.64	137	50.55	135	45.00	0.185
Hospital clinic	299	52.36	134	49.45	165	55.00	

Table 1: Continued.

Sample characteristics	All women ($n = 571$)		White non-Latina ($n = 271$)		Latina ($n = 300$)		p value
	N	%	N	%	N	%	
	Mean	SD	Mean	SD	Mean	SD	
Insurance type, N (%)							
Commercial/private	201	35.39	139	51.29	62	20.88	<0.001
No insurance/unknown	4	0.70	4	1.48	0	0.00	
Public	363	63.91	128	47.23	235	79.12	
GWG status with respect to IOM guidelines							
GWG status at the last prenatal visit, N (%)							
Within guidelines	152	26.62	66	24.35	86	28.67	0.016
Below guidelines	90	15.76	33	12.18	57	19.00	
Above guidelines	329	57.62	172	63.47	157	52.33	
GWG status in the 1st trimester, N (%)							
Within guidelines	148	26.43	69	26.24	79	26.60	0.537
Above guidelines	256	45.71	126	47.91	130	43.77	
Below guidelines	156	27.86	68	25.86	88	29.63	
Psychiatric factors							
Psychiatric history, N (%)							
None	445	78.21	203	75.19	242	80.94	0.003
Anxiety	15	2.64	11	4.07	4	1.34	
Depression	86	15.11	38	14.07	48	16.05	
Other	23	4.04	18	6.67	5	1.67	
Psychiatric medications, N (%)							
No	539	94.40	251	92.62	288	96.00	0.080
Yes	32	5.60	20	7.38	12	4.00	
Pregnancy outcomes							
Length of pregnancy, N (%)							
Term delivery	504	88.73	244	90.71	260	86.96	0.158
Preterm delivery	64	11.27	25	9.29	39	13.04	
Birth weight parameters							
SGA	56	10.04	20	7.60	36	12.20	0.012
Normal GA	454	81.36	212	80.61	242	82.03	
LGA	48	8.60	31	11.79	17	5.76	
LBW (<2500 gr)	53	9.45	23	8.68	30	10.14	0.390
Normal BW	456	81.28	213	80.38	243	82.09	
HBW (>4000 gr)	52	9.27	29	10.94	23	7.77	

p values are from Chi-square and t-tests for ethnic differences.

White women were more likely to have GWG within recommended ranges than Latinas) (Figure 2).

Table 2 presents unadjusted associations between demographics, behavioral factors and psychiatric history, and GWG status. GWG status was significantly associated with ethnicity, employment status at pregnancy onset, prepregnancy BMI, and first-trimester GWG (p values < 0.05). In logistic regression models, no effect modification by ethnicity

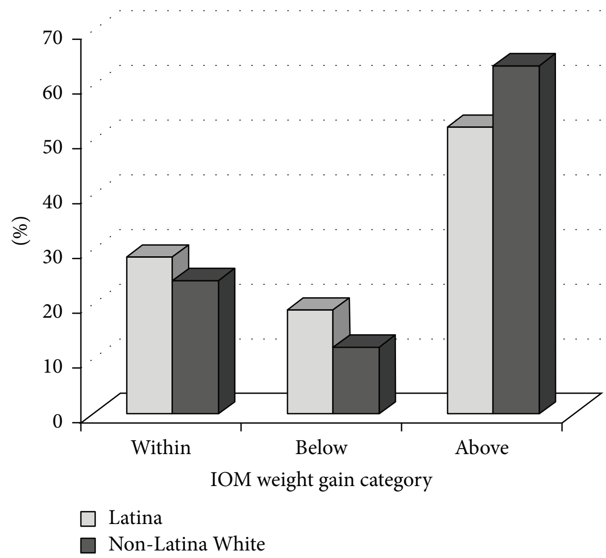

Figure 1: Gestational weight gain status among White non-Latina and Latina women.

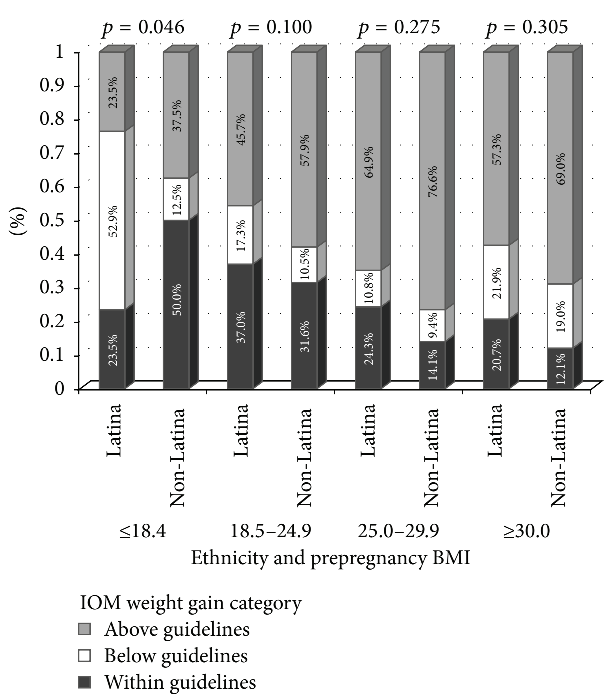

Figure 2: Gestational weight gain status by prepregnancy BMI for White non-Latina and Latina women.

was indicated (p values for interaction terms > 0.05); thus, results are presented for the entire sample. Multivariable logistic regression models estimating participant characteristics associated with GWG status at time of delivery (Table 3) indicated that odds of above-guideline GWG at time of delivery were greater among prepregnancy overweight and obese women compared to healthy weight women (OR = 3.4, CI = 1.8–6.5; OR = 4.5, CI = 2.3–9.0, resp.) and among those with first-trimester GWG above guidelines compared to those with GWG within guidelines (OR = 4.9, CI = 2.8–8.8). Odds of below-guideline GWG at time of delivery were greater among prepregnancy underweight and obese women compared to healthy weight (OR = 5.3, CI = 1.4–20.2; OR = 3.5, CI = 1.4–8.7, resp.) and among women with first-trimester GWG below guidelines compared to within-guideline GWG (OR = 3.0, CI = 1.3–6.8). Odds of below-guideline GWG were lower among women receiving care at hospital clinics compared to those receiving care from a private provider and among past smokers compared to never smokers (OR = 0.3, CI = 0.1–0.9; OR = 0.3, CI = 0.1–1.0, resp.).

A very small number of adverse events were observed within each ethnic group. Thus, Table 4 presents estimates of associations between GWG status and length of pregnancy (preterm versus full-term) and birth weight parameters for the overall sample. GWG status was unrelated to pregnancy length but was associated with birth size (a higher percentage of SGA in pregnancies with below-guideline GWG and a higher percentage of LGA in pregnancies with above-guideline GWG; p values < 0.05). Observed ethnic differences in birth size (Table 1) by which White women were more likely to have LGA neonates and Latina women were more likely to have SGA neonates were not impacted when adjusted for GWG status (data not shown). Supplemental analyses from running more parsimonious models and from sensitivity tests did not yield results that were substantially different from those presented (data not shown).

4. Discussion

Findings from this retrospective cohort study provide insights for identifying women at risk for nonadherence to IOM-recommended GWG and for developing targeted interventions. Above-guideline GWG was greater in this cohort (58%) than in previous studies of multiethnic samples (35%–57% in prior studies) [2–4, 7], suggesting that rates of above-guideline GWG may continue to increase, especially among White women. As noted in other populations [2, 7, 30], prepregnancy weight status predicted GWG in this study. Targeting weight prior to pregnancy is desirable but may be unfeasible for numerous reasons, such as lack of pregnancy intentionality. Targeting weight change during pregnancy may be a more feasible window, as a majority of women seek prenatal care during the first-trimester and are motivated to modify health behaviors [31]. To our knowledge, this is the first study to examine first-trimester GWG status as a predictor of GWG status at time of delivery in a multiethnic sample of women, with first-trimester GWG status predicting overall GWG status among non-Latina White and Latina women. Along with other research [22], study findings indicate that the first trimester of pregnancy may be a critical and feasible window to promote healthy GWG and associated maternal and neonatal outcomes; thus, the identification of women who are at elevated risk for below or above GWG guidelines (e.g., prepregnancy underweight and overweight/obese women) and subsequent delivery of targeted interventions for these subgroups during early prenatal care should be emphasized.

Table 2: Univariate associations of demographic, behavioral, and psychological factors and gestational weight gain status based on 2009 IOM recommendations ($N = 571$).

Category	GWG below guidelines		GWG within guidelines		GWG above guidelines		p value
	N	%	N	%	N	%	
Age category							
Age 15–19	26	20.47	26	20.47	75	59.06	0.179
Age 20–24	26	16.77	43	27.74	86	55.48	
Age 25–29	20	15.04	34	25.56	79	59.40	
Age 30–34	14	14.00	35	35.00	51	51.00	
Age ≥ 35	4	7.14	14	25.00	38	67.86	
Ethnicity							
Latina	57	19.00	86	28.67	157	52.33	0.016
White	33	12.18	66	24.35	172	63.47	
Marital status							
Divorced	1	12.50	2	25.00	5	62.50	0.931
Married	29	14.57	57	28.64	113	56.78	
Single	60	16.62	93	25.76	208	57.62	
Employment at onset of pregnancy							
Employed	33	12.41	82	30.83	151	56.77	0.044
Not employed	55	18.21	70	23.18	177	58.61	
Insurance type							
Commercial/private	21	10.45	64	31.84	116	57.71	0.064
No insurance/unknown	1	14.29	2	28.57	4	57.14	
Public	68	18.73	86	23.69	209	57.58	
Obstetric provider							
Private	42	15.44	76	27.94	154	56.62	0.793
Hospital clinic	48	16.05	76	25.42	175	58.53	
Parity							
0	35	15.02	57	24.46	141	60.52	0.913
1	26	16.25	42	26.25	92	57.50	
2	13	14.61	28	31.46	48	53.93	
3 or more	11	17.46	17	26.98	35	55.56	
Prepregnancy BMI							
BMI ≤ 18.4	11	33.33	12	36.36	10	30.30	<0.001
BMI 18.5–24.9	36	13.85	89	34.23	135	51.92	
BMI 25.0–29.9	14	10.14	27	19.57	97	70.29	
BMI ≥ 30.0	29	20.71	24	17.14	87	62.14	
Tobacco use							
No	65	16.58	112	28.57	215	54.85	0.236
Yes, past	8	11.94	18	26.87	41	61.19	
Yes, this pregnancy	17	15.45	21	19.09	72	65.45	
Alcohol use							
No	68	15.14	123	27.39	258	57.46	0.302
Yes, past	21	18.75	23	20.54	68	60.71	
Yes, this pregnancy	1	12.50	4	50.00	3	37.50	
GWG during the 1st trimester							
Above	8	3.13	43	16.80	205	80.08	0.001
Below	61	39.10	53	33.97	42	26.92	
Within	15	10.14	55	37.16	78	52.70	

Table 2: Continued.

Category	GWG below guidelines		GWG within guidelines		GWG above guidelines		p value
	N	%	N	%	N	%	
Psychiatric diagnosis							
None	71	15.96	123	27.64	251	56.40	0.955
Depression	13	15.12	21	24.42	52	60.47	
Anxiety	3	20.00	3	20.00	9	60.00	
Other	3	13.04	5	21.74	15	65.22	
Psychiatric medications							
No	86	15.96	143	26.53	310	57.51	0.871
Yes	4	12.50	9	28.13	19	59.38	
Psychiatric history or medications							
No	70	16.55	117	27.66	236	55.79	0.325
Yes	20	13.51	35	23.65	93	62.84	

p value is from a Chi-square test.

For both non-Latina White and Latina women in our study sample, maternal smoking status (previous smoker prior to pregnancy) was associated with lower odds of below-recommended GWG which is consistent with previous research indicating that smoking during pregnancy is related to lower GWG and smoking cessation associated with greater GWG [2, 3, 32, 33]. Between 29% and 70% of women reportedly quit smoking upon becoming pregnant [34]; thus, health care provider attention to smoking history and smoking patterns during pregnancy, with particular focus given to previous or current smokers during early prenatal care, is important to optimize GWG throughout pregnancy.

A larger proportion of SGA infants were born to Latina women than non-Latina White women, with the prevalence of SGA (12.2%) and preterm delivery (13.0%) among Latina women in our sample slightly higher than national estimates for Latina women (9%-10%) [35]. In contrast, a greater proportion of LGA infants were born to White women. We did not find an association between GWG status at time of delivery and pregnancy length as previously found [36]. In addition, we did not find ethnic differences in low or high birth weight, which is in contrast to prior data indicating that Puerto Rican Latinas have some of the highest rates of low birth weight neonates [15] and preterm births [16] in the US. Multiple factors not assessed in this retrospective cohort study (e.g., prior preterm births, gestational diabetes mellitus) may contribute to and account for differences in birth outcomes observed in this study compared to previous studies. In addition, conventional measures of GWG may introduce bias when studying GWG-preterm birth associations [37]. Additional studies with larger, ethnically diverse samples are needed to elucidate predictors driving racial/ethnic disparities in birth weight outcomes.

Study strengths include the sample's ethnic and socioeconomic diversity (i.e., White/Latina women, public/commercial insurance, and hospital clinics/private provider) and inclusion of women who delivered pre- and full-term (previous studies have been limited to women who delivered full-term) [2, 7]. Although no data were available on place of birth, most Latinos in the region where the study was conducted are of Puerto Rican descent, a largely understudied population with considerable health disparities, including infant mortality [38].

Study limitations include the retrospective study design and the use of existing medical record data (with data gathered within the context of clinical activities rather than by trained research staff). However, all providers completed similar maternal and prenatal medical forms, which were routinely filed in the hospital medical record database prior to delivery. Participants' self-reported prepregnancy weight (as opposed to prepregnancy weight measured in a clinical or research setting) was used to determine GWG status. However, the IOM guidelines are based on studies that similarly use self-reported prepregnancy weight [39], and self-reported prepregnancy weight has been found to be highly correlated with clinically measured weight [40–42]. Information available on smoking patterns during pregnancy (i.e., number of cigarettes, quit date) was restricted. Furthermore, smoking status data was collected in the context of the first prenatal appointment and may be subject to social desirability bias and may only reflect smoking status at the first prenatal visit. However, the prevalence of smoking in our sample (19%) is consistent with smoking rates among White [2, 3, 32, 33] and Latina pregnant women [43] in previous studies. Presence of gestational diabetes, shown to be associated with birth weight [44, 45], was not controlled for. Women without a first-trimester prenatal visit and with missing prepregnancy BMI data were excluded from analysis; as systematic biases might exist between women who were or were not missing these data, findings may not be representative of the larger population from which the study sample was drawn. Study findings may not be generalizable to other (non-Puerto Rican) Latino subgroups. Lastly, the study

Table 3: Multivariate analysis of predictors of gestational weight gain status in overall study sample ($N = 571$).

Variable	Adjusted OR for GWG below guidelines		Adjusted OR for GWG above guidelines	
	Odds ratio (95% CI)	p value	Odds ratio (95% CI)	p value
GWG during the 1st trimester				
Within guidelines	Reference	<0.0001		<0.0001
Above guidelines	0.29 (0.08–1.01)		4.92 (2.75–8.81)	
Below guidelines	3.01 (1.33–6.81)		0.39 (0.21–0.74)	
Prepregnancy BMI				
18.5–24.9	Reference	0.0072	Reference	<0.0001
≤18.4	5.26 (1.37–20.17)		0.19 (0.06–0.58)	
25.0–29.9	0.83 (0.27–2.58)		3.44 (1.82–6.50)	
≥30.0	3.47 (1.38–8.70)		4.55 (2.29–9.04)	
Ethnicity				
White	Reference	0.9446	Reference	0.0069
Latina	0.97 (0.43–2.17)		0.46 (0.26–0.81)	
Tobacco use				
No	Reference	0.0402	Reference	0.2008
Yes, past	0.26 (0.07–0.99)		1.09 (0.49–2.42)	
Yes, this pregnancy	1.77 (0.64–4.84)		2.01 (0.93–4.31)	
Alcohol use				
No	Reference	0.5637	Reference	0.1978
Yes, past	1.69 (0.64–4.49)		1.15 (0.57–2.30)	
Yes, this pregnancy	0.85 (0.05–13.18)		0.15 (0.02–1.29)	
Age group				
25–29	Reference	0.2141	Reference	0.1470
15–19	3.07 (0.87–10.91)		1.50 (0.61–3.67)	
20–24	1.35 (0.45–4.04)		0.83 (0.40–1.74)	
30–34	0.60 (0.20–1.76)		0.52 (0.25–1.08)	
≥35	0.50 (0.10–2.44)		1.18 (0.49–2.86)	
Insurance				
Commercial/private	Reference	0.3929	Reference	0.1126
Public	1.58 (0.55–4.57)		1.75 (0.88–3.50)	
Employment at onset				
Employed	Reference	0.2533	Reference	0.2683
Not employed	1.63 (0.71–3.76)		1.39 (0.77–2.50)	
Parity				
0	Reference	0.9476	Reference	0.5305
1	0.93 (0.38–2.29)		0.94 (0.51–1.74)	
2	1.24 (0.42–3.61)		0.73 (0.34–1.61)	
3 or more	1.28 (0.35–4.59)		0.52 (0.20–1.30)	
Obstetric provider				
Private	Reference	0.0255	Reference	0.3441
Hospital clinic	0.35 (0.14–0.89)		0.75 (0.41–1.37)	
Psychiatric medications				
No	Reference	0.6482	Reference	0.2837
Yes	0.67 (0.12–3.72)		0.51 (0.15–1.73)	
Psychiatric diagnosis				
None	Reference	0.6362	Reference	0.5163
Anxiety	2.08 (0.25–17.06)		1.26 (0.25–6.50)	
Depression	1.14 (0.37–3.52)		1.27 (0.60–2.67)	
Other	3.16 (0.42–23.92)		3.57 (0.66–19.31)	

was not adequately powered to examine ethnic differences in pregnancy outcomes by GWG status; thus, results of GWG associated with outcomes of interest by ethnicity are exploratory.

Understanding factors that contribute to inadequate and excessive GWG is critical to the development of interventions that seek to optimize recommended GWG. Additional researches on racial/ethnic differences in the influence of

Table 4: Prevalence of selected pregnancy outcomes by gestational weight status in overall study sample ($N = 571$).

Outcomes	Gestational weight gain status		
	Below	Within	Above
Length of pregnancy ($p = 0.966$)[1]			
Term delivery	80 (88.9)	134 (88.2)	290 (89.0)
Preterm delivery	10 (11.1)	18 (11.8)	36 (11.0)
Birth weight ($p = 0.001$)[1]			
SGA	18 (20.7)	15 (10.1)	23 (7.1)
Normal GA	66 (75.9)	124 (83.2)	264 (82.0)
LGA	3 (3.4)	10 (6.7)	35 (10.9)
Birth weight ($p = 0.061$)[1]			
LBW (<2500)	10 (11.5)	18 (12.1)	25 (7.7)
Normal BW	73 (83.9)	122 (81.9)	261 (80.3)
HBW (>4000)	4 (4.6)	9 (6.0)	39 (12.0)

[1] p value for association between GWG status and selected pregnancy outcomes in the entire sample.
GA: gestational age; SGA: small for gestational age; LGA: large for gestational age; BW: birth weight; LBW: low birth weight; HBW: high birth weight.

early GWG on GWG and other maternal and neonatal outcomes are needed to guide the development of interventions tailored for socioeconomically and ethnically diverse populations.

Additional Points

Implications for Practice and/or Policy. Study findings highlight the importance of identifying and targeting populations at high risk for excessive GWG, particularly in early pregnancy. Emphasizing early prenatal care and facilitating adherence to GWG recommendations in the first trimester are particularly relevant among prepregnancy underweight and overweight/obese women. Within the clinical setting, identifying populations at risk for both above- and below-guideline GWG during early prenatal care is critical for optimizing GWG. Timely targeted interventions are needed for health care providers and practitioners to deliver throughout pregnancy with the ultimate goal of improving maternal and neonatal short- and long-term outcomes.

Competing Interests

The authors have no competing financial interests to declare.

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Research Article

The Effect of the More Active MuMs in Stirling Trial on Body Composition and Psychological Well-Being among Postnatal Women

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Introduction. Physical activity is important for health and well-being; however, rates of postnatal physical activity can be low. This paper reports the secondary outcomes of a trial aimed at increasing physical activity among postnatal women. *Methods.* More Active MuMs in Stirling (MAMMiS) was a randomised controlled trial testing the effect of physical activity consultation and pram walking group intervention among inactive postnatal women. Data were collected on postnatal weight, body composition, general well-being, and fatigue. Participants were also interviewed regarding motivations and perceived benefits of participating in the trial. *Results.* There was no significant effect of the intervention on any weight/body composition outcome or on general well-being at three or six months of follow-up. There was a significant but inconsistent difference in fatigue between groups. Qualitative data highlighted a number of perceived benefits to weight, body composition, and particularly well-being (including improved fatigue) which were not borne out by objective data. *Discussion.* The MAMMiS study found no impact of the physical activity intervention on body composition and psychological well-being and indicates that further research is required to identify successful approaches to increase physical activity and improve health and well-being among postnatal women.

1. Introduction

Recent research suggests that physical inactivity in women over 30 years is the greatest preventable risk factor for cardiovascular disease [1]. Weight retention is a clinical problem among postnatal women and may be important in terms of lifetime obesity risk [2, 3]. Regular physical activity may contribute to short-term improved weight control (during and after pregnancy), longer-term overweight and obesity management, and diabetes treatment and prevention [4–6]. Also during the postnatal period psychological well-being has been shown to be enhanced by regular physical activity [7–9]. Recommendations for postnatal physical activity are now available via clinical guidelines published in five countries [10]. All promote the safety of physical activity and the beneficial effects of following generic guidelines for adults, with variable suitable periods suggested for gradual resumption (or uptake) of physical activity after birth.

Rates of postnatal physical activity participation vary considerably across studies but in general a low proportion of postnatal women report meeting physical activity guidelines [11–15]. In these studies there is considerable heterogeneity with regard to measurement approaches, the postnatal time period under study, and different definitions regarding what constitutes physical activity. Previous research suggests childbirth, pregnancy, and childrearing act as potentially negative influences on physical activity participation among women [16–18], partly due to increased caregiving responsibilities and societal and individual perceptions, particularly on how women prioritise their own needs in the context of their parental and/or working mother roles [19]. Qualitative evidence from mothers of young children lends some support to this [19, 20], as do surveys of postnatal women's self-reported PA barriers, which identify lack of time [21], lack of childcare, and low energy levels as the most frequently reported barriers [21–23]. Postnatal women reporting fewer barriers are more active [19], and self-reported self-efficacy (confidence) for overcoming barriers to PA (including setbacks to implementing PA plans) can predict positive changes to postnatal PA behaviour [22].

Our review and meta-analysis of postnatal interventions identified some evidence of a moderate positive effect on frequency of physical activity participation among postnatal women who received physical activity interventions [24]. Efficacious studies (in terms of physical activity outcomes) were generally those omitting dietary components and those utilising theoretically sound and evidence-based behavioural techniques such as goal-setting and self-monitoring. However, these studies did not report on other outcomes (e.g., weight management and indicators of postnatal well-being). Methodological flaws such as a poor sample size and lack of an objective measure of physical activity suggested further research was warranted. We designed, developed, and implemented the More Active MuMs in Stirling (MAMMiS) trial to address this underresearched area.

The primary aim of MAMMiS was to investigate the effect of an intervention comprising physical activity consultations and a 10-week pram walking programme on objectively measured physical activity in healthy but insufficiently active postnatal women. Main trial results are reported elsewhere [25]. This paper reports on secondary outcomes, with a particular focus on postnatal health and well-being indicators (specifically weight management, well-being, and fatigue). Although the MAMMiS trial was not designed as a postnatal weight management intervention (weight and body composition were secondary outcomes), this together with postnatal well-being outcomes is of importance to researchers, clinicians, and postnatal women themselves. The qualitative phase (aspects of which are reported here and explored in more detail in [26]) also considered intervention feasibility and acceptability from the perspective of the postnatal women participating in the trial.

2. Materials and Methods

MAMMiS study methods have been reported in detail elsewhere [27]. In this paper we present brief details of the central features of study design, participants recruited, and intervention and outcome measures of interest for this paper.

2.1. Design and Setting. MAMMiS was a randomised controlled trial conducted in one region within Central Scotland. The community has approximately 3–3500 births annually [28] and is reasonably diverse in terms of socioeconomic status and urban and rural classification, although ethnic minorities are underrepresented, which can be problematic for recruitment of a diverse sample [29].

2.2. Participants. Postnatal women who had given birth between 6 weeks and one year previously were included in the study. Inclusion criteria are given in full in Gilinsky et al. [27]. In brief, postnatal women (following postnatal check-up) who were insufficiently active (defined in relation to their self-reported physical activity stage of change [30], which assessed their current physical activity in relation to physical activity guidelines [31]) were included. Postnatal women were excluded if they were pregnant/planning a pregnancy or had medical contraindications to physical activity.

2.3. Intervention and Control Procedures. The intervention was delivered by a health psychologist with experience in motivational interviewing and delivery of behaviour change (plus walk leader training) and consisted of a face-to-face physical activity consultation (approximately 45 minutes in length) delivered at the start of a 10-week group pram walking programme with a second consultation (approximately 25 minutes in length) delivered at the end of the programme. The physical activity consultation approach was theoretically and evidence based (e.g., [32–34]) and was derived from models of behaviour change, in particular the Transtheoretical Model (TTM) [35]. The specific behaviour change techniques used in the physical activity consultations have been reported in detail elsewhere [27] and were chosen following a review of literature on determinants of postnatal physical activity. A workbook was used by participants to structure their activity plan (e.g., goal-setting, planning, and self-monitoring sheets). Participants also received a pedometer to monitor steps and were given information on the pram walk programme in their area. Participants could attend one session/week for 10 weeks and all women were encouraged to attend. Walks were conducted at a moderate-intensity (e.g., brisk pace) between 30 to 55 minutes per session. Four women who were unable to attend (e.g., because they had an infant and a toddler) received a 10-minute support phone call instead.

The control group received a leaflet "Active Living during and after Pregnancy," an NHS Health Scotland publication with information on physical activity guidelines and advice on implementation.

2.4. Outcome Measures. The primary outcome measure for the MAMMiS study was change in physical activity (measured by accelerometry and questionnaire), which has been reported elsewhere [25, 27]. Secondary outcomes were weight, body mass, general well-being, and fatigue and these were assessed at baseline and three-month and six-month follow-up. Weight (kg) and body composition (BMI, % fat mass) were measured using the Tanita 300 MA portable bioelectrical impedance monitor in accordance with procedures specified in the technical manual [36]. Each test was conducted at the same time of day and participants were given instructions to improve the accuracy of the body composition measurements. Before each test participants were asked to avoid caffeine for four hours, eating and drinking for 4 hours, intense exercise for 12 hours, taking diuretics for 7 days, and alcohol for 48 hours; participants were also asked to empty their bladder within 30 minutes before the test. Height was measured in centimetres (to the nearest cm) using a stadiometer at baseline only. Participants were categorised as underweight, healthy weight, overweight, or obese according to their BMI (kg/m^2). Psychological well-being was measured using the Adapted General Well-Being Index (AGWBI) [37]. This 22-item 5-point Likert response scale assesses well-being, self-control, anxiety and depression, vitality, and general health concerns in the past two weeks and has been validated within a GP practice in the UK [38]. Fatigue was measured using a visual analogue scale (VAS) response to one question. Visual analogue scales are a commonly used unidimensional method of assessing health status and are appropriate for measuring experience of short-term fatigue severity in general and clinical populations [39]. Participants were asked to place a mark on a 100 mm line to indicate the extent to which they had been "affected by fatigue in the past two weeks," where no fatigue was equal to 0 and worst possible fatigue was equal to 100 on the VAS. All measurements were taken at participants' homes or at the university site, depending on participant preference.

2.5. Posttrial Interviews. For the qualitative phase participants from each trial group were sought and we aimed to recruit a representative sample of at least half of all MAMMiS participants. The qualitative phase consisted of one in-depth interview (30–90 minutes in length). These took place after completion of all outcome measures at participants' homes or another suitable venue. All interviews were conducted by a separate researcher not involved in the main trial (who also led the qualitative analysis). The rationale for this was to create an open atmosphere to explore trial experiences and assess acceptability of the intervention. A topic guide was developed to guide the interview; however participants were also encouraged to raise issues important to them. All interviews were tape-recorded and transcribed verbatim.

2.6. Analysis

(i) Quantitative Data. Mann-Whitney U tests were used to analyse differences between the intervention and control group for changes in weight and body composition from baseline to 3 months and from 3 to 6 months, as these outcomes were not normally distributed. Psychological well-being and fatigue were analysed using independent and paired-samples t-tests to investigate differences between the intervention and control group on changes in these outcome measures between baseline and three months (the intervention period) and between baseline and six months (follow-up period). All statistical analyses were discussed and agreed with an independent statistician.

(ii) Qualitative Data. Posttrial interviews with study participants were coded using NViVO qualitative analysis software to manage the dataset. Thematic analysis based on the approach described by Braun and Clarke [40] was used to analyse, iteratively code, and build up a final set of themes and subthemes. Two people coded a sample of interviews prior to compiling a final list and then quotes were extracted to exemplify themes. For the purpose of this paper the results will report on the following areas explored during interviews: reasons for participating in the trial (i.e., motivating factors) and belief in personal health and well-being benefits acquired from taking part in the trial (from a perceived increase in physical activity or other change, e.g., in secondary outcomes or motivations for being active).

3. Results

3.1. Participant Characteristics. Baseline characteristics for the sample are shown in Table 1. Postnatal women who enrolled in the MAMMiS study were on average 33 years of age with their youngest child averaging 24 weeks. Most participants were primiparous, married, degree-educated, and on maternity leave at baseline. Most study participants had given birth vaginally. Changes in weight and BMI following pregnancy were evident; average weight gain was around 4.5 kg from prepregnancy (self-reported) to enrolment in the study (measured weight). There appeared to be differences in baseline weight between the two study groups, with intervention participants being heavier and more likely to be overweight/obese (OW/OB). Control participants were more likely to be breastfeeding at baseline. None of the differences were statistically significant.

Although the group of women expressing interest in joining the study were representative of postnatal women in Scotland in respect to their age, deprivation, and urban/rural classification, women actually enrolling in the study were more likely to be from affluent Scottish Index of Multiple Deprivation (SIMD) areas [40] (data not shown) and were older (only 18% were under 30 years) compared with the total number of women who expressed an interest in joining the study.

Trial participants ($n = 35$) who completed posttrial interviews were representative of the main trial sample in terms of their number of children, postnatal stage at study onset, BMI classification at study onset, and whether they remained or dropped out of the study [26].

3.2. Study Flow. All 65 participants completed baseline assessments and were randomised to the intervention or control group. All received the intended intervention or control condition and 92% (60/65) completed assessments at three months. Twenty-nine of the 33 intervention participants attended at least one pram walk, with the average number of walks attended being five (s.d. = 3.13) out of possible ten walks. At six-month follow-up 91% (59/65) of the sample completed assessments (see Figure 1). The number of participants not completing at least one assessment period (defined as withdrawals) was similar across the groups with no evidence that withdrawals differed from nonwithdrawals on baseline physical activity "stage of change," weight status, SIMD, or number of children at home, although withdrawals were younger and had a younger baby (data not shown).

3.3. Effect of the Intervention on Postnatal Weight and Body Composition Outcomes. Table 2 shows the median and interquartile range for weight, BMI, fat mass, and % fat mass at all measurement points during the study. There was no significant effect of the intervention on any weight/body composition outcome at three- or six-month follow-up (Table 2). Both groups showed a similar small decrease in weight/body

Table 1: Participant baseline sociodemographic and clinical characteristics.

Characteristic*	Intervention (n = 33)	Control (n = 32)
Mean age ± SD, y	33.1 ± 4.1	33.8 ± 5.4
Mean age of youngest child ± SD, weeks (range)	24.0 ± 11.0 (9–48)	24.8 ± 15.5 (7–50)
Median number of children (range)	1 (1–4)	1 (1–5)
Marital status, n (%)		
Married/cohabiting	27 (82)/5 (15)	27 (84)/5 (16)
Single	1 (3)	0
Employment status, n (%)		
Maternity leave or housewife	31 (94)	24 (74)
Working (full or part time)	2 (6)	5 (16)
Unemployed	0	3 (9)
Breastfeeding status, n (%)		
Breast (exclusively or incl. solids)	13 (39)	18 (56)
Bottle (exclusively or incl. solids)	16 (49)	11 (34)
Mixed (can include solids)	4 (12)	3 (9.4)
Method of delivery**, n (%)		
Vaginal labour	24 (73)	26 (81)
Caesarean section	8 (24)	6 (19)
Mean self-reported prepregnancy weight ± SD, kg	65.2 ± 9.9	63.1 ± 8.2
Mean prepregnancy BMI ± SD, kg/m^2	25.1 ± 4.1	23.6 ± 3.1
Prepregnancy BMI classification, n (%)		
Underweight (<18.5 kg/m^2)	0	1 (3)
Healthy range (18.5–24.9 kg/m^2)	14 (54)	20 (69)
Overweight (25–29.9 kg/m^2)	10 (39)	7 (24)
Obese (≥30 kg/m^2)	2 (8)	1 (3)
Mean measured current weight ± SD, kg	72.9 ± 10.9	68.2 ± 10.4
Mean current BMI ± SD, kg/m^2	27 ± 4.2	25.5 ± 3.9
Current BMI classification, n (%)		
Healthy range (18.5–24.9 kg/m^2)	13 (39)	18 (56)
Overweight (25–29.9 kg/m^2)	11 (34)	9 (28)
Obese (≥30 kg/m^2)	9 (27)	5 (16)

Body mass index, BMI. *At enrolment. **Missing data from one participant from the intervention group.

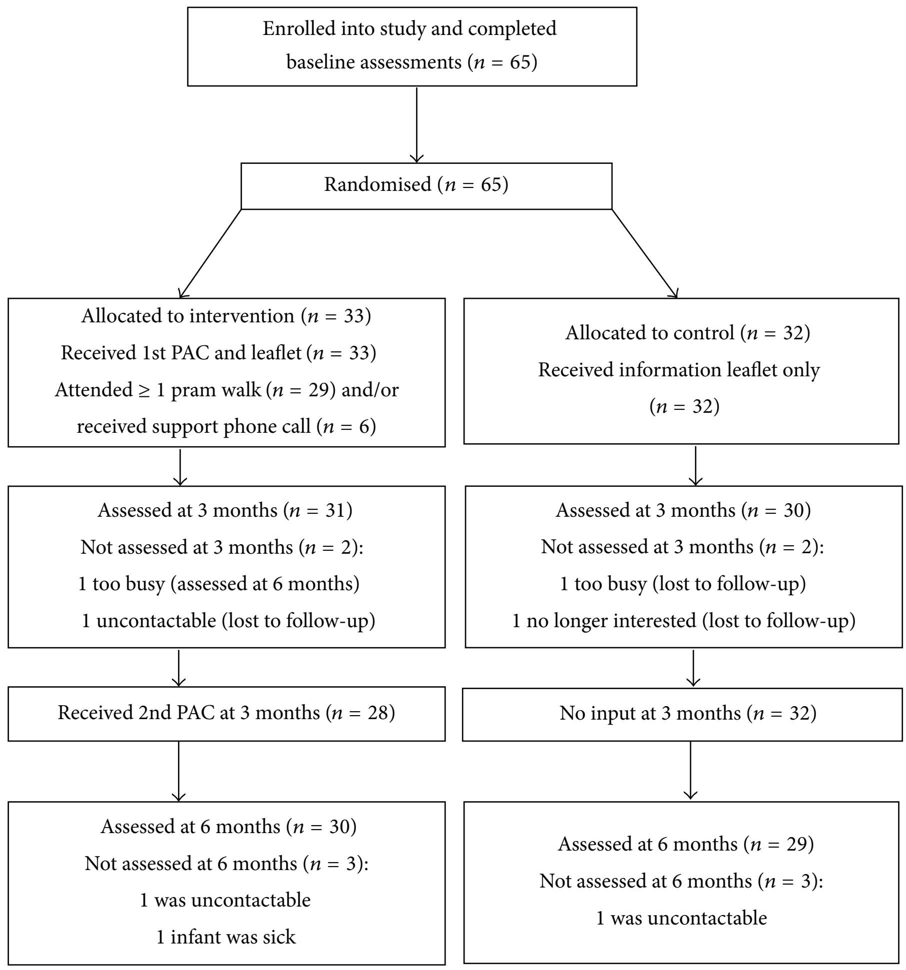
composition outcomes from baseline to three months and from three to six months; however these time effects were associated with large confidence intervals and changes were not significant (Table 2). All outcomes remained higher in the intervention group compared with controls at all measurement points. Some participants did show a clinically significant change in BMI status over the six-month study period (Figure 2); that is, 25% (n = 5) of the 20 participants in the intervention group and 50% (n = 7) of the 14 participants in the control group who were overweight or obese at baseline went from obese to overweight or overweight to normal weight. Due to the small sample of overweight/obese participants this was not tested statistically.

3.4. Effect of the Intervention on Postnatal Psychological Well-Being and Fatigue Severity. Over the study period there was little evidence of an effect of the intervention on psychological well-being; that is, there were no significant between groups' differences from baseline to three- (p = 0.09; 95% CI −0.77, 10.95) and three- to six-month follow-up (p = 0.19; 95% CI −9.68, 1.97) (see Table 3).

Fatigue decreased in the intervention group from baseline to three months, while among control group participants fatigue increased from baseline to 3 months; this difference between the groups was significant (p < 0.01; 95% CI −36.49, −9.14). However, this pattern was reversed from three to six months, with fatigue increasing among intervention participants and decreasing among controls (p < 0.01; 95% CI 5.20, 34.86). Note: change measures were analysed using t-tests as these were normally distributed; however the median and IQ range scores are given in Table 4 as there was evidence of skew at each measurement point.

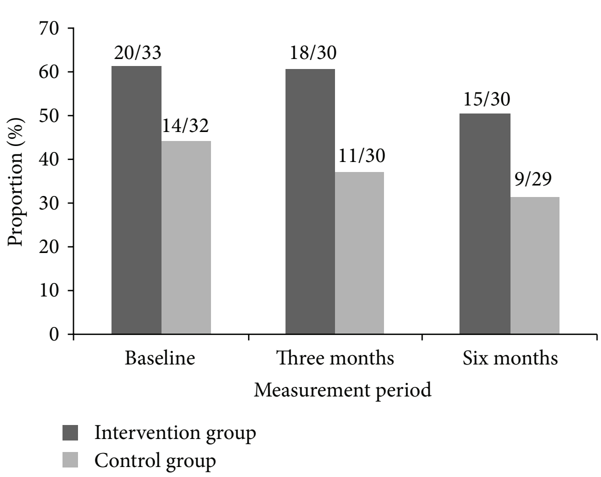
3.5. Posttrial Interviews

Personal Reasons for Participating in the Trial and Wanting to Be Active. A variety of reasons were given for joining the trial. Many mentioned weight management and the role that



PAC = physical activity consultation

Figure 1: Flow of participants through the MAMMiS study.



Note: overweight: BMI > 25 kg/m^2; obese: BMI > 30 kg/m^2

Figure 2: Proportion of overweight and obese participants at baseline and three and six months in response to a 10-week physical activity intervention.

physical activity can play in relation to losing weight, "*I put loads of weight on, and I was really inactive all through my pregnancy, and I hated it, and I really wanted to, like start doing more, like exercise,*" and the possibility of increasing activity to compensate for eating habits, "*I like to keep my weight down and I love to eat loads of nice things. . .and I find that the more activity I do, you can have these treats more.*"

However, motivations for joining the trial were also related to the perceived general health benefits of pursing a more active lifestyle, including relaxation/mood improvement, "*the long-term reason is that I think it benefits your health. And I think it increases, in terms of, it improves your mood.*" Some postnatal women mentioned using activity to manage stresses of motherhood, "*I used to do yoga and stuff, that was very relaxing. . .I really need the time to myself,*" and/or to be a role model or better mother: "*it is quite important for these two to see from early – we try to go for family walks at the weekend. . .so they get used to it. My mum's not one for being active.*"

Table 2: Weight and body composition results at baseline and three and six months of follow-up in response to a 10-week physical activity intervention.

	Intervention Median (IQ range)	Control Median (IQ range)
Weight (kg)		
Baseline (n = 33, 32)	72 (65, 80)	68 (62, 72)
Three months* (n = 30)	69 (63, 79)	65 (62, 72)
Six months** (n = 30,29)	68 (61, 79)	65 (61, 71)
BMI (kg/m²)		
Baseline (n = 33, 32)	27 (24, 30)	25 (22, 27)
Three months* (n = 30)	26 (23, 29)	24 (22, 27)
Six months** (n = 30, 29)	25 (23, 29)	24 (22, 27)
Fat mass (kg)		
Baseline (n = 33, 31)	26 (20, 33)	22 (18, 26)
Three months* (n = 30)	25 (20, 32)	20 (17, 26)
Six months** (n = 29)	25 (18, 34)	19 (17, 25)
% fat mass		
Baseline (n = 33, 31)	35 (32, 41)	32 (30, 36)
Three months* (n = 30)	35 (35, 40)	31 (29, 35)
Six months** (n = 29)	34 (29, 41)	30 (27, 35)

BMI, body mass index; IQ range, interquartile range. n = numbers in intervention and control group at each measurement time period.
*Tested with Mann-Whitney U tests not between group differences from baseline to three months for weight (p = 0.80), BMI (p = 0.80), fat mass (p = 0.55), and % fat mass (p = 0.81).
**Tested with Mann-Whitney U tests not between group differences three to six months for weight (p = 0.84), BMI (p = 0.58), fat mass (p = 0.66), and % fat mass (p = 0.78).

Table 3: Psychological well-being at baseline and three and six months in relation to a 10-week physical activity intervention.

Measurement period	Intervention group (n = 30) Mean (s.d.)	Control group (n = 29) Mean (s.d.)
Baseline	86 (10.6)	90 (8.1)
Three months	89 (9.9)	89 (8.2)
Six months	88 (10.1)	92 (7.5)

Note: the Adapted General Well-Being Index (AGWBI) Likert scale range is 22–110 with higher scores representing more positive well-being.

Table 4: Fatigue score at baseline and three and six months in relation to a 10-week physical activity intervention.

Measurement period	Intervention group median (IQ range)	Control group median (IQ range)
Baseline[1]	44 (31, 66)	28 (20, 49)
Three months[2]	26 (15, 58)	49 (26, 61)
Six months[3]	49 (16, 62)	27 (17, 46)

N in the intervention (I) and control (C) groups: [1]I = 33, C = 32, [2]I = 31, C = 29, [3]I = 31, and C = 28.

3.6. Belief in Benefits Gained by Becoming More Active as a Result of Joining the Trial. Regardless of group allocation in the trial, many participants perceived a benefit from being in the study and many felt they had become more active as a consequence of participating in the trial. When describing their personal benefits gained from increasing physical activity during the trial, one participant described feeling "*fitter and less fat.*" However, for many participants their perception of the value of physical activity appeared to relate to the importance of physical activity for addressing day-to-day challenges to their well-being, such as through increasing their energy levels/stamina, promoting good sleeping habits, and improving mood/releasing stress, "*more energy, without a doubt, sleep better, definitely helps mood I think. Kind of feel less tense – just overall well-being.*" Some participants reported unanticipated benefits related to being active since joining the trial; these also tended to focus on the benefits of activity to enable participants to cope with their life as a mother, "*I think the fresh air and getting out every day walking, we had a nice structure to our day. That helped me mentally, you know, just relax, not worry. It's my first baby and you spend a lot of time worrying, in general. Lots of worrying and I think that helped.*"

Unanticipated benefits were also reported by one mother reflecting on her return to work, "*The nature of my job is extremely stressful and so busy throughout the day, that I love the space of getting out on my own and having time – I find a lot of my best ideas come from that space and actually getting away from it all, just to be alone with your thoughts,*" although both work-life and mothering presented specific challenge in terms of making time for physical activity, "*I feel there's always something to be done and I find it hard, and it always will be there's never going to come a point when I find oh yes I've got a spare hour to go to the gym or something. I think women find it harder to cut off from what is needing to be done.*"

4. Discussion

The MAMMiS study found no impact of the physical activity intervention on secondary health outcomes for postnatal women. Changes in weight and body composition, along with general psychological well-being, were not significantly different between the postnatal women receiving a physical activity consultation and taking part in pram walking and those receiving an NHS leaflet. There was a significant positive impact on fatigue at three-month follow-up but this was not sustained at six months.

4.1. Lack of Significant Effects on Weight and Body Composition. The absence of a significant impact on weight/body composition-related secondary outcomes could be explained by the lack of a significant effect on objectively measured physical activity [25]. The small changes in weight/body composition in our study groups may indicate a natural return towards prepregnancy weight or may be due to the fact that over a third of women in both groups reported engaging in dietary control strategies to manage their weight. There is evidence that physical activity trials lacking a dietary component have little effect on postnatal weight outcomes [24] and among women in more general trials [41]. While weight management or concerns about body composition motivated some participants to take part in our trial [26] this may not be a good indicator of the sustained effort required to maintain a physically active lifestyle [42]. Participants in our trial also tended to be more affluent postnatal women who are less likely to experience long-term postnatal weight retention [43, 44] and more than half were of healthy prepregnancy weight suggesting less opportunity to demonstrate effect.

4.2. Lack of Significant Effects on Psychological Well-Being. MAMMiS was the first study to consider the impact of a physical activity consultation combined with group pram walking on general psychological well-being in healthy postnatal women. Although participants discussed concerns for their well-being as a motivator for taking part in the trial, psychological well-being remained stable over time in both groups with no evidence of an impact of the intervention. This may reflect the absence of change in physical activity or the relatively high psychological well-being at baseline. There is some evidence that group physical activity interventions, including pram walking, can improve well-being or postnatal depression scores in healthy postnatal women [45] and in women with postnatal depression [46, 47]. However, it is unclear whether these outcomes are attributable to changes in physical activity or to the addition of social support provided via group exercise, which is an ongoing issue in the postnatal physical activity literature [8]. There is some suggestion from our qualitative study that participating in the trial improved participants' perception of well-being despite a lack of increased objectively measured physical activity. A pilot study that used physical activity consultation only (and promoted physical activity through walking) among women with postnatal depression was underpowered to detect changes in postnatal depression and like MAMMiS did not demonstrate a significant change in physical activity behaviour at follow-up [48].

The primary outcome for our trial was an objective assessment of moderate to vigorous physical activity (MVPA) [25], and this was not improved by the intervention. However, findings from the qualitative study indicate that many participants perceived an improvement to their physical activity behaviour and related this to perceived improvements in psychological well-being. Studies comparing self-reported versus objectively measured MVPA show that people tend to overestimate the intensity and duration of MVPA, particularly activities performed as part of daily life (e.g., household and caregiving activities) [49]. Thus, the intensity of the additional activity perceived by many participants may have been "light" rather than moderate or vigorous which may explain the discrepancy between the quantitative and qualitative physical activity findings. Alternatively, many participants reported fluctuating physical activity levels (which were seen as an unavoidable consequence of having young children) and felt that accelerometer measurement at the follow-up periods was not fully representative of changes to their physical activity. The psychological gains attributed to being more active were more likely to be proximal outcomes (i.e., concurrent or day-to-day) of importance to the participants. Previous research from a successful physical activity trial has shown that endorsing statements about more immediate outcomes after physical activity (e.g., "feel energized, better overall mood, enjoyment and sense of accomplishment") [50, page 599] is related to being more active compared to more distal outcome expectancies (e.g., weight loss, fitness change).

While fatigue severity significantly improved in the intervention group compared to the control group (with the control group showing a worsening of fatigue) from baseline to three months, this pattern was reversed between 3 and 6 months. There is some evidence for a positive effect of physical activity on fatigue [9]. This trial recruited women with postnatal depression and improvements were greater among those adhering to the programme [9], highlighting the importance of having an effect on physical activity behaviour.

The participants in the MAMMiS trial were a heterogeneous sample and while randomisation ensured that there were no significant differences between the control and intervention groups it is likely that some of the differences within the groups might affect outcomes. For example, the age of infant, number of siblings, and feeding methods can impact on a mother's ability to take part in physical activity and lose weight. Prepregnancy and current weight and BMI will also affect the potential of a trial to impact on body composition outcomes as suggested by a greater effect in the small number of overweigh/obese women in our trial. Recruiting a more homogenous sample, by either narrowing the inclusion criteria or targeting clinically at-risk groups (e.g., overweight, gestational diabetes, or postnatal depression), might show more benefit from increasing physical activity than in a general healthy postnatal population, although evidence is still inconclusive and to date this has not been tested using objective measures [51, 52]. Furthermore using objective measures for assessing activity levels prior to enrolment might ensure recruitment of a more inactive population. The face-to-face interaction and type of intervention in our trial are likely to appeal to more affluent women who tend to have greater access to social support and fewer environmental and economic barriers to physical activity [53] while E-health or text interventions might reach a more disadvantaged population of postnatal women [54, 55].

4.3. Strengths and Limitations. The main strengths of the MAMMiS study were the use of a randomised controlled design, inclusion of an objective measure of physical activity (i.e., accelerometers), and a three-month postintervention follow-up. Prior to the conception and implementation of the trial these methods had not previously been used in physical activity promotion research among postnatal women [24]. The intervention approach used in MAMMiS [27] was theoretically and empirically sound as it had been shown to be effective in other groups and was relevant to research on motivators and barriers to physical change in the postnatal population and the precise content of the intervention was detailed with reference to the behaviour change technique taxonomy in use at the time [56].

The main limitation of the study was that despite attempts to recruit an insufficiently active sample, baseline levels of activity were higher than expected [25]. We used a stage of change questionnaire to screen eligibility prior to baseline measures; this subjective measure is therefore susceptible to self-report bias. It is also likely that our definition of insufficient activity was too high, that is, not achieving five sessions of physical activity per week of at least thirty minutes [30]. In addition, a number of factors can affect estimation of body fat using the bioelectrical impedance method; therefore we controlled for as many of these factors as possible (as described in Section 2); however we were unable to schedule body fat measurements with participants' phase of their menstrual cycle, which may have influenced the body fat results.

5. Conclusions and Implications

Although there are substantial health and well-being benefits from participating in regular physical activity during the postnatal period, results from this study (and others) suggest we still lack a definitive approach to increasing physical activity participation among this group.

Competing Interests

The authors declare that they have no competing interests.

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Research Article

Pregnant Women in Louisiana Are Not Meeting Dietary Seafood Recommendations

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Background. The 2015–2020 Dietary Guidelines for Americans recommend that pregnant women and women of childbearing ages consume 8–12 oz. of seafood per week. Fish are the major dietary source of omega-3 long chain polyunsaturated fatty acids, which have benefits for the mother and fetus. *Methods*. In this observational study, we investigated dietary habits of pregnant women in Baton Rouge, Louisiana, USA, to determine if they achieve recommended seafood intake. A print survey, which included commonly consumed foods from protein sources (beef, chicken, pork, and fish), was completed by pregnant women at a single-day hospital convention for expecting families in October 2015. Women (n = 221) chose from six predefined responses to answer how frequently they were consuming each food. *Results*. Chicken was consumed most frequently (75% of women), followed by beef (71%), pork (65%), and fish (22%), respectively. Consumption frequency for the most consumed fish (catfish, once per month) was similar to or lower than that of the least consumed beef, chicken, and pork foods. Consumption frequency for the most consumed chicken and beef foods was at least once per week. *Conclusion*. Our data indicate that pregnant women in Louisiana often consume protein sources other than fish and likely fail to meet dietary seafood recommendations.

1. Introduction

Optimal fetal development and infant outcome depend on availability of specific nutrients during the preconceptual and gestational periods, including the omega-3 long chain polyunsaturated fatty acids (LCPUFAs), docosahexaenoic acid (DHA), and eicosapentaenoic acid (EPA) [1, 2].

In response to maternal omega-3 LCPUFA intake during pregnancy, infants have improved performance on cognitive and developmental tests [3–5], accelerated maturation of the visual and autonomic nervous systems [6–8], and leaner body composition [9, 10].

Health benefits of omega-3 LCPUFA intake in pregnancy may also extend to the mother. The relationship between dietary omega-3 LCPUFA intake and maternal mental health conditions (depressive disorders during and after pregnancy) has been examined. There is evidence that omega-3 LCPUFA intake may benefit women with preexisting depressive illnesses [11–14]. These findings are complemented by observational studies which point to an association between low dietary omega-3 LCPUFA intake, especially DHA, and increased risk of depressive disorders during and following pregnancy [15, 16].

There is evidence that omega-3 LCPUFAs also positively affect general pregnancy outcome. Omega-3 LCPUFAs prolong pregnancy duration, reducing the risk of birth before 34 gestational weeks by 31% in normal and 61% in high-risk pregnancies [17, 18]. Increasing pregnancy duration has implications for decreasing incidence of preterm birth and intrauterine growth retardation [19].

These measurable and documented benefits of omega-3 LCPUFA underscore the recommendations of the 2015–2020 Dietary Guidelines for Americans [20] that pregnant women and women of childbearing ages consume 8–12 oz., or two to three 4 oz. servings, of seafood per week, as cold water marine fish are the major dietary source of omega-3 LCPUFAs (Table 1) [21]. In general, fish are regarded as good dietary sources of omega-3 LCPUFAs; however, fatty acid content depends on variety, geographical location, method of farming/harvesting, and other factors [21].

Table 1: DHA and EPA content of major dietary sources of omega-3 LCPUFA[1,2].

	DHA, mg/4 oz.	EPA, mg/4 oz.	Number of 4 oz. servings to provide 250 mg DHA + EPA[3]	Oz. to provide 250 mg DHA + EPA
Bass				
Sea	492	183	0.37	1.48
Striped	663	192	0.29	1.17
Catfish				
Farmed	64	19	3.02	12.10
Wild	265	147	0.61	2.43
Cod				
Atlantic	136	72	1.20	4.81
Pacific	109	39	1.69	6.76
Herring				
Atlantic	977	804	0.14	0.56
Pacific	781	1099	0.13	0.53
Flounder	123	155	0.90	3.61
Salmon				
Atlantic, farmed	1251	977	0.11	0.45
Atlantic, wild	1264	364	0.15	0.61
Pink	377	207	0.43	1.71
Sockeye	1797	395	0.11	0.46
Tilapia	97	5	2.44	9.74
Trout	599	229	0.30	1.21
Tuna				
Bluefin	1009	321	0.19	0.75
Light, canned in water	223	32	0.98	3.93
Yellowfin	100	13	2.21	8.82
White, canned in water	713	264	0.26	1.02

[1]Adapted from the USDA National Nutrient Database for Standard Reference, Release 27 [21]; DHA: docosahexaenoic acid; EPA: eicosapentaenoic acid; LCPUFA: long chain polyunsaturated fatty acid.
[2]Nutrient values are estimates and depend on species of fish, total fat content of fish, geographical location, method of raising/harvesting, and cooking. All values are for raw portions and, as such, are overestimates after cooking is considered [21].
[3]Number of servings (4 oz.) were calculated to meet 250 mg of omega-3 LCPUFA per day, as recommended for pregnant women by the Dietary Guidelines for Americans (2015–2020) [20].

These recommendations translate to approximately 250 mg omega-3 LCPUFAs per day and are in line with the recommendation of 200 mg DHA per day set forth by an international panel of experts in an earlier consensus statement [22].

The Food and Drug Administration and Environmental Protection Agency further specify that servings should be from a variety of fish that have low levels of methylmercury [23]. Nearly all fish contain trace amounts of methylmercury; however, larger fish with longer lifespans have greater accumulations of the neurotoxin [24]. As methylmercury crosses the placenta, it accumulates in the fetus at higher concentrations than those in the mother [25, 26]. Fetal exposure to excess amounts of methylmercury in utero, when the brain is especially vulnerable to environmental insults, can negatively affect brain and nervous system development [27]. Tilefish from the Gulf of Mexico, shark, swordfish, and king mackerel contain high levels of methylmercury [21, 23]; thus, pregnant women and women of childbearing ages are advised to avoid these fish [23].

During pregnancy, the fetus relies on maternal intake and placental transfer of nutrients to meet developmental demands. Although prenatal vitamins and other vitamins/supplements are marketed to pregnant women, they may not contain omega-3 LCPUFAs or women may not consume them at all or with any regularity [28]. Thus, low fish intake during pregnancy could result in low fetal accumulation of DHA and EPA.

Previous estimates of dietary omega-3 LCPUFA intake point to low consumption by pregnant women and women of childbearing ages. In a small sample ($n = 21$) of pregnant women in Baton Rouge, Louisiana, USA, data from our laboratory [28] indicate the average dietary intake of DHA is 72 mg per day, which translates to 95% of pregnant women not meeting the recommendation of 200 mg DHA per day [22]. When supplement intake was taken into consideration, 62% of pregnant women still failed to meet the recommended DHA intake. In an earlier study, we reported that nonpregnant women of childbearing ages ($n = 183$; average age: 20 years; age range: 18–28 years) consumed an average of 66 mg DHA per day, which included both dietary and supplemental sources of DHA [29].

Given the role of omega-3 LCPUFAs in infant development, pregnancy outcome, and maternal health, it is important to assess if pregnant women are adhering to the dietary recommendation to include seafood in their diets and, if not, what foods they are choosing to consume instead. Therefore, the aim of the study was to investigate the dietary habits of pregnant women in Baton Rouge, Louisiana, USA. Specifically, we evaluated their consumption of various dietary protein sources.

Geographically, Baton Rouge is located directly on the Mississippi River and approximately 157 miles north of the Gulf of Mexico. As Louisiana is a coastal state and fish are an intricate part of the regional culture and cuisine [30], we hypothesized that pregnant women in the Greater Baton Rouge area would meet the recommended seafood intake for pregnant women and women of childbearing ages.

2. Materials and Methods

2.1. Study Overview. For this observational study, we approached women at an event held for expecting women and their partners at a hospital in Baton Rouge, Louisiana. The free, single-day event was held in October 2015. Women were approached and invited to complete a survey about their dietary habits during pregnancy and respond to a demographic questionnaire; the survey and questionnaire were provided as separate documents. All pregnant women who visited the research booth at the event were invited to participate; the only inclusion criterion was current pregnancy and there was no selection bias. Our efforts resulted in 221 completed surveys and questionnaires; the responses from each were separated at the time of completion.

Compensation for study completion was entry into a raffle for free baby books and other materials for expecting families. Women provided their first name and telephone number on a separate piece of paper; this paper was not attached to the survey or questionnaire. When a name was drawn in the raffle, the woman was contacted by a call or text and returned to the booth to pick up her raffle prize. All contact information was destroyed at the conclusion of the convention.

The survey included a statement that completion of the survey constituted consent to participate and participation were voluntary. All procedures involving human subjects were approved by The Louisiana State University AgCenter and Woman's Hospital Institutional Review Boards.

Contact and demographic information were not attached to the survey and, as such, responses were anonymous. The women were allowed to complete their survey and the questionnaire and provide their contact information on an individual clipboard standing away from the table at which the researchers were stationed.

2.2. Survey and Demographic Questionnaire. The survey was designed to be completed by participants in approximately 5 minutes with minimal input or direction from the researchers. Women were instructed to complete the survey in accordance with their usual dietary habits during pregnancy. The survey has not been previously validated and was developed as a tool to provide preliminary, descriptive data that provides a direction and foundation upon which to build for future research.

The survey contained four sections ("protein sources"), labeled and ordered as follows: "Beef," "Chicken," "Fish," and "Pork." Each section included a list of foods commonly consumed for that respective protein source; these foods were subjectively chosen by the researchers.

"Beef" included, in order, "Steak," "Hamburger," "Stew meat," "Brisket," and "Roast." "Chicken" included, in order, "Wings," "Breast," and "Legs." "Fish" included, in order, "Canned tuna," "Tuna steak," "Tilapia," "Salmon," "Cod," "Catfish," "Swordfish," "Trout," "Bass," "Flounder," and "Herring." "Pork" included, in order, "Chop," "Tenderloin," and "Roast."

More specific information about the foods and food preparation was not sought. For example, "Steak" could include any cut of steak, "Salmon" could include any species of salmon, and "Wings" could include any preparation and/or cooking style of chicken wings.

Each question had six predefined responses to assess how frequently the women were consuming each: "Never," "Once/week," "2-2+/week," "Once/month," "2-3/month," and "4-4+/month." The majority of women checked only one box per food; however, if multiple or none of the boxes were checked, that data point was entered as missing.

As the primary focus of our study was fish consumption by pregnant women, we constructed our survey to include a variety of fish, including those that are poor and good sources of omega-3 LCPUFAs and those that are indigenous and nonnative to the area (canned tuna, tuna steak, tilapia, salmon, cod, catfish, swordfish, trout, bass, flounder, and herring).

The demographic questionnaire, included as a separate document, included questions about participant age, ethnicity, education level, and if she was a first-time mother. All documents were provided in print.

2.3. Interpretation of Results. Our survey did not indicate the size of a serving. Rather, we asked how often the women consumed each food and assumed portion sizes for each. In speculating whether pregnant women are meeting the omega-3 LCPUFA recommendations by dietary fish intake, we assumed each serving to be 4 oz.

This assumption was based on a table in the 2015–2020 Dietary Guidelines for Americans [20]. Nutritional aspects of common seafood varieties were provided for 4 oz. portions of each. Although the guidelines specify that pregnant women should "consume 8 to 12 oz. of seafood per week from a variety of sources", a serving size is not defined. However, The Food and Drug Administration and Environmental Protection

Table 2: Demographics of the survey population.

	% of women, n = 221
Age, years	
<20	3.2
20–25	29.0
26–30	37.3
31–35	23.0
36–40	6.9
No answer	0.5
Education	
Some high school	3.2
High school graduate	6.5
Some college	23.5
2-year degree	8.8
4-year degree	29.0
Graduate degree	28.6
No answer	0.5
Ethnicity	
African American	20.3
Caucasian	71.4
Hispanic	2.3
American Indian	0.5
Asian	4.6
Multiracial	0.5
No answer	0.5
First-time mom	
Yes	78.5
No	21.5
No answer	1.4

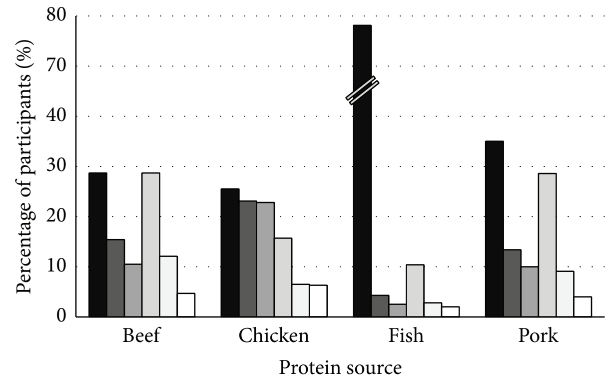

Figure 1: Consumption rate and frequency of protein sources by pregnant women.

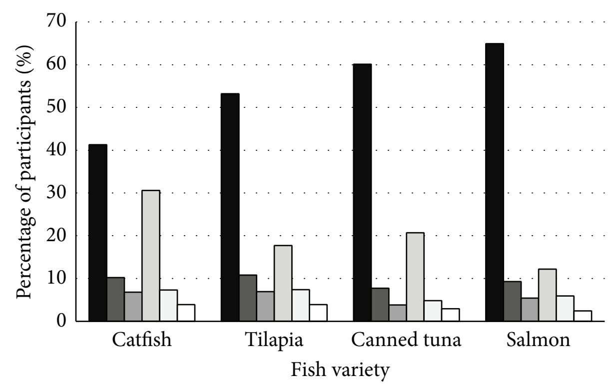

Figure 2: Consumption rate and frequency of the more consumed fish varieties by pregnant women.

Agency specify that the recommended 8–12 oz. translates to two to three servings of fish per week [23].

3. Results

3.1. Population Demographics. Demographic data (n = 221) for our survey population are provided in Table 2. The majority of the women in our population were Caucasian (71%), 26–30 years old (37%), and had completed some college (24%), a 4-year college degree (29%), or a graduate degree (29%). African American was the second most common ethnicity (20%) and 20–25 years of age was the second most common age range (29%). First-time mothers comprised the majority of our population (79%).

3.2. Response Rate. Of the women approached (estimated 250–275), 221 completed the survey. The average response rate for each food was 92%. Women responded to the frequency with which they ate stew meat least often (i.e., did not answer the question; 88% response rate) and chicken breast most often (96% response rate).

3.3. Consumption Habits of Pregnant Women: Fish. Twenty-two percent of women reported consuming fish, when consumption of all individual varieties was averaged (Figure 1). Catfish was consumed by a majority of the population, 59% of women. Tilapia, canned tuna, and salmon were consumed by 47, 40, and 35% of women, respectively. Swordfish, herring, and flounder were consumed by less than 3% of women.

The most common consumption frequency for catfish, tilapia, canned tuna, and salmon was once per month, followed by once per week. Consumption rate and frequency for each fish variety are presented in Figures 2 and 3.

3.4. Consumption Habits of Pregnant Women: Beef, Chicken, and Pork. Consumption rate for beef, chicken, and pork, when all foods were averaged within protein source, was 71, 74, and 65%, respectively. Hamburger, chicken breast, and pork chops were the most consumed foods for each protein source, with 90, 92, and 63% of women reporting that they

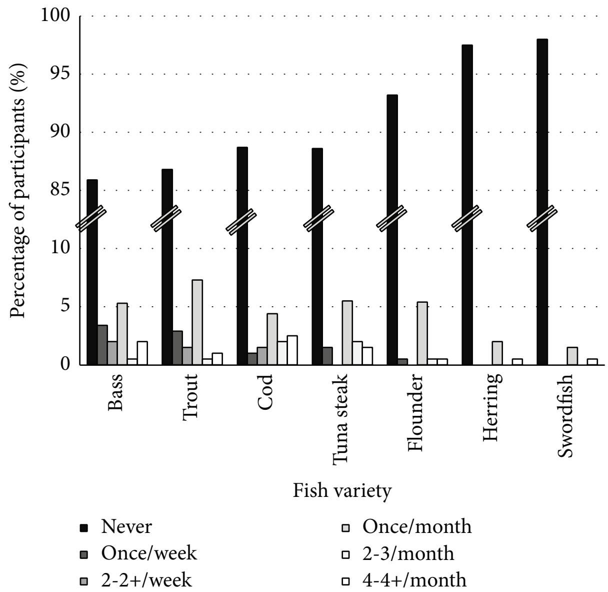

Figure 3: Consumption rate and frequency of the less consumed fish varieties by pregnant women.

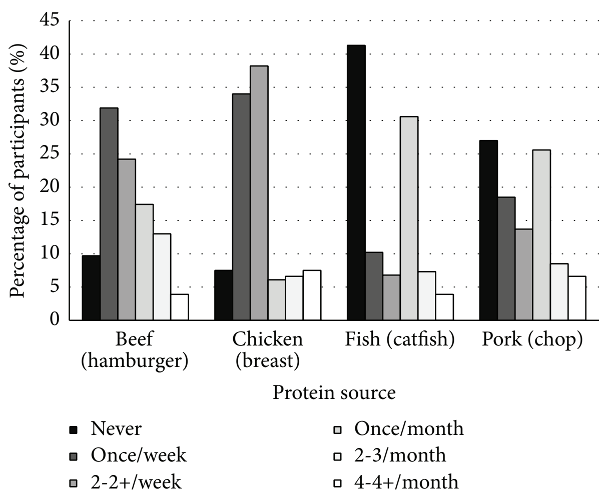

Figure 4: Consumption rate and frequency of the most consumed foods for each protein source by pregnant women.

consume each, respectively. Brisket, chicken legs, and pork roast were the least consumed foods for each protein source, with 52, 65, and 58% of women reporting that they consume each, respectively.

Women most commonly reported intake of the most consumed beef (hamburger) and chicken foods (chicken breast) at a frequency of once or at least twice per week. A consumption frequency of once per month was the most common response for the least popular beef, chicken, and pork foods (brisket, chicken legs, and pork roast, resp.). The most popular pork food (pork chops) was most often consumed at a frequency of once per month. Consumption rate and frequency of consumption for the most and least consumed foods, grouped by protein source, are presented in Figures 4 and 5, respectively.

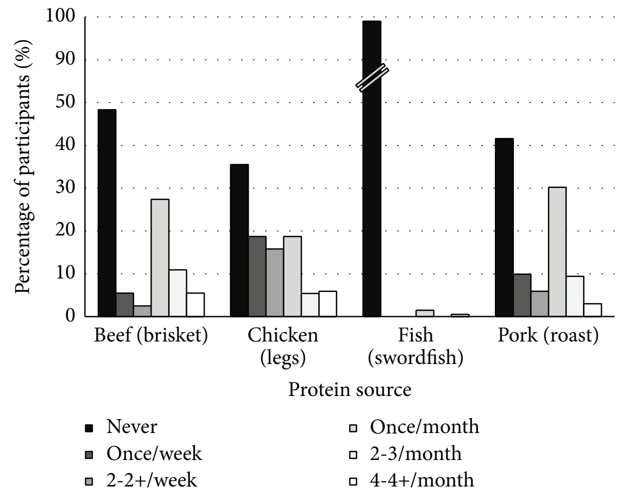

Figure 5: Consumption rate and frequency of the least consumed foods for each protein source by pregnant women.

4. Discussion

4.1. Achieving Dietary Omega-3 LCPUFA Recommendations for Pregnant Women. The two most commonly consumed fish varieties by our population (catfish and tilapia) have significantly lower concentrations of omega-3 LCPUFAs than the varieties which were rarely consumed (Table 1) [21]. Of particular interest is the finding that canned tuna, which is widely available, is inexpensive, has a long shelf life, and is amenable to easy preparation [31], was not consumed by more women or more frequently. Salmon, a similar variety to canned tuna in terms of preparation and favorable omega-3 LCPUFA content [21], was also consumed at a low frequency.

To meet the recommendation of an average intake of 250 mg omega-3 LCPUFA per day [20], one would have to consume 12 oz. of farmed catfish or 9.7 oz. of tilapia every day (Table 1) [21]. This equates to approximately 21 servings of farmed catfish or 17 servings of tilapia per week, assuming a 4 oz. serving size. As the women in our population reported consuming catfish, tilapia, and canned tuna (the three most consumed varieties) each at a frequency of once per month, they are likely to not be achieving recommended intakes of omega-3 LCPUFAs.

Dietary incorporation of canned white tuna and/or salmon at a frequency of twice per week would satisfy recommended levels of omega-3 LCPUFA intake, exclusive of intake of other varieties (Table 1) [21].

4.2. Intake of Fish Known to Have High Methylmercury Content. The Food and Drug Administration and Environmental Protection Agency advise pregnant women and women of childbearing ages to avoid consumption of tilefish from the Gulf of Mexico, shark, swordfish, and king mackerel due to their high methylmercury content [23]. In our population, three women (1.4%) reported consumption of swordfish at a frequency of once per month and one (0.5%) indicated she consumed swordfish at least four times per month. The other varieties were not included in our survey. These data may point to a need to further emphasize the recommendation that pregnant women and women of childbearing ages should avoid fish known to contain high levels of methylmercury [23].

4.3. Comparison of Dietary Intake of Fish and Other Protein Sources. In the current study, consumption rate of beef, chicken, and pork was at least threefold higher than that of fish. The most consumed fish varieties were consumed at a frequency that was similar to or less than that of the least consumed beef, chicken, and pork foods. Clearly, when choosing a protein source, pregnant women are opting to consume beef, chicken, and/or pork in favor of fish.

4.4. Comparison with Previous Findings and International Differences in Dietary Seafood Habits. Our data is in line with that of a previous investigation [32] in which it was reported that 89% of pregnant women in Massachusetts, USA, consume less than 3 fish meals per month and the average canned tuna consumption is 2 servings per month. Similarly, pregnant women in Ontario, Canada [33], were reported to consume 0.7 fish meals per week, which equates to less than 3 fish meals per month. These findings are also similar to those for pregnant women in southwestern Quebec, Canada, where the women consumed 3.6 fish meals per month [34].

There is a stark difference in dietary seafood habits of pregnant women between the North American countries of the United States and Canada and that of other regions.

A large, observational study [35] found that 88% of pregnant women in the United Kingdom consumed at least 8 seafood meals per month. Pregnant Norwegian women, on average, consumed approximately 45 seafood meals per month [36] and 77% of pregnant women living on the Faroe Islands consumed at least 12 seafood meals per month [37].

A comparison of two studies assessing pregnant women in Denmark [38] and Netherlands [39] revealed that 22% of the Danish population consumed at least 560 g of fish per month (equivalent to 4.9 servings) versus 56% of the Dutch population. These results are in agreement with those in a different Danish population [40], where the average fish consumption for pregnant women was 3.9 meals per month. Pregnant Swedish women were reported to consume 6.7 fish/shellfish meals per month, with less than 1% of women reporting they never consumed fish at all [41].

In Spanish populations, 86% of pregnant women reported consuming at least 12 seafood meals per months [42] and 61% of pregnant women ate canned tuna at a minimal frequency of 4 times per month [43]. Findings from a Taiwanese study indicate 99% of pregnant women in Taipei consumed fish during pregnancy at an average rate of 11 meals per month [44].

Although those North American populations outlined above [32–34], along with the population in the current study, all live within 160 miles of the coast or a major body of water, it is apparent that pregnant women in these locations eat less seafood than their European and East Asian counterparts. The international difference in fish and seafood consumption is likely fueled by the typical Western diet that is characteristic of North America, as supported by our current observation that pregnant women in Baton Rouge, Louisiana, USA, have a strong preference for hamburger or chicken breast.

Given the wide availability of seafood in coastal regions [45], one may expect pregnant women living in inland locations in North America to have even lower seafood intakes than those reported in the current and previous studies. It is important to note, as well, that our population is well educated, with 90% having completed some college. Thus, even pregnant women who are educated are not consuming recommended amounts of fish.

The international disparity in seafood intake reflects the findings of a 2010 study, which qualitatively determined knowledge and behavior of pregnant women ($n = 22$) in Northeastern USA with regard to fish consumption [46]. The researchers found that while a fair amount of pregnant women (46%) was aware that fish contained a potential toxic contaminant (methylmercury), less knew that fish contained DHA (36%) or a function of DHA during pregnancy (23%). Furthermore, none of the women (0%) had been advised to consume fish during pregnancy.

Two studies [32, 34] from 2003 and 2004 found that women from Northeastern USA and Canada more often maintained or reduced fish intake after becoming pregnant rather than increasing it. The decreased consumption after becoming pregnant was calculated to be 1.4 servings per month [34]. The authors speculated that this effect was a result of national mercury advisories in the early 2000s which recommended pregnant women limit consumption of certain fish [32]. These findings contrast those of the aforementioned study in Taiwan [44], conducted in 2006, where the percentage of women who consumed fish increased from 95 to 99% upon becoming pregnant. Thus, our data may suggest that, in 2015, pregnant women in North America may remain uncomfortable incorporating fish as a dietary protein source and opt for chicken, beef, or pork foods instead.

It is important to note that, for each study outlined above, dietary data were collected from and reported in a variety of ways. For comparison with our results, we converted the data to servings per month by assuming a serving was 4 oz., if the data were reported as g consumed per unit of time. We note that dietary data were collected by various methods (food frequency questionnaires, 24-hour dietary recalls) but assumed each method to be equal. These data manipulations could affect the precision of our comparisons.

4.5. Future Research Direction. Future studies should assess whether pregnant women and women of childbearing ages have knowledge of the dietary recommendations for seafood consumption. These efforts should aim to elucidate if (1) there are specific groups of pregnant women who are less likely to meet dietary fish recommendations and (2) why these women fail to meet those recommendations.

Replication of the current survey across different geographic areas would also provide insight into the effect of coastal versus inland location on fish intake and dietary protein preferences.

4.6. Study Limitations. Our survey was conducted in a convenience sample and since the survey and demographic questionnaires were not connected, we are unable to examine potential group differences or correlations between demographic parameters and responses.

We assumed values for portion sizes. Although this assumption does not affect our observations of dietary habits, it does affect the precision of our calculations in regard to whether pregnant women are meeting omega-3 LCPUFA recommendations or not. Furthermore, we did not consider how foods were prepared. Certain cooking styles are related to differences in the fatty acid content of the resulting product [21]. This, too, affects calculations of omega-3 LCPUFA intake.

The characteristics of our study population differ from those published by the United States Census Bureau [47] for Baton Rouge, Louisiana. The population of Baton Rouge are African Americans (55%) or Caucasians (39%) who have completed high school (26%) or some college (23%). The overall population of Louisiana is more similar to that of our study population; 63% Caucasian or 32% African Americans who have completed high school (26%), some college (23%), or a 4-year college degree (19%).

It is important to note that educational attainment data from the United States Census Bureau data reflects that of the population aged 25 years and older, without specificity to gender. Approximately 32% of our population was aged 25 years or less. Additionally, the ethnic breakdowns provided by the United States Census Bureau data reflect that of the entire population in that region without regard to age, gender, or pregnancy status. These discrepancies make it difficult to draw conclusions on the generalizability of our data.

5. Conclusion

These data reveal that pregnant women in Baton Rouge, Louisiana, USA, are not meeting dietary recommendations for seafood consumption and, therefore, likely do not consume adequate amounts of omega-3 LCPUFAs for optimal maternal health, fetal development, and infant outcome. These data also reveal the protein sources and specific foods that pregnant women are consuming in lieu of fish.

The apparent deficit in omega-3 LCPUFA intake has major implications during and after pregnancy and should be addressed with intensified efforts to provide nutrition and lifestyle education to pregnant women and women of childbearing ages.

Although our data indicate pregnant women, in general, do not meet dietary seafood recommendations, future research will help us better understand the habits of pregnant women, directing us in our development of targeted education efforts which emphasize the importance of consumption of fish low in methylmercury during pregnancy.

Competing Interests

There are no competing interests regarding the publication of this paper.

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Research Article

Clinician's Attitudes to the Introduction of Routine Weighing in Pregnancy

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Background. Excessive gestational weight gain poses significant short- and long-term health risks to both mother and baby. Professional bodies and health services increasingly recommend greater attention be paid to weight gain in pregnancy. A large Australian tertiary maternity hospital plans to facilitate the (re)introduction of routine weighing of all women at every antenatal visit. *Objective.* To identify clinicians' perspectives of barriers and enablers to routinely weighing pregnant women and variations in current practice, knowledge, and attitudes between different staff groups. *Method.* Forty-four maternity staff from three professional groups were interviewed in four focus groups. Staff included midwives; medical staff; and dietitians. Transcripts underwent qualitative content analysis to identify and examine barriers and enablers to the routine weighing of women throughout pregnancy. *Results.* While most staff supported routine weighing, various concerns were raised. Issues included access to resources and staff; the ability to provide appropriate counselling and evidence-based interventions; and the impact of weighing on patients and the therapeutic relationship. *Conclusion*. Many clinicians supported the practice of routine weighing in pregnancy, but barriers were also identified. Implementation strategies will be tailored to the discrete professional groups and will address identified gaps in knowledge, resources, and clinician skills and confidence.

1. Introduction

Excessive gestational weight gain (eGWG) for women of any prepregnancy Body Mass Index (BMI) is associated with adverse maternal and infant outcomes, including diabetes, preeclampsia, caesarean section, fetal macrosomia, admission to neonatal nursery, increased risk of postpartum weight retention, and risk of chronic disease for both mother and baby [1–6].

Routine weighing of women throughout their pregnancy used to be standard practice. In the first half of the twentieth century weight monitoring was conducted primarily to ensure that patients complied with the then common policy of encouraging weight restriction with target weights considerably lower than today. It was thought that excess weight gain caused preeclampsia, complicated births, and obesity [7]. In the 1960s and 1970s it became clear that this focus on weight restriction contributed to increased rates of low birth weight infants and associated morbidity and mortality. Target weights were adjusted and regular weighing continued with the new rationale that it was to ensure that women put on enough weight [8]. In the 1990s the practice was challenged after studies found that monitoring weight was not particularly effective in identifying women who would give birth to infants small for gestational age or for the development of preeclampsia. Clinicians argued that "routine weighing of patients may produce unnecessary anxiety and should cease" [9, 10]. In many jurisdictions routine weighing was replaced by a once-off calculation of a woman's BMI at the initial visit only, with the prevailing view that "maternal weight change is not a clinically useful screening tool for detection of growth restriction, macrosomia or pre-eclampsia" [11].

Informed by a growing evidence base, international guidelines are increasingly suggesting that assessment and promotion of appropriate gestational weight gain (GWG) should be reintroduced as a part of routine antenatal care for all women [12–15]. The revised US Institute of Medicine's (IOM) guidelines state that "health care providers should chart women's weight gain and share the results with them so that they become aware of their progress" [12]. Canadian guidelines suggest that health professionals "can use weight monitoring tools to assess the progress of pregnancy, track a woman's weight gain over time and identify unusual patterns of weight gain earlier in pregnancy. . . A single measure is not enough to determine whether weight gain is on track" [14]. Australian guidelines state that "assessment of appropriate weight gain should form part of routine care for all women" [15].

Routine weighing may help facilitate conversations about weight, enable more appropriate goal setting, and lead to more accurate measurement, and it may reduce GWG for all women. It has been shown that if health practitioners do not raise the issue of weight, women perceive it as not important [16]. The evidence indicates that it also matters who weighs women, with self-reporting being inaccurate. Furthermore, overweight and obese women are much more likely to overestimate appropriate weight gain compared to healthy weight women [17] and to underreport their weight [18]. Recommended target weight gains for pregnant women have been strongly associated with actual weight gain [19]. Indeed, the sole intervention of regular weighing (at 2–4-week intervals from 16 weeks of gestation) may reduce gestational weight gain for overweight women [20].

A range of barriers to regularly weighing pregnant women have been reported. Although many health professionals are aware of the adverse consequences of overweight/obesity in pregnancy [21] and are concerned about the impact of inappropriate GWG on patient outcomes [22–25], health professionals are reluctant to raise the issue of weight. Some staff feel that discussing weight gain causes women unnecessary anxiety during pregnancy [26], that it is ineffective [27], or that weight gain is "beyond the control of the woman" and so elect to discuss it only when the patient raises the issue [28]. However, patients find the advice they receive from clinicians helpful and that if a clinician was concerned about their weight they would also be more likely to take it seriously [29]. A number of Australian studies have demonstrated that most staff believe that they have inadequate training in the management of eGWG [28, 30, 31]. There is also some evidence that care providers are unaware of guidelines [21, 31].

To effect change in the delivery of health care it is necessary for interventions to be targeted to known barriers and designed in accordance with psychological and organisational theory that explains behavioural change. Specifically, interventions should be founded in theory that recognises the context and conditions required for behaviour and practice change to occur in health professionals. Indeed, evidenced-based behaviour change interventions have been shown to be more effective than interventions that are designed around situational or intuitive solutions [32, 33].

This study was conducted in a large Australian tertiary maternity hospital with approximately 6000 public births/year. Interviews were conducted prior to the introduction of a policy of weighing all pregnant women at every antenatal clinic visit. To investigate barriers and enablers to routine weighing of women during pregnancy at our hospital, this qualitative study explored clinicians' responses to the proposed introduction of this procedure.

2. Methods

All staff who would potentially provide care for women around gestational weight gain were included in this study. Obstetricians, midwives, and dietitians providing care to pregnant women at the study site were eligible to participate. Staff were informed about the study at routine meetings and via emails sent by managers inviting voluntary participation in focus group interviews. Consent was obtained immediately prior to interviews, which were recorded and transcribed by an external professional service.

An interview topic guide was developed with questions addressing four main areas: current practice; general attitudes to regular weighing; perceived patient factors that would influence weighing; perceived clinician factors that would influence weighing. Each question had a series of prompts to help elicit or expand on responses from interviewees (Table 1).

The hospital Human Research Ethics Committee reviewed and approved the study. Interviews were conducted from May to September 2015. Two authors (Tim Hasted and Shelley A. Wilkinson) independently coded the transcripts to extract key themes [34–36]. The coding was cross-checked and consensus was reached on the enablers and barriers that had been identified, as well as the current practices, general attitudes, and areas of contention amongst the different professional groups.

3. Results

Forty-four staff participated in four separate group interviews: 16 hospital staff midwives; 12 midwifery group practice (MGP) midwives; two dietitians; and 14 medical staff, comprising obstetric registrars and consultant obstetricians.

In addition to reporting on current weighing practices, four main themes were identified from the interviews, including (1) Systems and Resources; (2) Patient and Clinician's Personal Characteristics; (3) Advantages and Disadvantages of Routine Weighing; and (4) Evidence for Routine Weighing and Interventions.

3.1. Current Weighing Practice. The interviews identified wide variation in current practice. Both dietitians reported weighing all women at every visit. Some doctors reported almost never weighing women while others weighed only demonstrably obese patients. Midwives based in the hospital antenatal clinic reported varying practices, from weighing all women to rarely weighing any woman but always weighing if they were concerned about whether women were gaining appropriate weight. MGP midwives reported recording weight only at the booking in visit. When asked to assess

Table 1: Interview topic guide.

Question	Prompts
Describe the various measurements you undertake during an antenatal clinic visit.	(i) Specifically what measurements do you undertake concerning weight and calculating BMI? (ii) Do you currently weigh women? All women? When? Sometimes? (iii) Are you aware of the prompts on Matrix (electronic database) concerning weight? (iv) Is there anything that makes this easy? Is there anything that makes this difficult?
We are planning on introducing routine weighing for all pregnant women at every antenatal clinic visit. What do you think about this?	(i) Are there practical obstacles you think might make regular weighing difficult? (ii) Does weighing affect the patient-practitioner relationship? (iii) Have you had women refuse to be weighed? (iv) Does anyone have experiences at other centres that regularly weigh patients? (v) Do you think routine weighing would impact patient outcomes?
What patient factors influence whether they will be weighed in the antenatal clinic?	(i) Does the woman's baseline weight influence whether you will weigh a woman? (ii) Does a woman's interest in her own weight gain influence whether you will weigh a woman? (iii) In your last antenatal clinic session who were the women that you could or could not weigh?
What clinician factors influence whether they will be weighed in the antenatal clinic?	(i) Some studies have found that overweight clinicians find it more difficult to counsel patients about weight. Do you think a clinician's weight effects their likelihood to weigh women? (ii) Do you feel that you have enough knowledge about gestational weight gain to counsel women about their weight?

the number of women individual clinicians had weighed in their last clinic session, dietitians had weighed all women; most midwives had weighed a minority or none. With the exception of one doctor who had weighed one woman, doctors did not record the weights of women booked into their clinics.

3.2. System and Resources. The following three subthemes were identified: (i) available resources; (ii) standardising and normalising the process; and (iii) documentation.

3.2.1. Available Resources. Available resources concerned clinicians' access to weighing scales, the use of a hospital-developed weight tracker, and the availability of dietitians to receive referrals.

All groups interviewed identified a lack of calibrated scales as an impediment to weighing all patients at every visit:

> *If they're coming in regularly and they're going to be weighed regularly, we'll have the same set. We have something that we can use for reference, and that the team and everyone else is aware of as well* (dietitian).

Hospital staff (dietitians, clinic midwives, and doctors) also commented on the lack of privacy, as the scales were in a highly visible and busy location alongside the reception counter:

> *I think where the scales are now makes it hard. There's people everywhere and if there are people anxious about their weight the last thing they want to do is get on the scales in front of 15 people waiting to check in* (ANC midwife).

> *Having scales in every room would be good* (ANC midwife).

All staff groups suggested that placing scales in all clinic rooms would make routine weighing easier.

The MGP midwives objected to carrying scales with them to appointments on the ground that they were too heavy/bulky and issues concerned with maintaining accurate calibration:

> *If they* [pregnant women] *haven't got scales we'll just have to estimate* (MGP midwife).

All staff groups volunteered opinions about the hospital's Personalised Pregnancy Weight Tracker [37], a resource that allows women to track their own weight gain against the IOM's [12] recommendations. The consensus was that this tool allowed women to be more proactive in keeping weight gain within recommended ranges, based on self-reported BMI at the first booking visit. Doctors and midwives reported that the Tracker made it easy to discuss weight and to help educate women:

> *I find it quite easy to talk about the weight tracker just because some people are quite keen to keep on track. So I'll just say, because of the - your BMI being a little bit* [unclear], *it will trigger a referral and I can send you a weight tracker so that you*

> *can read about what foods are good in pregnancy and to also keep an eye on your weight* (MGP midwife).

However some ANC midwives felt it easier if it had already been explained:

> *It's easy if the dietitians have introduced it* [weight/weighing] *first* (ANC midwife).

This was reinforced by the dietitians, who reported that some women they see had been given a weight tracker but not been told how to use it.

Midwives and doctors all expressed concerns about not usually having their first contact with women until well into the second trimester, by which time clinicians had *"already missed a great big chunk of their pregnancy"* (Doctor).

All groups discussed the need for appropriate follow-up if women were going to be weighed at every visit. The midwives and doctors stated that it was important to have sufficient numbers of dietitians to whom they could refer women:

> *I guess that becomes a big point against - like a barrier to doing it is do we have somewhere to send somebody with a result* (Doctor).

> *Sometimes they* [pregnant women] *bring it up themselves. I've had a couple of women go "I think I've put on a bit too much weight". Then you talk about it and I usually send them off to a dietician* (MGP midwife).

> *If it* [weight] *goes too high, that's when she can come back in and you go, now I'd like to link you in with a dietician* (MGP midwife).

3.2.2. Standardising and Normalising the Process. Many staff members discussed using a single, agreed upon approach that reinforced the process as routine and did not single out specific (high) BMI women. It was suggested that staff discuss the importance of monitoring weight gain in all women and that this discussion should be documented earlier in pregnancy:

> *It's strange though because it is just another measurement, just like we're measuring their blood pressure. If they've got high blood pressure, we'd react to that* (ANC midwife).

> *We all run our clinics differently and that's hard for women as well [. . .] For some people things like this aren't really brought up a lot and for other people we do talk about it a lot. There's probably other things at the other end of the spectrum that, if we could have some sort of uniformity* (ANC midwife).

While guidelines can standardise practice, dietitians stated that some maternity staff appeared to be unaware of hospital guidelines and the evidence around weight gain in pregnancy. Indeed as one doctor declared: "*Yeah we have guidelines but they really mean nothing because I'm not using them."*

One doctor reflected on the issue of continuity of care and building rapport, stating that it was easier to weigh his private patients rather than these public patients:

> *I mean in private practice it's easy, because you can see the patients dramatically changing because you've got continuity of care. It is harder in a hospital. There might be an argument for that, where they're seeing a different clinician at every visit.*

It was also thought that the way "weight" and "weighing" is discussed makes it easier to weigh women:

> *They learn at their first visit at the diabetes clinic, someone would take them in and show them* [where to be weighed] *because they do their own urinalysis as well. They'd do that and they'd learn how to weigh themselves, and then, where they'd come to each week* (MGP midwife).

> [At other sites it's an expectation] – *"it's how it's done here"* (Doctor).

Many doctors agreed that they would find it difficult to find the time to weigh women and then discuss excessive weight gain, in addition to the other routine aspects required during a consultation. Furthermore, doctors and midwifery group practice midwives suggested that women could just weigh themselves and inform clinicians at each visit:

> *If they got weighed on the way in, do you know what I mean - that would be one less-so (1) it would get done 100 per cent of the time and (2) it's something that we don't have to think about doing* (Doctor).

> *You have to expect that there will then be a question from them that will come to you about how's my weight going doctor? Is that okay? What would be normally expected at this gestation and there's another two minutes of your consultation time gone, about something that may not be that relevant* (Doctor).

3.2.3. Documentation. The subtheme of documentation highlighted the need to have weights recorded in a systematic way and in a standard place, as well as the benefits of regular recording. This would make it easier to weigh as a reminder would exist and it would be part of the flow of each consultation. Both midwifery groups and the doctors felt that if Matrix (the computerised hospital database) had a prompt or a field that required populating (as is the case for blood pressure, fetal heart rate, and other routine measurements) this would encourage a change in practice towards routine weighing:

> *Can we have one* [Matrix prompt] *for weight as well because every woman loses her weight*

> *tracker. I'm constantly going out and getting new ones and doing it from scratch and they can't remember what their previous weights were and some midwives enter them and some don't* (ANC midwife).

3.3. Patient and Clinician's Personal Characteristics. Participants were asked if there were characteristics that made weighing women difficult or easier.

3.3.1. Patient Characteristics. Both midwifery groups agreed that it was easier to introduce the topic and to weigh women who were proactive and interested in their own weight gain or who mentioned weight themselves. The hospital staff midwives felt it was more difficult to weigh women who were "in denial," or if their partners were with them. Doctors reported that women's anxiety was a barrier to weighing, while dietitians reported that often women with a higher BMI or those who had gained excessive amounts of weight were less likely to want to be weighed, as were those who were self-conscious or "worried about judgment." However, according to clinicians women generally agree to be weighed with reassurance from the clinician with "*no woman ever refusing*" using this approach. One doctor suggested that women "*understand that we're mostly looking at it for a reason.*"

3.3.2. Clinician Characteristics. The training that clinicians had received influenced their confidence and attitude in discussing and monitoring weight. Dietitians felt that some clinicians lacked knowledge in monitoring gestational weight gain and one doctor confirmed this:

> *"I think one of the barriers for me too is not knowing how to counsel those women who are not gaining weight* [appropriately]*."*

Another doctor asked, *"What do I tell them? How do I counsel them? How do I reassure them?"*

The ANC midwives also stated that they had limited training in this area, with one midwife stating, *"So we can all take weight but what are we going to do with that information?"*

Additionally, one doctor noted they did not raise or pursue a discussion around weight due to a concern about the effectiveness of their advice.

All groups discussed staff attitudes; dietitians and MGP midwives stressed the importance of a nonjudgemental approach, although one midwife stated, *"it's very difficult to maintain that when somebody's weight is staring you in the face."*

Additionally, both midwifery groups mentioned that their own weight influenced their approach around monitoring gestational weight gain:

> [The/my] *comfort and ease to discuss is influenced by my own weight* (ANC midwife).

> *I find it difficult to try and lecture somebody about healthy eating because yes, personally I, yeah - weight has always been a* [problem for me] (MGP midwife).

3.4. Advantages and Disadvantages of Routine Weighing. Participants pointed to a number of general advantages and disadvantages to the introduction of a policy of routine weighing.

3.4.1. Advantages of Routine Weighing. Dietitians and hospital staff midwives were of the opinion that the practice would normalise weighing and reduce stigma. Staff midwives seemed to generally agree that if routine weighing was approached in the same way as measuring blood pressure, women would come to expect it. One doctor stated that it would allow for opportunistic counselling "*during the pregnancy as opposed to after it,*" although not all of the doctors agreed with the importance of this.

Some staff focussed on the benefit of having recorded weights for future research:

> *There is one big advantage of weighing women that - making it compulsory each visit that they come to the antenatal clinic. I mean realistically it doesn't take that long if you've got a set of scales in the room to do a weight. It's not - and documenting it... The big advantage of that for us is that women very quickly have a very large database of women to look at* (Doctor).

> *Not recording means we don't know how women are going compared with guidelines* (Doctor).

3.4.2. Disadvantages of Routine Weighing. Some clinicians were concerned about the effect of the policy on the patient-practitioner relationship. Both the doctors and MGP midwives felt that women would find the practice intrusive. Doctors were concerned about women being made to feel uncomfortable at their antenatal clinic appointments:

> *Women don't like getting on scales. Full stop.* (MGP midwife).

> *I reckon that they'd stop turning up. They wouldn't make as many appointments. They wouldn't - yes, because they think, well you're just going to judge me* (MGP midwife).

Both dietitians and MGP midwives expressed concern that some patients might respond to closer monitoring of their weight with unhealthy eating habits. One of the dietitians was concerned that some patients might restrict their food intake and in turn "*compromise their nutritional status*":

> *I know we're trying to encourage healthy habits and healthy weight gain but I think it could actually have the opposite effect of bingeing or whatever* (MGP midwife).

Table 2: Solutions.

Theoretical domains	Barriers	Solution
Environmental context and resources	(i) scales in public places, lack of scales in every room, MGP midwives not having access to scales (ii) lack of access to dietitians and lack of clarity about when to refer (iii) Matrix (online database) not prompting an entry for weight (iv) Time for weighing and discussing weight	(i) Funding was secured to purchase scales for every ANC room and for MGP midwives (ii) Dietitians are rostered to every antenatal clinic; referral guidelines have been updated and circulated (iii) The need for a compulsory weight prompt is being evaluated (iv) This will be evaluated after implementation and clinic appointment times altered if necessary
Knowledge *Skills* *Beliefs about capabilities* *Beliefs about consequences*	(i) lack of knowledge about effects of eGWG, how to counsel women on weight, and what interventions to recommend (ii) Skepticism about impact of eGWG and evidence for interventions	(i) Written materials and guidelines have been circulated and training sessions and workshops will be arranged to update staff on evidence around: the impact of eGWG, how best to approach the issue of weight with women, and interventions that have been shown to result in healthier GWG and better outcomes

3.5. Evidence for Routine Weighing and Interventions. Doctors were the most vocal group in questioning the evidence behind routinely weighing pregnant women and interventions for women who gained more weight than the recommended guidelines. One doctor stated, *"What's the intervention? What intervention are you going to put in place to change that?"*

Most doctors agreed that current evidence confirmed that counselling by clinicians did not result in sustained weight loss. One doctor stated, *"I'm not convinced that the evidence is strongly there that weighing all women changes outcomes."*

Both doctors and MGP midwives agreed that while women were once routinely weighed throughout pregnancy, robust evidence to reintroduce the practice was currently lacking:

> *I mean I think part of the reason it went out was really because it was having a significant negative psychological impact on women during pregnancy that was - I think that was one of the drivers certainly for it going out [...] there wasn't a great deal of evidence to say that weight change at that stage was - was particularly influenced outcomes, but also there was the additional thing which was that a lot of women really found it quite intrusive* (Doctor).

> *Previously we used to weigh everybody and they said, we don't need to do it anymore. So now it's like, it's being brought back in. No, we did, then we didn't [...] Is there actually a need for this? If it was so important, why was it taken away in the first place?* (MGP midwife).

However, one of the dietitians disagreed, saying that *"there's a lot of evidence around gestational weight gain and the outcomes for both the mum and the bub."*

4. Discussion

While many clinicians identified benefits to routine weighing, various challenges need to be addressed in order to successfully implement the process of routine weighing of all women at every antenatal visit.

4.1. Implementing Change and Addressing Barriers. It is apparent from these results, and as highlighted in the literature, that availability and/or dissemination of guidelines alone do not change practice [38]. Health service change theory outlines that barriers and enablers must be systematically assessed and subsequent service (behaviour) change strategies must be systematic and theory-driven [39]. French and others suggest that assessment must reflect individual, team, and organisational requirements within a robust framework (e.g., Theoretical Domains Framework or TDF) [39]. Applying this framework to our findings suggests that our barriers exist in the theoretical domains: *knowledge, skills, beliefs about capabilities, belief about consequences, and environmental context and resources.*

In formulating effective solutions to overcome these barriers (Table 2) we have employed the TDF methodology.

The training content will specifically target the barriers outlined above (knowledge of guidelines, of the evidence regarding interventions, and of available resources and referral pathways within the service) and will be informed by the implementation science literature to facilitate skill development and behaviour change. Our results suggest that staff education about the role of weighing and the evidence for available interventions would need to form part of an implementation strategy for all groups, but particularly doctors and MGP midwives.

4.2. Evidence for Interventions. The majority of pregnant women engage in low amounts of physical activity and they become increasingly more sedentary as their pregnancy progresses [40]. Regular physical activity may help women gain an appropriate amount of weight, reduce the risk of gestational diabetes and preeclampsia, and decrease physical complaints such as back pain [41]. While no one in this study questioned that exercise or changes to diet might control gestational weight gain, some clinicians did question the health service's ability to enable women to make these changes. While some of the participants in this study were concerned about the impact of weighing on women and on their therapeutic relationship there is no evidence that monitoring has any adverse effects for patients [42]. The evidence for routine weighing without other interventions is not conclusive. Some studies have shown a benefit [19, 20], while others have found that routine weighing alone has little or no influence on GWG [43, 44].

While strong evidence in favour of routine weighing is currently lacking, identifying eGWG may guide management and other interventions, for which there is a growing evidence base. The 2015 Cochrane review concluded that "high-quality evidence indicates that diet or exercise, or both, during pregnancy can reduce the risk of excessive GWG" [45]. The authors found that other benefits may include a lower risk of caesarean delivery, macrosomia, and neonatal respiratory morbidity, particularly for high-risk women receiving combined diet and exercise interventions. While some studies suggest that interventions encouraging healthy dietary habits or physical activity have little or no effect on GWG [46, 47], most show that educational interventions [48], behavioural interventions [49–52], counseling interventions [53], or a combination of approaches [54–56] can be successful in both obese and normal weight women.

4.3. Study Limitations and Areas for Future Research. This study has a number of limitations. We acknowledge that the use of a group forum for interviews did allow for some robust discussion and it is possible that more outspoken participants prevented contrary opinions and experiences to be raised by others. Nevertheless, the group format did allow for some views to be interrogated or affirmed by others and for a group consensus to form on issues after they had been debated.

We also acknowledge that we had relatively small sample sizes, especially in our dietitian group, although we interviewed 2 of the 3 dietitians working in the service.

Future research could also look at the practices and attitudes of general practitioners, who provide antenatal care for over one-quarter of Australian women and who care for nearly all of our women prior to referral to maternity services and who are therefore critical in any strategy to reduce eGWG.

The impact of the introduction of routine weighing on eGWG and subsequent fetal and maternal outcomes at our hospital will be the subject of another longitudinal study.

5. Conclusion

While many clinicians support the idea of routine weighing in antenatal clinic, a variety of barriers to its introduction have been identified. Clinicians raised concerns about existing resources, time constraints, and clinician and patient characteristics; clinicians' knowledge base; and access to evidence-based interventions and follow-up. Implementation strategies at our hospital will be tailored to these specific barriers to ensure all clinicians within the service are supported to be able to deliver evidence-based health care to ensure optimal outcomes for women and their babies.

Competing Interests

The authors declare that they have no competing interests.

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Research Article

Neighborhood-Level Poverty at Menarche and Prepregnancy Obesity in African-American Women

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Introduction. Menarche is a critical time point in a woman's reproductive system development; exposures at menarche may influence maternal health. Living in a poorer neighborhood is associated with adult obesity; however, little is known if neighborhood factors at menarche are associated with prepregnancy obesity. *Methods*. We examined the association of neighborhood-level poverty at menarche with prepregnancy body mass index category in 144 pregnant African-American women. Address at menarche was geocoded to census tract (closest to year of menarche); neighborhood-level poverty was defined as the proportion of residents living under the federal poverty level. Cumulative logistic regression was used to examine the association of neighborhood-level poverty at menarche, in quartiles, with categorical prepregnancy BMI. *Results*. Before pregnancy, 59 (41%) women were obese. Compared to women in the lowest neighborhood-level poverty quartile, women in the highest quartile had 2.9 [1.2, 6.9] times higher odds of prepregnancy obesity; this was slightly attenuated after adjusting for age, marital status, education, and parity (odds ratio: 2.3 [0.9, 6.3]). *Conclusions*. Living in a higher poverty neighborhood at menarche is associated with prepregnancy obesity in African-American women. Future studies are needed to better understand the role of exposures in menarche on health in pregnancy.

1. Introduction

Prepregnancy obesity is associated with adverse pregnancy and birth outcomes, including increased risk of gestational diabetes, preeclampsia, caesarean section, and having a large-for-gestational-age neonate [1, 2]. Prepregnancy obesity rates in the US are high, affecting approximately 1 in 5 pregnancies [3]. African-American women have increased risk of prepregnancy obesity [4]. There is growing interest in intervening on weight during the preconception phase to improve perinatal outcomes [5]. Importantly, intervening earlier, such as during puberty, may have a greater impact on preventing or reducing the burden of obesity in pregnancy as child and adolescent obesity is strongly associated with adulthood obesity [6].

There is limited, but growing, evidence regarding the role of childhood factors and experiences with obesity during pregnancy [7, 8]. Menarche is a critical time point in a woman's sexual development, reflecting significant biological changes and signaling the transition to the reproductive phase [9]. Obesity in childhood is associated with early age of menarche [10]. The association between obesity at menarche and adult obesity, however, is not fully explained by childhood obesity nor with age at menarche [11, 12]. Age at menarche may be a proxy for sexual maturation reflecting the influence of other factors, such as social and economic conditions, that affect biological maturity [12].

In developed countries such as the US, poverty increases risk of obesity, particularly in women; it is hypothesized that this association may be due to factors such as limited access to high quality, inexpensive food, or perceived discrimination over the life course [13]. Neighborhood-level poverty at the census tract level is one contextual factor that can be used to capture socioeconomic status (SES) over time and in a variety of populations including in children who have little control over their own socioeconomic standing [14]. While neighborhood-level poverty (measured in childhood) is associated with obesity in the transition from adolescence to young adulthood [15] and currently living in a poor area is associated with obesity in pregnancy [16], to our knowledge, no studies have examined associations of neighborhood-level poverty at time of menarche with prepregnancy obesity. A life-course approach to studying obesity that focuses on different developmental stages and exposures during those stages [17] may be especially relevant in the study of obesity in non-white groups [18]. Thus, we examined if neighborhood-level poverty at the time of menarche was associated with prepregnancy obesity in a sample of pregnant, African-American women.

2. Methods

2.1. Sample. The study population and data collection procedures have been described in detail elsewhere [19, 20]. A total of 203 pregnant African-American women in their 2nd trimester being seen for prenatal care at Henry Ford Health System in metropolitan Detroit, MI, were recruited for a study visit. Women provided written informed consent and the study was approved by the Institutional Review Boards at the participating institutions.

2.2. Prepregnancy BMI. As part of routine prenatal care, women were asked to self-report their height and weight from the time just before they became pregnant. Prepregnancy body mass index (BMI, in kg/m^2) was calculated. Prepregnancy obesity was defined as BMI ≥ 30, overweight as BMI ≥ 25 and <30, normal weight as BMI > 18.5 and <25, and underweight as BMI ≤ 18.5; only 8 women were classified as underweight and thus were combined with the normal weight category for analysis. Consistent with other studies [21], self-reported prepregnancy BMI was highly correlated ($r = 0.97$; $P < 0.001$) with the 1st measured BMI during pregnancy obtained from the prenatal medical record (measured at mean 9.4 ± 3.7 weeks of gestation).

2.3. Menarche and Neighborhood-Level Poverty. Age at menarche was self-reported and time since menarche calculated as the difference between age at study visit and age at menarche. Women were asked to think about when they got their first period and then they were asked to report the address where they were living at the time of menarche. If women were unable to report an address, they were asked if they could report what the major cross streets were where they lived. A few participants reported intersections ($n = 7$), and those were used to identify the closest postal address. We used participant self-reported year of menarche to identify the appropriate census year to obtain neighborhood-level poverty. One participant began menarche in the late 1970s and her address was mapped to the 1980 census tract; participants reporting menarche between 1980 and 1985 were also mapped to 1980 census tracts. Those who reported menarche between 1986 and 1995 were mapped to 1990 census tracts. Finally, we mapped participants reporting menarche in 1996 and later to 2000 census tracts. Since census tract boundaries may change over time, we used the geocoded address at menarche to obtain data for the appropriate census tract corresponding to the year of census as described above. A similar approach to defining poverty during puberty in a study of premenopausal women was used elsewhere [22].

Neighborhood-level poverty was defined as the proportion of residents in a census tract living below the federal poverty level (using poverty level at the time of the corresponding census). In our sample, at menarche, participants lived in neighborhoods that ranged from having 3.4% of residents living under the federal poverty level to having 63.1% of residents living under the federal poverty level. Mooney et al. recently demonstrated that estimates of the association of neighborhood contextual factors, based on census level variables, on health outcomes may result in biased estimates if the continuously distributed factor is used [23]. However, use of quantiles to partition the contextual factor results in unbiased estimates [23]; thus, we calculated sample quartiles of neighborhood-level poverty at the time of menarche. In our sample at menarche, quartile 1 consisted of women living in neighborhoods where the proportion of residents under the federal poverty level ranged from 3.4 to 14%; Quartile 2 ranged from 14 to 29%; Quartile 3 ranged from 29 to 38%; and quartile 4 consisted of women living in neighborhoods where at least 38% of residents lived under the federal poverty level.

Women also reported current residential address. We utilized a similar approach to obtain current neighborhood-level poverty. Addresses were mapped to the US Census Bureau's American Community Survey 2006–2010 data to obtain census tract and the corresponding census tract poverty level.

Further, in order to assess individual-level SES at the time of menarche, participants were asked to report the maximum level of education of their mother; to differentiate this from the participant's education, this is referred to as *grandmother's* education.

2.4. Covariates. Women self-reported race, marital status, and household income. Parity (number of previous viable pregnancies) was obtained from the maternal medical record.

2.5. Statistical Analysis. All analyses were conducted using SAS 9.4. Participant characteristics were compared by prepregnancy BMI category using chi-square or Fisher's exact test for categorical variables and ANOVA or Kruskal-Wallis for continuous variables. Cumulative logistic regression was used to examine the association of neighborhood-level poverty at menarche in quartiles with categorical prepregnancy BMI. Models were fit unadjusted (model I), adjusted for maternal age, marital status, and maternal education at the time of pregnancy (model II), and finally additionally adjusted for parity (model III).

We conducted several sensitivity analyses. First, childhood SES is often associated with adulthood SES. Models

Table 1: Participant characteristics by prepregnancy BMI category ($N = 144$); data are mean ± standard deviation or n (%).

Characteristic	Under/normal weight	Overweight	Obese	P
n	50 (34.7%)	35 (24.3%)	59 (41.0%)	
Age at menarche (years)	12.7 ± 1.6	12.2 ± 2.0	12.0 ± 1.7	0.111
Time since menarche (years)	10.9 ± 5.0	13.9 ± 5.9	17.4 ± 5.5	<0.001
Age at study visit (years)	23.6 ± 4.7	26.1 ± 5.8	29.4 ± 5.6	<0.001
Married/living as married	8 (16.0%)	8 (22.9%)	23 (39.0%)	0.022
Maternal education (years)	12.6 ± 1.4	13.3 ± 1.9	13.0 ± 1.7	0.128
Parity	0.4 ± 0.6	0.9 ± 1.2	1.3 ± 1.2	<0.001
Nulliparous	32 (64.0%)	19 (54.3%)	17 (28.8%)	0.001
Grandmother's education (years)[a]	13.3 ± 2.0	12.7 ± 2.4	13.2 ± 2.1	0.700
Neighborhood-level poverty at menarche (%)	24 ± 13	26 ± 14	30 ± 13	0.054
Quartiles of neighborhood-level poverty at menarche[b]				0.320
Quartile 1	16 (32.0%)	9 (26.5%)	10 (17.0%)	
Quartile 2	12 (24.0%)	11 (32.4%)	13 (22.0%)	
Quartile 3	13 (26.0%)	7 (20.6%)	16 (27.1%)	
Quartile 4	9 (18.0%)	7 (20.6%)	20 (33.9%)	
Current neighborhood-level poverty (%)	27 ± 14	25 ± 15	31 ± 15	0.170
Quartiles of current neighborhood-level poverty[c]				0.639
Quartile 1	12 (24.0%)	11 (32.4%)	12 (20.7%)	
Quartile 2	16 (32.0%)	8 (23.5%)	12 (20.7%)	
Quartile 3	12 (24.0%)	7 (20.6%)	18 (31.0%)	
Quartile 4	10 (20.0%)	8 (23.5%)	16 (27.6%)	

[a]8 women missing grandmother's education.
[b]Quartile 1: 3.4–14%; Quartile 2: ≥14–29%; Quartile 3: ≥29–38%; Quartile 4: ≥38%.
[c]Quartile 1: 0.8–14%; Quartile 2: ≥14–29%; Quartile 3: ≥29–40%; Quartile 4: ≥40%.

II and III were fit additionally adjusted for current neighborhood-level poverty quartiles. Second, individual-level SES at the time of menarche may be a potential confounding variable. A previous study found maternal education to be more strongly associated with obesity than paternal education [24]; thus, we utilized *grandmother's* education as our measure of individual-level childhood SES. Several women ($n = 8$) had missing data for *grandmother's* education; to preserve sample size for the sensitivity analysis, mean imputation was used and models II and III were fit additionally adjusted for *grandmother's* education. Finally, since longer time since menarche may be associated with greater risk for obesity, we refit our final models adjusting for time since menarche instead of maternal age.

3. Results

As described previously [19], 3 women were *a priori* excluded due to prepregnancy morbid obesity preventing accurate assessment of weight with standard scales. Five women missing age at first period and five women reporting an address at menarche outside of Michigan were excluded. Sixteen women reported a complete address at menarche that was not mappable to the appropriate census tract and 30 women reported insufficient address information at menarche to allow for geocoding. Our final analytic sample consisted of 144 (72%) women able to report a valid residence at menarche. There was minimal clustering by neighborhood with the 144 women residing in 131 neighborhoods at the time of menarche.

There were no significant differences in women with and without reported address at menarche with respect to prepregnancy BMI ($P = 0.52$), age at menarche ($P = 0.25$), or age at study visit ($P = 0.91$).

3.1. Prepregnancy BMI. Overall, mean prepregnancy BMI of women was $29.0 \pm 7.4\,kg/m^2$; 59 (41.0%) women were obese at the start of pregnancy. Participant characteristics are presented by prepregnancy BMI category in Table 1. Time since menarche, age at study visit during pregnancy, marital status, parity, and being nulliparous were each statistically significantly associated with prepregnancy BMI category (all $P < 0.05$). Although obese participants had slightly younger age at menarche than overweight and normal weight participants, this was not statistically significant.

3.2. Neighborhood Poverty. At menarche, participants were living in neighborhoods where, on average, 27 ± 13% of residents were living below federal poverty levels, which is consistent with US estimates of childhood poverty between 1980 and 2000 [25]. Neighborhood-level poverty at menarche was statistically significantly and positively associated with parity ($P = 0.005$) and inversely associated with being nulliparous ($P = 0.004$) but was not statistically significantly

Table 2: Association of neighborhood-level poverty (in quartiles) at menarche with body mass index category.

Neighborhood-level poverty in quartiles at menarche	Model I		Model II		Model III	
	OR [95% CI OR]	P	OR [95% CI OR]	P	OR [95% CI OR]	P
4 versus 1	2.9 [1.2, 6.9]	0.049	2.6 [1.0, 6.7]	0.048	2.3 [0.9, 6.3]	0.091
3 versus 1	1.7 [0.7, 4.1]	0.870	2.5 [1.0, 6.7]	0.057	1.9 [0.7, 5.2]	0.214
2 versus 1	1.5 [0.6, 3.6]	0.752	2.5 [1.0, 6.6]	0.054	2.3 [0.9, 6.0]	0.101

Model I is unadjusted, Model II is adjusted for maternal age, marital status, and maternal education, and Model III is additionally adjusted for parity.
OR, odds ratio; CI, confidence interval.

associated with any other descriptive factor (all $P > 0.1$; data not shown).

3.3. Relationship between Poverty and BMI. Mean neighborhood-level poverty at menarche was higher among women in higher prepregnancy BMI categories (Table 1; $P = 0.054$). Table 2 presents the association of neighborhood-level poverty at menarche, in quartiles, with prepregnancy BMI category. In unadjusted models, women in the highest compared to lowest quartiles of neighborhood-level poverty at menarche had statistically significantly increased odds of being in a higher BMI category ($P = 0.049$). After adjusting for maternal age at study visit, maternal education, and marital status, compared to women in the lowest quartile of neighborhood-level poverty at menarche, women in the fourth quartile of poverty had increased odds of being in a higher prepregnancy BMI category compared to women in the 1st quartile ($P = 0.048$). After further adjusting for parity, the association was slightly attenuated and was no longer statistically significant ($P = 0.09$).

3.4. Sensitivity Analysis. There was a statistically significant and positive correlation between neighborhood-level poverty at menarche and current neighborhood-level poverty ($r = 0.19$, $P = 0.021$). In a model adjusted for maternal age, marital status, maternal education, and current neighborhood-level poverty, neighborhood-level poverty at menarche remained statistically significantly associated with prepregnancy obesity ($P = 0.048$); women in the highest compared to lowest quartile of neighborhood-level poverty at menarche had statistically significantly increased odds (OR = 2.7; 95% CI 1.0, 7.1) of being in a higher BMI category. This was slightly attenuated after further adjusting for parity (OR = 2.5; 95% CI 0.9, 7.0; $P = 0.078$). In a model adjusting for maternal age, maternal education, marital status, and *grandmother's* education [i.e., measure of childhood SES], the association between neighborhood-level poverty and prepregnancy BMI category was slightly attenuated (OR = 2.6; 95% CI 1.0, 6.8; $P = 0.057$). Further adjusting for parity, the association between neighborhood-level poverty and prepregnancy BMI category was slightly attenuated (OR = 2.4; 95% CI 0.9, 6.6; $P = 0.092$). Finally, in a model adjusting for time since menarche, marital status, and maternal education, the association of neighborhood-level poverty was slightly attenuated (OR = 2.3; 95% CI: 0.9, 5.9; $P = 0.096$) and remained elevated; however it was nonsignificant after adjusting for parity (OR = 2.1; 95% CI: 0.8, 5.7; $P = 0.145$).

4. Discussion

We provide first-time, observational evidence suggesting that living in a higher poverty neighborhood at the time of menarche is associated with greater prepregnancy obesity risk in African-American women. The association between neighborhood-level poverty at menarche and prepregnancy obesity remained elevated, although it was no longer statistically significant, after adjusting for parity. Our findings are consistent with a recent study showing lower neighborhood SES at puberty, but not in earlier childhood, was associated with lower levels of sex hormone binding globulin in a sample of 143 premenopausal, nonpregnant women (mean age 36.8 ± 5.5 years; 32.2% African-American) [22]; sex hormone binding globulin levels increase during pregnancy, with lower levels associated with measures of obesity [26].

Neighborhood poverty may impact obesity in several ways [27]. Poorer neighborhoods tend to have lower quality food retailers (i.e., more convenience and liquor stores and/or fast food restaurants) which may promote, by necessity, poorer eating habits [28]. This is often coupled with limited access to safe avenues for physical activity [29]. African-American women in particular may adopt unhealthy behaviors in early life, especially overeating of "comfort foods," as a learned, coping strategy to manage chronic stress [30]. Together, along with increased exposure to crime and other stressors, these factors may be contributing to prepregnancy obesity. Such exposures may be especially relevant during puberty [31]. In mouse models, stress (shipping) specifically experienced during puberty results in altered behavioral response to hormones and changes in the hypothalamic-pituitary adrenal (HPA) axis response [32]; dysregulation of the HPA axis activity is associated with obesity [33] and thus provides a potential biologic mechanism linking neighborhood poverty at menarche with prepregnancy obesity. Whether this is mediated through HPA axis activity, however, would require future study.

In our sample of African-American women, 41.0% were obese prepregnancy; this is higher than prepregnancy obesity rates in African-American women (31.5%) from 9 states in the Pregnancy Risk Assessment Monitoring System (PRAMS) [4]. In contrast, only 20.5% of Caucasian women were obese before pregnancy in PRAMS [4]. Data from Michigan, where obesity rates are nearly 37% among African-American adults [34], was not included in PRAMS which may explain why obesity rates are higher in our study.

In a recent study, the disparity in obesity rates between African-American and Caucasian youth was explained by neighborhood economic deprivation [27]. Neighborhood-level factors in adolescence, such as poverty, could directly promote disparities in prepregnancy obesity seen in adult women in the US. Our analysis focused on neighborhood at the time of menarche; although this is a critical stage in reproductive development [9] and thus may have particular relevance for health during pregnancy, future studies should capture other early-life time points (e.g., neighborhood at birth, at age 18 years) to establish and test the life-course approach.

After adjusting for parity, the association between neighborhood-level poverty and prepregnancy obesity was attenuated and no longer statistically significant. Higher poverty is associated with higher pregnancy rates [35]. Higher parity is also associated with increased prepregnancy obesity risk [4], as weight from previous pregnancies is often maintained into subsequent pregnancies. Because parity may be an intermediate variable in the association of neighborhood-level poverty at menarche with prepregnancy BMI, adjusting for it in our final models may have led to an overadjustment bias [36]. Similarly, the association between neighborhood poverty at menarche and obesity was attenuated when we adjusted for time since menarche instead of maternal age. Earlier age at menarche is associated with adult obesity [12] as well as with growing up in poverty [37] and thus future studies are needed to determine whether earlier age at menarche may act as a confounder or intermediate variable in the association of neighborhood poverty at menarche with prepregnancy obesity.

In the US, over half (51%) of pregnancies are unintended [38], making preconception programs to reduce the burden of maternal obesity during pregnancy challenging. Further, black women in the US have the highest rate of unintended pregnancy (69% of pregnancies) [38]. A recent Cochrane systematic review concluded that there were no randomized controlled trials that evaluated the impact of preconception interventions in overweight and obesity [39]. If the risk for prepregnancy obesity originates during puberty, the ideal time to intervene may be during adolescence. However, during pediatric well-child visits, pubertal topics are addressed less frequently than recommended [40] and may represent a gap in care that could improve future maternal and child health.

There are several limitations. Given the observational nature of the study, we cannot provide causal evidence of a relationship between neighborhood poverty at menarche and prepregnancy obesity. The association between neighborhood-level poverty at menarche and prepregnancy obesity, although only slightly attenuated, was not robust to inclusion of parity. Future studies with a larger sample size are needed to better understanding if parity is a confounding factor or a mediating variable. A number of women were unable to report address at menarche; while we found no differences between women who were and were not able to report address at menarche in selected characteristics, our results may be biased by this missing data. As done elsewhere [8], our primary outcome variable was based on self-reported prepregnancy weight. Although there was high correlation between first measured pregnancy weight and self-reported prepregnancy weight in our study and others have shown that categorization of prepregnancy weight comparing self-report to first measured pregnancy weight is similar [41], our results may still be subject to self-report bias. We did not have measures of body size at menarche, so we were unable to account for potential mediating effects via menarche body size. We assigned neighborhood poverty to women based on the decennial census year closest to year of menarche; this may not fully represent the neighborhood condition at menarche and may have introduced increased variability in the exposure assessment. While women's ability to recall age at menarche has been shown to be valid [42], the ability to recall residence at menarche has not been explored; thus we may be subject to recall bias. However, because menarche is a central, unique event of puberty, memory of characteristics surrounding this event (i.e., "flashbulb memories") may have enhanced recall of residential location at this time [42]. Any misclassification due to reporting errors in address at menarche would most likely be nondifferential with respect to prepregnancy weight and thus would bias results toward the null.

Despite these potential limitations, there are a number of strengths of the current study, including the fact that we have a relatively large sample of African-American women, a group at disproportionate risk of prepregnancy obesity [4] and typically underrepresented in research studies. Although measures of individual-level poverty at menarche and during pregnancy are potential confounders, the difficultly in self-reporting family poverty at menarche (compared to reporting a parent's education level) and the lack of willingness of research participants to report current income prevented accounting for these factors in our models. However, we were able to adjust our models for both individual-level SES at menarche (*grandmother's* education) and at pregnancy (participant's education) and results were similar. To our knowledge, this is the first study to examine neighborhood characteristics at menarche with prepregnancy obesity, which provides a life-course approach linking critical reproductive time points. Future studies are needed to examine such a life-course approach; such studies should capture not only information on the neighborhood at critical points in development, but also individual-level characteristics such as BMI and family income over the life course.

5. Conclusions

In summary, we found new evidence that neighborhood-level poverty at menarche is associated with prepregnancy obesity in African-American women. While interventions in adulthood to reduce preconception BMI have shown success [43], intervening earlier in life during adolescence to promote healthy weight throughout a woman's reproductive years may further improve maternal preconception health [44–46]. Including a social perspective in such interventions, such as the impact of neighborhood-level poverty during adolescence, may be promising [47]. This may be especially important for African-American adolescents, who are at highest risk for living in poverty during childhood [48]. Future studies, however, are needed to confirm our findings and to better understand the role of exposures at menarche in health before and during pregnancy.

Competing Interests

The authors declare that they have no competing interests.

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Research Article

A Qualitative Study to Examine Perceptions and Barriers to Appropriate Gestational Weight Gain among Participants in the Special Supplemental Nutrition Program for Women Infants and Children Program

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Women of reproductive age are particularly at risk of obesity because of excessive gestational weight gain (GWG) and postpartum weight retention, resulting in poor health outcomes for both mothers and infants. The purpose of this qualitative study was to examine perceptions and barriers to GWG among low-income women in the WIC program to inform the development of an intervention study. Eleven focus groups were conducted and stratified by ethnicity, and each group included women of varying age, parity, and prepregnancy BMI ranges. Participants reported receiving pressure from spouse and family members to "eat for two" among multiple barriers to appropriate weight gain during pregnancy. Participants were concerned about gaining too much weight but had minimal knowledge of weight gain goals during pregnancy. Receiving regular weight monitoring was reported, but participants had inconsistent discussions about weight gain with healthcare providers. Most were not aware of the IOM guidelines nor the fact that gestational weight gain goals differed by prepregnancy weight status. Results of these focus groups analyses informed the design of a pregnancy weight tracker and accompanying educational handout for use in an intervention study. These findings suggest an important opportunity for GWG education in all settings where pregnant women are seen.

1. Introduction

The current high rates of obesity continue to be a significant public health concern [1]. The childbearing years pose potential obesity risk for women because of excessive gestational weight gain (GWG) and postpartum weight retention [2–4]. Excess GWG and postpartum weight retention result in suboptimal pre- and perinatal health and predispose both mothers and their infants to long-term chronic diseases. In response to the mounting evidence, the Institute of Medicine (IOM) revised its 1990 recommendations and released new GWG recommendations in 2009 [5, 6]. These guidelines are specific to a woman's prepregnancy body mass index (BMI); for example, underweight women (BMI of $<18.5\,kg/m^2$) should gain 28–40 lbs; normal weight women (BMI of $18.5–24.9\,kg/m^2$) should gain 25–35 lbs; overweight women (BMI of $25.0–29.9\,kg/m^2$) should gain 15–25 lbs; and obese women (BMI $\geq 30.0\,kg/m^2$) should gain 11–20 lbs. Despite these guidelines, almost one-half of women exceeded the IOM recommendations [7]; groups particularly at risk for excess GWG are Black and Hispanic mothers [8, 9]. Adverse health outcomes from excess GWG during pregnancy include gestational diabetes, hypertensive disorders, cesarean delivery and operative complications [10, 11], and postpartum overweight and obesity [2–4, 12]. Excessive GWG from a previous pregnancy is a significant nutritional risk factor for subsequent pregnancies, leading to adverse health outcomes for the child, including increased risk of macrosomia and childhood obesity [10, 13, 14]. Consequently, increasing trends of maternal overweight and excessive GWG may set the stage for a transgenerational cycle of obesity as heavier mothers give birth to heavier daughters, who are at increased risk of becoming obese themselves during their childbearing years [15].

The Special Supplemental Nutrition Program for Women Infants and Children (WIC) is a food and nutrition education program for pregnant, breastfeeding, and postpartum women, infants, and children under age five who are low-income (up to 185% of the Federal Poverty Level) and at nutritional risk. Nationwide, approximately 25% of the individuals served are women, and approximately half of these women are pregnant with the other half postpartum. WIC services are available in every state and US territory, and currently WIC services are delivered to over 8 million participants each month. In Los Angeles County (LAC), WIC currently serves approximately 67% of all infants and about half of all children ages one to five, translating into approximately 500,000 individuals and 350,000 families each month. Because of WIC's deep reach in low-income ethnic minority communities, understanding and programming interventions to target WIC participants can potentially lead to significant positive outcomes in perinatal health of women and their young children.

Because WIC is uniquely positioned to potentially mediate perinatal health of mothers and children, especially ethnic minority and underresourced communities, research on GWG in this population is vital. The most recent quantitative studies of GWG have focused on predictors of child weight based on maternal weight [16, 17]; only two studies have specifically focused on women in the WIC program [18, 19]. Qualitative studies have the advantage of allowing researchers to explore GWG in multiple and complex dimensions such as knowledge, attitudes, opinions, and reported behaviors during pregnancy. Currently, the qualitative literature has a scant, but growing body of work which document knowledge and barriers to gestational weight gain, and most of these studies have focused on low-income Black or Hispanic women [20–22]. The results of these studies suggest the need for more qualitative work in these communities to better understand cultural barriers and facilitators of appropriate GWG during pregnancy.

One qualitative study of African-American women suggested focusing research on GWG in the WIC program in order to develop strategies for improving long-term health of mothers and their children [22]. To date, we are not aware of any qualitative studies which have specifically examined the perceptions of GWG among an ethnically diverse group of participants in the WIC program. Therefore, the objectives of this qualitative study were threefold: (1) to explore knowledge, attitude, and perceptions regarding weight gain during pregnancy among participants in the WIC program; (2) to assess participants' knowledge and awareness of the IOM guidelines for weight gain during pregnancy; and (3) to solicit participant feedback and suggestions to inform the development of a gestational weight gain intervention in the WIC program.

2. Materials and Methods

2.1. Study Design, Participants, and Recruitment. Between February and December 2013, we conducted a series of 11 focus group interviews with a total of 59 WIC participants across 3 ethnic groups (Caucasian, Black, and Hispanic) to inform the design a gestational weight gain intervention among WIC participants. These ethnic groups were chosen because they represent the largest ethnic groups in the US as well as in the WIC program [23, 24]. WIC participants were recruited for this study if they met the study criteria of being pregnant at the time of the study and self-identified as white/Caucasian, Black/African-American or Hispanic/Latina. Each focus group was stratified by ethnicity in order to explore potential cultural variations in perceptions, attitudes, and behaviors with regard to gestational weight gain. Within each focus group, there was diversity in age, parity, and prepregnancy BMI ranges among the participants. Focus groups with Hispanic participants were grouped into English-speaking and Spanish-speaking in order to facilitate discussion among those with limited English proficiency. Recruitment of focus group participants and facilitation of focus group interviews were accomplished with support from staff from the Public Health Foundation Enterprise (PHFE) WIC Program in a number of WIC centers around Los Angeles, California.

Inductive semistructured focus group guides were developed by the research team, with feedback from PHFE-WIC research staff. Open-ended questions were utilized to stimulate discussion and included probes to address more specific dimensions of each topic. Focus group guides explored the following major topics: (1) health perceptions during pregnancy; (2) barriers to appropriate weight gain; (3) weight monitoring during pregnancy; (4) knowledge and recognition of IOM weight gain guidelines. Additionally, we solicited participant opinions on how to develop educational tools, including a gestational weight gain tracker that would help mothers track their weight gain through pregnancy, for the intervention phase of the study. Focus group guides were translated into Spanish and back-translated to ensure integrity and consistency.

Focus group moderators were trained in qualitative research and had experience moderating focus group interviews. The Spanish-speaking focus group moderator was bilingual and bicultural. Focus groups ranged from 5 to 8 women, and each session lasted an average of 90 minutes, with question and answer format so the discourse was unhurried. Prior to the start of a focus group discussion, participants provided written informed consent and completed a short demographic questionnaire which included self-reported height and prepregnancy weight. All focus group sessions were videotaped and audio recorded. All recording files were password protected and stored on a secure server at Pepperdine University. All transcripts were transcribed verbatim by an independent contractor; focus group sessions conducted in Spanish were transcribed verbatim in Spanish, then translated to English, and checked for accuracy by an independent reviewer. All aspects of the study were reviewed and approved by the University of California, Los Angeles,

Table 1: Description of the sample ($N = 59$).

	N	%	Mean	s.d.
Age	59		28.20	5.41
Years in WIC	59		2.39	3.16
Years in the US	24		14.27	7.69
Birthplace				
US born	35	59.3		
Foreign born	24	40.7		
Children in WIC				
Pregnant	30	50.8		
One child	21	35.6		
Two children	8	13.6		
Ethnicity				
White	13	22.0		
Black	20	33.9		
Hispanic-English-speaking	18	30.5		
Hispanic-Spanish-speaking	8	13.6		
Marital status				
Married	19	32.2		
Divorced	3	5.1		
Separated	4	6.8		
Never married	33	55.9		
Education				
Up to 12th grade	16	27.1		
High school grad or GED	15	25.4		
Some college/associate	21	35.6		
Bachelors and beyond	7	11.9		
Employment				
Self-employed	17	28.8		
Unemployed	24	40.7		
Homemaker	9	15.2		
Student	6	10.2		
Unable to work	3	5.1		
Maternal BMI				
Underweight	4	6.8		
Normal weight	24	40.7		
Overweight	12	20.3		
Obese	19	32.2		

and Pepperdine University's Institutional Review Board for the protection of human research subjects. As a token of gratitude for their time and participation in the study, each participant received a $20 gift card.

2.2. Data Analysis. Descriptive statistics were computed using SPSS version 22 (Chicago, IL) and are summarized in Table 1. All transcripts and interviewer notes were organized and coded using ATLAS.ti version 6.1 (ATLAS.ti Scientific Software Development GmbH, Berlin, Germany) and analyzed using thematic analysis [25, 26]. The research team, consisting of the lead author and research students trained in qualitative methods, analyzed these data. The analysis process began with the research team conducting multiple independent readings of the transcripts to allow themes to emerge. To develop consensus, the research team convened after the initial reading to discuss codes and build emerging themes. Subsequently, a second pass of the transcripts was completed to ensure that all themes were captured. Following a third reading, the research team convened again to discuss any additional themes and reconciled any inconsistencies. Percentages presented in the results section reflect participant responses during the focus group by a show of hands or a nod in response to a count question. The researchers compiled these percentages by reviewing the video recordings to count participant responses.

3. Results and Discussion

3.1. Participant Characteristics. Demographic characteristics are summarized in Table 1. Focus groups were stratified by ethnicity, and overall about one-fifth of the participants were Caucasian, one-third were Black, and nearly half were Hispanic. On average, focus group participants were 28 years old and had been in the WIC program for 2.39 years, and about half (50.8%) of the participants were pregnant with their first child. More than half of the participants were born outside of the US and of these, most reported being from Mexico or Central America. About one-third of the participants were married, and more than 75% of the participants had at least a high school diploma or GED equivalent. More than half of the participants were either overweight or obese.

3.2. Focus Group Concepts and Emerging Themes. The following shows sample focus group questions organized by the four major topics.

Perceptions of health during pregnancy:

> To you, what does it mean to be healthy?
>
> Generally, how healthy do you think you are? Would you say you are in excellent, very good, fair or poor health? Why?
>
> During pregnancy, do you think you are as healthy as when you are not pregnant? Why?

Barriers to appropriate GWG:

> How would you say you are doing in terms of weight gain during pregnancy? Would you say you are gaining too, too little, or just the right amount of weight?
>
> Are you concerned about how much weight you have gained at this time? Does anyone in your family share your concerns about how much weight you have gained?
>
> What is the biggest challenge for you to gain the right amount of weight during pregnancy?
>
> What do you think are the consequences of gaining too much or too little weight during pregnancy?

Weight monitoring during pregnancy:

> Are you weighing yourself or getting weighed regularly?
>
> When you come for your pre-natal visits, does your doctor talk with you about how much weight you have gained? Please share about this experience.
>
> When you come for your regular WIC visit, do WIC staff talk with you about your weight? Please share about this experience.
>
> When WIC staff talk with pregnant moms about their weight, how do you think WIC staff should approach the topic of weight gain during pregnancy?

Knowledge and recognition of IOM guidelines and ideas for education:

> Have you heard of or seen these IOM guidelines for weight gain?
>
> Are you aware there are different weight gain recommendations for pregnant women, based on your pre-pregnancy weight? If so, where did you learn about these recommendations?
>
> When we develop the GWG tracker tool [participants provided samples], how should we differentiate the different pre-pregnancy weight groups? Should we put these terms (underweight, normal weight, overweight or obese) on the tracker?
>
> If WIC develops classes about gaining the right amount of weight, what specific issues do you think we need to address?

Figure 1 provides a schematic overview of the topics discussed in the focus groups; within each topic, clear themes emerged from focus groups discussions, and we describe them in more detail below.

3.2.1. Perceptions of Health during Pregnancy. The focus group discussion began with a general open-ended question about participants' perception of health. Participants were asked to rate their health as excellent, good, fair, or poor and to elaborate on why they chose a particular rating. A majority of the participants (85%) rated their health as either fair or good; only 4 of the 59 participants reported being in excellent health. Those participants who indicated having fair or good health commented that they rated their health that way because they were overweight or ate too much fast food or junk food. For those who indicated that they were in poor health, they also reported being overweight, not exercising, and eating out or eating "street food" too often. For the few who indicated being in excellent health, they reported eating healthy, exercising, and drinking water on a regular basis.

When asked about their perception of health during pregnancy, a majority of the participants (more than 80%) indicated that they felt healthier during pregnancy than when they were not pregnant. When probed about why they felt healthier, participants reported (1) being mindful of the baby inside and feeling responsible to help baby grow as healthy as possible and (2) trying to choose healthier foods, cutting back on "street food" and cooking at home, consuming less junk food, drinking more water, and cutting back on sodas and other sugar-sweetened beverages. One mother shared, "I think I'm healthier because I feel like I've got to do this for the baby more than me." Another participant stated, "I would say [I am] more healthy because you have the responsibility to take care of yourself and your baby who's growing inside of you. You want a healthy baby."

3.2.2. Barriers to Healthy Weight Gain during Pregnancy. When asked about their ability to maintain appropriate and healthy weight gain during pregnancy, participants reported the following reasons as barriers to being able to maintain healthy weight, which these women defined as "not too much, not too little weight gain." The first barrier was the encouragement from family members to "eat for two." Participants shared that spouses, mothers-in-law, siblings, and grandparents encouraged them to eat more because they had to feed their babies. As a result, these women reported difficulty in being able to maintain their weight. Even when they did not want to eat, participants reported being strongly encouraged to eat more by family members. Second, participants reported having cravings as a barrier to being able to maintain healthy weight, as one mother reported, "With my first son, I craved a lot of fruit, so it was more healthy. But this time around, I crave chocolate, cakes, all that sugary stuff." Third, participants indicated that being tempted by what family members were eating around them was another barrier to maintaining healthy weight. Because the family members were able to eat without any restrictions, these pregnant women also wanted to be able to eat whatever others around them were eating. Many participants were cognizant that they could not because of the excessive calories associated with overeating, particularly high sugar foods. One participant lamented, "It's harder because I have my kids and my husband. They want to go get burgers and here I am with my turkey sandwich. If it was my first pregnancy, it [wouldn't] be as hard. It's harder because my kids want soda. I don't give them that much, but sometimes just a cup of soda. I want some soda too but I can't. It's harder on me because of my family." Another barrier reported was the lack of knowledge about what to eat during pregnancy. One participant shared, "When I lived with my mother-in-law, she would eat a lot of meats, but also she would cook a lot of vegetables – boiled. So now that I live on my own, I look in the refrigerator and I'm like, 'well, what do I cook?' I know how to cook, but I just don't know, what [do I] cook? Or when I'm in there, or I look at the pantry and I'm like 'how do I make that?'". The last barrier reported was having morning sickness symptoms such as nausea and vomiting as barriers to being able to eat healthy.

3.2.3. Weight Monitoring during Pregnancy. When the discussion focused on weight monitoring during pregnancy, all participants shared affirmatively that they were concerned

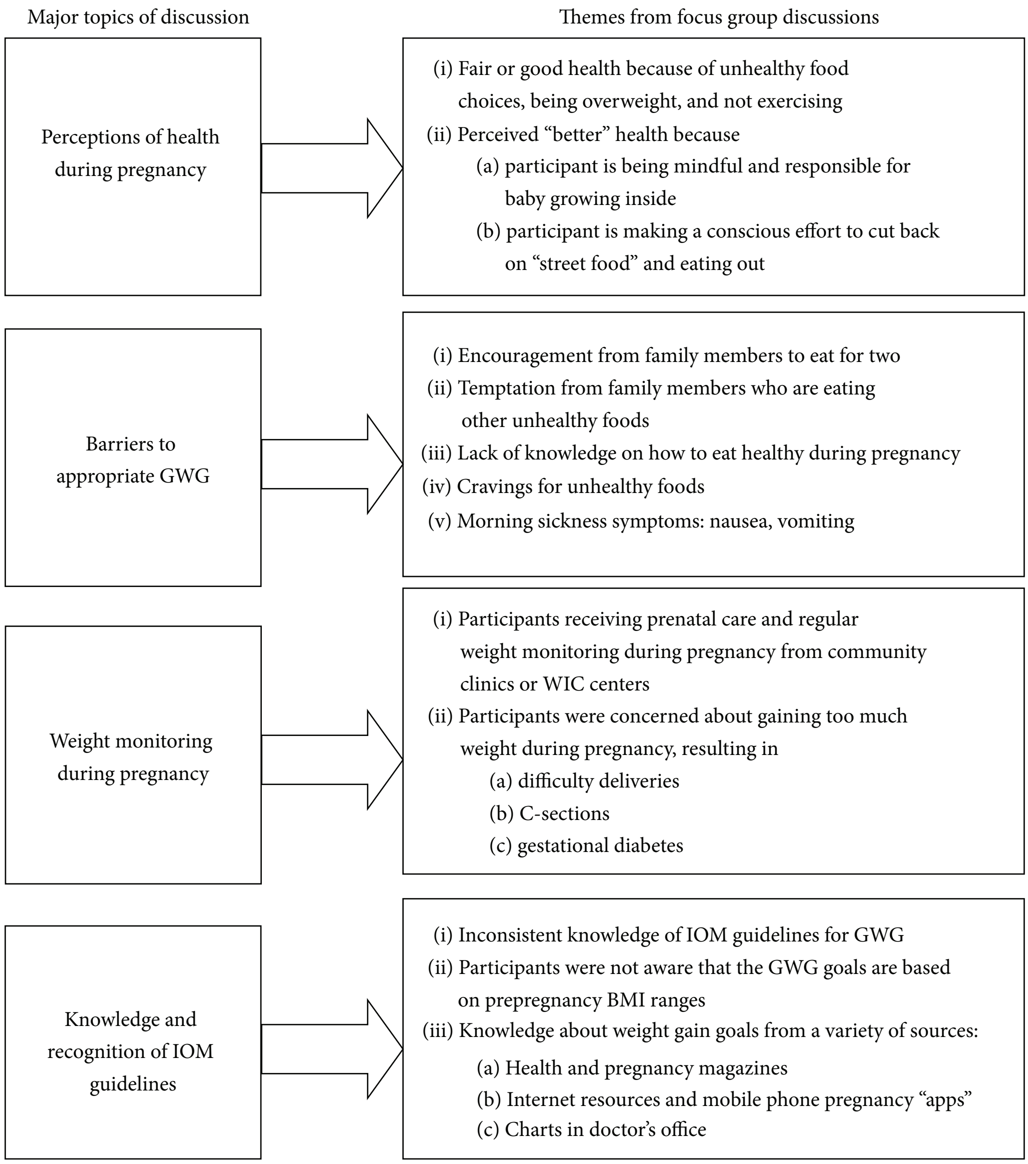


Figure 1: Overview of focus group topics and emerging themes.

about their weight, but they did not know how much weight they should be gaining during pregnancy. These concerns centered on having difficult deliveries or complications, such as C-sections. One mother shared, "I'm actually very concerned if I gain a lot of weight because my doctor said if I gain a lot more than I should, it will be very hard for the delivery time." Second, women were concerned about weight loss after delivery. One mother reported, "Gaining too much. It's hard to lose the weight after. You have to think of the aftermath because once the baby comes out you're stuck with this weight." Finally, about one-third of the women shared that they were concerned about developing gestational diabetes if they were overweight during pregnancy. One mother suggested, "I guess, if you gain too much weight, then your baby is going to be bigger and then in my case if I gain too much, then I can get gestational diabetes, which I never had with any of my other pregnancies."

All women reported receiving some form of prenatal care and weight monitoring during their pregnancy, either from a private doctor or community clinic. Most women also reported being weighed regularly at a prenatal visit or at WIC. Additionally, some participants also weighed themselves regularly at home; these participants were particularly concerned about their risk of developing gestational diabetes. A few women admitted to being in denial, not wanting to know their weight. Some felt that pregnancy was a "special time" in their lives, so weight should not be the focus. Others were resigned that they were already "big," so it was of no benefit to step on a scale. One participant lamented, "I don't [weigh myself] at home. I don't know, I just think that if I do it

I'm going to obsess over the weight, and I don't want to harm my baby. But then if I feel that my clothes don't fit, I'll start drinking water."

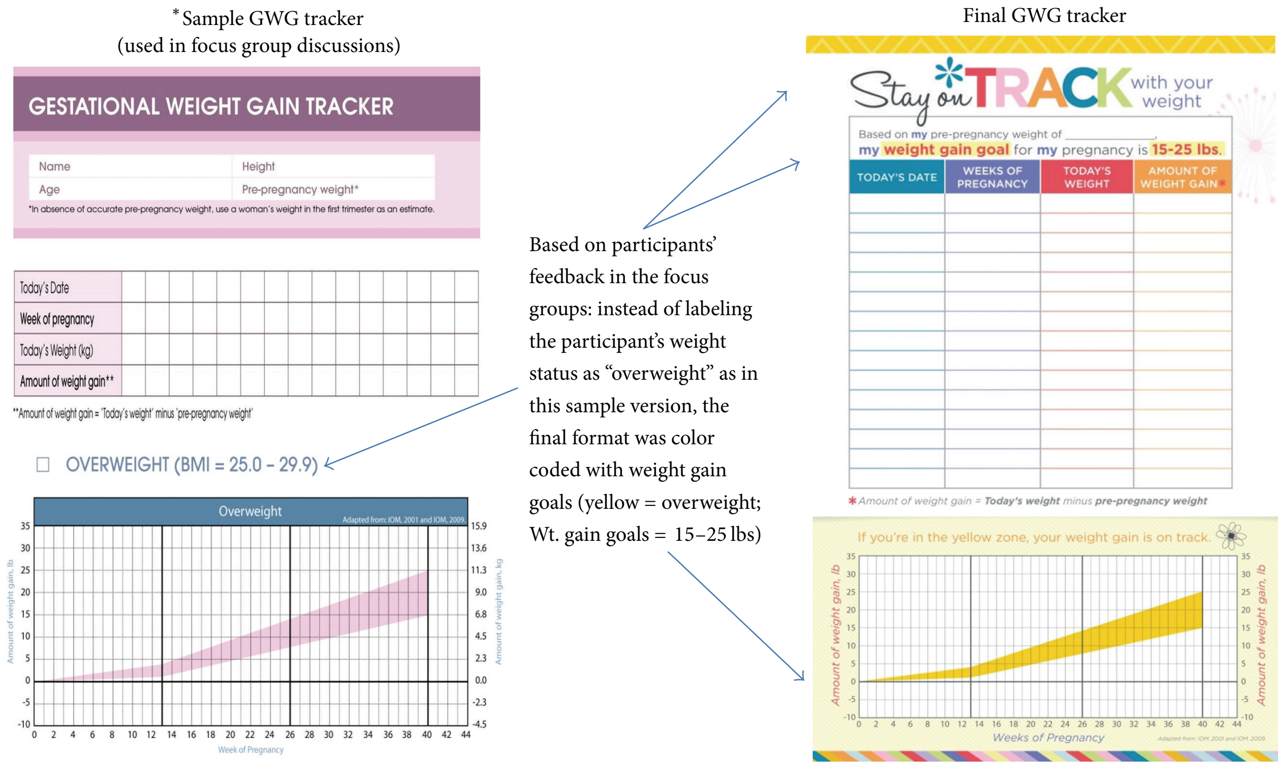
When asked if they discussed weight gain goals during pregnancy with their healthcare providers during prenatal visits, participants shared inconsistencies with regard to whether their doctors discussed weight gain during pregnancy. For some participants, their doctors discussed weight gain goals and provided feedback so participants were aware of whether they were gaining the appropriate amount of weight during pregnancy. For other participants, their doctors told them they were "fine" and did not have to worry about their weight. Some others shared that there was minimal or no discussion of their weight during their monthly prenatal visits. One participant reported, "In my case, they haven't told me that I am gaining too much weight. They always tell me that I am fine and that is why I don't worry. Now if they told me that I gained too much then I would have to do something; but till now they haven't told me that I am bad."

3.2.4. IOM Guidelines for Weight Gain during Pregnancy. A few women (5 of 59) had no knowledge or awareness of any guidelines for weight gain during pregnancy; most of these women were more recent immigrants. Some participants had seen weight gain goals and were aware of the concept of weight gain goals during pregnancy. Among those who knew about weight gain ranges, there were inconsistencies with the weight gain ranges reported by these participants. Some reported ranges that were higher than the IOM guidelines, while others reported lower weight ranges. Among those who knew about weight gain ranges, some shared that they knew about weight gain goals from their doctor, charts in the doctor's office, educational pamphlets, baby magazine and "baby" books, or online resources (websites and mobile phone applications or "apps"). A few women indicated they had learned about their weight gain goals from WIC staff. One participant reported, "Here in WIC, yes. Every time they weigh me they say that 10–15 pounds is what is normal to gain during pregnancy for me. But in the [health] clinic, no." Most importantly, most women (>75%) were not aware that their gestational weight gain goals differed by prepregnancy weight status. These results are confirmed by Anderson and colleagues, who also found that women received inadequate or conflicting information about pregnancy nutrition and GWG from health care providers [27]. This suggests an important opportunity and avenue for education in all settings where pregnant women are routinely seen.

3.2.5. Ideas for Educational Tools: A Pregnancy Weight Tracker. One of the complications of determining appropriate GWG is that guidelines are based on four categories of prepregnancy weight: underweight, normal weight, overweight, or obese. In the focus group discussions of how to differentiate the pregnancy weight tracker tool based on prepregnancy weight status, participants offered different ideas for how to identify the woman's weight category. Some participants wanted the weight designation (underweight, normal weight, overweight, and obese) listed on the pregnancy weight tracker because it was an accurate reflection of their weight status; others expressed concern that the labels posed a negative stigma. One mother said, "I agree, some people might not be able to accept that [they are overweight]. I don't know, but I agree you shouldn't get mad, because it's the truth if you're overweight." For a majority of Caucasian and Hispanic participants, the designation of "overweight" or "obese" on the tracker was a sensitive issue, and they preferred not to have these labels on the pregnancy weight tracker; instead, the participants suggested color coding the four weight ranges and including the weight range goals on the pregnancy weight tracker. One participant commented, "You don't know how sensitive a person may be when it comes to words like 'obese' or 'overweight', and like she said, what does it mean? How do you define that for a person? So, I think maybe that's a bit more sensitive matter." Another participant suggested distinguishing the different weight categories by color: "No, I don't think [overweight or obese] should be on the pregnancy weight tracker. I think it would be a constant reminder that you're overweight. But having different colors for different weights is better."

When asked if participants were interested in having a way to track their weight gain during pregnancy, all the participants indicated a strong interest in having a tool to track their weight during pregnancy. Most women reported a willingness to use a pregnancy weight tracker if WIC provided one; also, the women suggested that the pregnancy weight tracker would be helpful to facilitate discussion of their weight gain goals at regular prenatal visits with their healthcare provider, as well as WIC visits. A majority of the women indicated that they would like a "credit card" sized pregnancy weight tracker for their purse and "half sheet" to be used at home, to be placed either on the refrigerator or in the bathroom. Participants shared affirmatively that they were interested in having accountability with using the pregnancy weight tracker, along with educational handouts. Participants shared that having a pregnancy weight tracker (GWG tracker) on hand to discuss with WIC staff and their doctors would encourage them to monitor their own weight and stay on track with weight gain goals. One participant suggested that the pregnancy weight tracker should be a routine part of WIC services, "They ask about our address and income when we come, and they should ask about that [pregnancy weight tracker] too when they give it out."

3.2.6. Applications of Focus Group Findings to an Intervention Study. Findings from this study suggest that participants face significant barriers to being able to gain the appropriate amount of weight and are very interested in tools and education to help stay on target with weight gain. Results of focus groups analyses were utilized to design a GWG tracker and accompanying educational handout for use with pregnant moms enrolling in WIC. A GWG tracker was developed based on their feedback (compact size so participants can carry it with them and color coded rather than identifying their weight status). The educational handout incorporated messages related to the barriers women identified. The first



*Sample GWG tracker is from http://www.healthcanada.gc.ca/nutrition
Link to available resources from PHFE-WIC: https://www.phfewic.org/Projects/GestationalWeightGain.aspx

Figure 2: Sample and final pregnancy weight tracker (GWG tracker).

barrier discussed by the participants was the theme of "eating for two." This perception of having to "eat for two" contributed to participants feeling the need to eat more, which then encouraged higher gestational weight gain rather than discouraging it. These findings are confirmed in other qualitative research studies with African-American and Puerto Rican mothers [20, 21, 28]. This suggestion from family members to eat for two is derived from motivation and desire to optimize pregnancy outcomes and fetal growth. If mothers do not perceive excess weight gain to be problematic, there will be little "buy-in" to follow the IOM guidelines. These perceptions of threat and susceptibility are at the heart of the Health Belief Model [29]; as such, these findings suggested the need to direct nutrition education to target debunking this myth of "eating for two." The educational handout developed for the intervention phase served to debunk the myth in the following ways: (1) providing clarification for weight gain distribution during pregnancy; (2) explaining how excess weight gain leads to complications with pregnancy and delivery; (3) providing IOM weight gain ranges so participants are aware and can track their weights during pregnancy.

We found that a majority of the focus group participants were concerned about gaining too much weight but had many misperceptions and barriers that needed to be clarified and corrected; these findings are corroborated by another study [22]. The educational handout serves to debunk myths and correct understandings about GWG. Figure 2 provides a sample GWG tracker tool that was developed for use during the focus group discussions; focus group participant feedback and suggestions led to the final GWG tracker. This GWG tracker tool allows participants to be accountable about their weight gain goals and facilitates discussions with their doctors about weight gain during prenatal visits and with WIC nutritionists. Finally, placement of the GWG goals on the pregnancy weight tracker builds awareness among participants of appropriate weight gain during their pregnancy. Building this awareness among WIC participants for appropriate GWG provides important perceived benefits which, based on the Health Belief Model [29, 30], may go a long way in raising consciousness among WIC participants.

While this qualitative study provided important grounding for the development of an intervention study to prevent excessive GWG among WIC participants, it is not without its limitations. Because the sample is specific to the WIC population, these findings may have limited generalizability to the entire population of pregnant women who have varying socioeconomic and cultural backgrounds. Second, the Hispanic population of WIC participants is primarily from Mexico, and this may not be generalizable to WIC programs in other parts of the US. Finally, while it is possible that our findings may have been impacted by the presence of women with different BMI classifications within a focus group, our moderators used qualitative methodology skills to encourage all participants to share. It would be beneficial in future studies to also further stratify focus groups by BMI classifications to ensure a more homogenous grouping of women based on weight groupings. Despite these limitations, the benefit of this qualitative study was to allow for an unhurried and open discussion of the IOM gestational weight gain guidelines and challenges to appropriate weight gain during pregnancy in the WIC program; the findings from these discussions were applied directly to inform the development of the intervention.

4. Conclusion

Findings from this study have important implications for how perinatal health is conceptualized and assessed. These findings illustrate the complex nature of weight gain during pregnancy, particularly among low-income ethnic minority groups. This work extends the discussion beyond a simplistic and unidimensional conceptualization to one which considers the multilevel and complex socioecological landscape in which immigrant communities navigate their health decisions. Employing qualitative research methods in maternal and child health research with immigrant groups allow for findings and interpretations to be grounded in the cultural context of daily lived experiences. Second, narratives give voice to and illuminate our understanding of how individual experiences collectively and simultaneously affect pregnancy outcomes, thus providing a more holistic perspective on the impact of culture on perinatal health. At a practical level, this holistic approach allows for a better understanding of the contextual environment in which many of these low-income families live; as a result, we will be able to design WIC-based programming and health-related interventions that will address these barriers and move us forward in bridging the gap in health disparities.

Competing Interests

The authors declare that there are no competing interests regarding the publication of this paper. Funding from USDA/UCLA did not lead to any competing interests regarding the publication of this paper. The authors have no other possible competing interests to reveal in the publication of this submitted paper.

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Research Article

Obesity-Related Dietary Behaviors among Racially and Ethnically Diverse Pregnant and Postpartum Women

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Introduction. Obesity is common among reproductive age women and disproportionately impacts racial/ethnic minorities. Our objective was to assess racial/ethnic differences in obesity-related dietary behaviors among pregnant and postpartum women, to inform peripartum weight management interventions that target diverse populations. *Methods.* We conducted a cross-sectional survey of 212 Black (44%), Hispanic (31%), and White (25%) women, aged ≥ 18, pregnant or within one year postpartum, in hospital-based clinics in Baltimore, Maryland, in 2013. Outcomes were fast food or sugar-sweetened beverage intake once or more weekly. We used logistic regression to evaluate the association between race/ethnicity and obesity-related dietary behaviors, adjusting for sociodemographic factors. *Results.* In adjusted analyses, Black women had 2.4 increased odds of fast food intake once or more weekly compared to White women (CI = 1.08, 5.23). There were no racial/ethnic differences in the odds of sugar-sweetened beverage intake. *Discussion.* Compared with White or Hispanic women, Black women had 2-fold higher odds of fast food intake once or more weekly. Black women might benefit from targeted counseling and intervention to reduce fast food intake during and after pregnancy.

1. Introduction

Obesity is increasingly prevalent among reproductive age women [1–3] and is associated with pregnancy complications such as gestational diabetes and hypertensive disorders of pregnancy [2, 4–6]. Obesity disproportionately impacts women of racial and ethnic minorities, with highest rates in Black women, followed by Hispanic and White women [3], and potentially contributes to racial and ethnic disparities in other chronic diseases such as diabetes, hypertension, and cardiovascular disease [7–9]. Like preconception obesity, gaining excessive gestational weight disproportionately affects racial and ethnic minorities [2] and is associated with pregnancy complications and future risk of long term overweight and obesity [10, 11].

Pregnancy provides an opportunity to identify unhealthy behaviors and promote healthy eating habits, which can be sustained beyond pregnancy. Understanding racial and ethnic differences in health behaviors could inform and target future interventions. However, evidence is not yet clear as to whether the observed racial and ethnic differences in preconception obesity and gestational weight gain are associated with differences in obesity-related dietary behaviors [12–16]. Further, we found no studies specifically evaluating fast food and sugar-sweetened beverage intake in this population, two potentially modifiable dietary behaviors which are associated with obesity [17–19]. Previous studies used health behavior surveys to evaluate differences in dietary habits between Black and Hispanic women, but results did not show consistent differences between the racial and ethnic groups

[12–14, 16]. The largest of these four studies excluded women with chronic medical comorbidities such as hypertension or diabetes [12] or high risk pregnancies [16]. Another large, prospective cohort of 2394 women used food frequency questionnaires to evaluate dietary differences among racial groups [15], but the study populations were primarily middle class.

Our primary objective was to address an important evidence gap: the association between race and ethnicity and differences in women's obesity-related dietary behaviors during pregnancy and after delivery, among a socioeconomically diverse group of women. Based on evidence from previous studies [1–3, 12, 14], we hypothesized that Black women would have higher odds of both fast food and sugar-sweetened beverage intake.

2. Methods

2.1. Study Design. We conducted a cross-sectional analysis using data collected in a convenience sample, using a one-time, self-administered questionnaire describing health behaviors among a sample of pregnant and postpartum women. This study was approved by the Johns Hopkins University School of Medicine Institutional Review Board.

2.2. Sample Population. A total of 247 English or Spanish speaking women, ≥18 years old, pregnant or within 1 year postpartum, who reported the ability to read the survey in English or Spanish, completed the survey. Women were recruited from 1 of 4 outpatient clinics (including high risk obstetrics and pediatrics practices) in 2 academic hospitals in Baltimore, Maryland, between January and April 2013. Participants completed a one-time, self-administered questionnaire at the time of their or their children's appointments. Of the 247 women, the 212 women who were identified as Black, Hispanic, or White were included in this secondary analysis. The 35 participants in the other racial categories were as follows: 4% were Asian, 0.4% were Hawaiian or Pacific Islander, 1.6% were American Indian or Native Alaskan, and 3.3% described themselves as multiethnic. The diversity of the other racial/ethnic group limited our ability to make comparative inferences about their dietary habits, and these women were thus excluded from this analysis.

Our study was performed on a convenience sample. Data was collected only from those women who were approached and agreed to participate. We did not calculate the percentage of patients approached who agreed to participate in our study or evaluate the ways in which the participating women may differ from those women that chose not to participate.

2.3. Measure. The survey, which included questions about sociodemographics and dietary behaviors, was adapted from validated national survey instruments [20–22]. Items on fast food were adapted from the Coronary Artery Risk Development in Adults Study: How many times in the past week did you eat out in a fast food restaurant such as McDonald's, Burger King, Wendy's, Arby's, Pizza Hut, or Kentucky Fried Chicken? (1) Never or less than once weekly, (2) 1-2 times per week, (3) more than 3 times per week but less than daily, or (4) at least daily [20]. Items related to sugar-sweetened beverages were adapted from the Behavioral Risk Factor Surveillance System: In the past 7 days, how often did you drink soda (not diet) or other sugar-sweetened beverages, like Hawaiian Punch, lemonade, or Kool-Aid? (1) Never or less than 1 can per week, (2) 1-2 cans per week, (3) more than 3 cans per week but less than daily, (4) about 1 can per day, or (5) 2 or more cans per day [21].

The final questionnaire was translated into Spanish and back translated to English. A pilot study was performed to ensure that the questionnaire met criteria for a 5th-grade literacy level, as well as culture appropriateness, ease of understanding, and quick time to completion.

2.4. Definition of Main Predictor Variables: Race/Ethnicity and BMI. Race and ethnicity were self-reported on the questionnaire. Participants were asked the following questions: Are you Hispanic or Latino? Which of the following best describes your race? Check all that apply: Asian, African American or Black, Caucasian/White/European American, Native Hawaiian or other Pacific Islander, American Indian/Alaska Native, or Multiethnic or mixed. We then categorized the racial and ethnic groups into African American/Black, Hispanic, Caucasian, or other races/ethnicities. As above, women reporting other racial or ethnic categories were not included in the analysis.

Preconception body mass index (BMI) was calculated based on self-reported height and preconception weight for pregnant women and current weight for postpartum women and categorized into obese (BMI ≥ 30) and nonobese (BMI < 30) [23, 24].

2.5. Definition of Outcomes. The primary outcomes were fast food frequency and sugar-sweetened beverage intake, both defined as less than once weekly versus once or more weekly. The rationale for these cut-points was based on the median intake in our sample. Prior studies used similar cut-points and showed that the consumption of fast food two or more times per week was associated with weight gain and insulin resistance over 15 years, when compared to those who eat fast food less than twice weekly [18]. Notably, existing literature on sugar-sweetened beverage intake demonstrated greatest risk of weight gain [25] and coronary heart disease [26, 27], with at least daily consumption of sugar-sweetened beverages. A frequency cut-point of once or greater per week was also deemed simple to assess clinically and to be potentially actionable.

2.6. Other Covariates. Sociodemographic variables included age, language proficiency, marital status, education, employment, and income. Age was categorized as follows: 18–24, 25–29, 30–34, and ≥35. English language proficiency was categorized as "adequate" if the respondent reported very good English language proficiency and "limited" for other responses, based on response categorization in the US Census [28]. A binary variable for marital status was created to assess

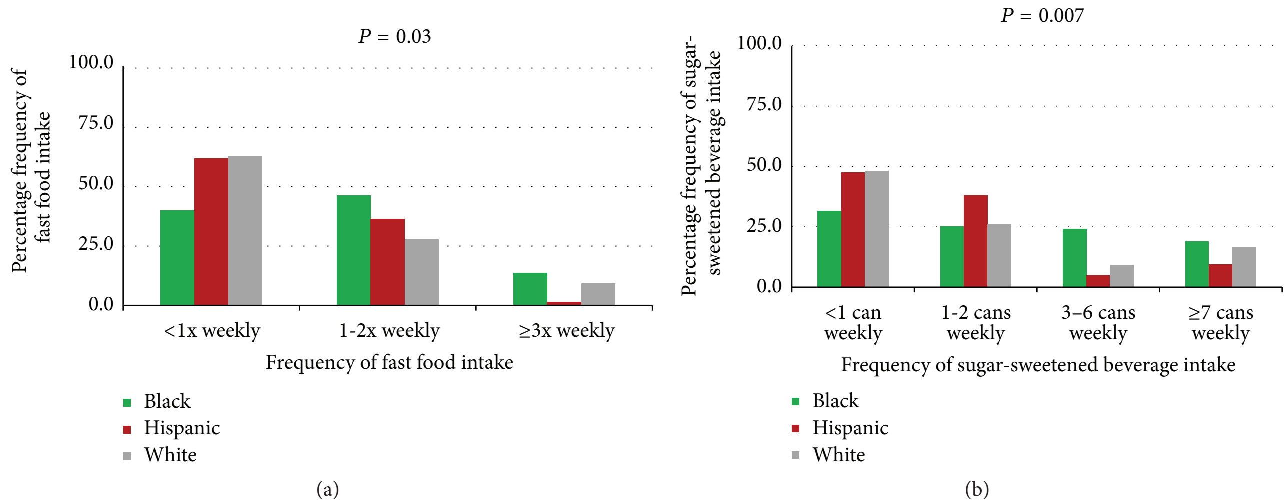

Figure 1: (a) Unadjusted weekly fast food intake by race/ethnicity. (b) Unadjusted weekly sugar-sweetened beverage intake by race/ethnicity.

differences between those who were married or living with a partner and those who were not.

Education level was divided into three variables including those with less than a high school education, those graduating high school or obtaining a GED, and those with one or more years of college. Employment was assessed and categorized into employed (full or part time), unemployed, maternity leave, home maker, disability, or student. We also assessed income and categorized the data into broad categories, as noted in Table 1. Financial strain was a separate income variable, based on participant response to the survey question, "In the past 12 months, was there ever a time when you did not have enough money to meet the daily needs of you and your family?"

Pregnancy status and medical comorbidities were binary variables based on responses to the question, "Have you been told that you have had any of these health problems? Check all that apply: overweight or obese, type 2 diabetes, gestational diabetes (diabetes in pregnancy), high blood pressure, preeclampsia or toxemia, and none of the above." A binary variable was created for smoking, in which a yes response represents any smoking.

2.7. Analysis. Descriptive analyses were used to explore the data by race and obesity categories and to describe the proportion who endorsed barriers to healthy behaviors. We utilized univariate and multivariate logistic regression models to evaluate for confounders [29]. Age, marital status, English language proficiency, presence of a child under age 5 at home, and education level were included in the model based on our review of the literature. Financial strain was included as the financial variable, rather than income, due to concerns about differential bias as a result of the large percentages of Black (23%) and Hispanic (37%) participants who declined to answer the question on income.

To evaluate the role of obesity in the relationship between race/ethnicity and dietary behaviors, we assessed effect modification using stratified samples by BMI $\geq$ 30 and <30. The rationale was that obesity may be the result of poor dietary behaviors but obese pregnant women may be more likely to receive behavioral counseling and thus make lifestyle changes. While we do not know of any specific data examining the role of race in these behaviors, there is data demonstrating racial and cultural differences in body image [30], which could potentially lead to modification of racial differences in fast food and sugar-sweetened beverage intake, based on obesity.

We performed two sensitivity analyses. First, we limited the sample to include only the pregnant women (n = 179) as pregnant and postpartum women may report different behaviors. The percentage of postpartum women was so small (16%) that we were unable to compare these two groups. We compared the results in just pregnant women to the results in the entire model to assess for differences. Second, we changed the cut-point of sugar-sweetened beverage intake to assess daily not weekly intake, ≥1 versus <1 sugar-sweetened beverage daily, and reevaluated our model. This sensitivity analysis was designed to address the difference between the cut-point we utilized in our study (intake of 1 or more sugar-sweetened beverages weekly) and that used in the literature pertaining to sugar-sweetened beverages (intake of 1 or more sugar-sweetened beverages daily) [25–27].

3. Results

Table 1 shows the characteristics of the 212 women in our sample by race/ethnicity.

Figure 1 shows the preadjustment frequency of fast food (Figure 1(a)) and sugar-sweetened beverage (Figure 1(b)) intake by race/ethnicity. Overall, 52% of women reported fast food intake less than once weekly or never, 39% reported intake 1-2 times weekly, and 9% reported intake ≥3 times weekly. In terms of sugar-sweetened beverage intake, the plurality (40.6%) reported less than 1 serving weekly, while 29.3% reported 1-2 servings and 14.6% reported 3–6 servings weekly.

Table 1: Characteristics of pregnant and postpartum women by race/ethnicity*.

	Overall $n = 212$ Number (%)	Black $n = 95$ Number (%)	Hispanic $n = 63$ Number (%)	Caucasian $n = 54$ Number (%)	P value
Individual demographic covariates					
Maternal age					**<0.0001**
18–24	74 (34.9)	46 (48.4)	21 (33.3)	7 (13.0)	
25–29	65 (30.7)	30 (31.6)	19 (30.2)	16 (29.6)	
30–34	36 (17.0)	9 (9.5)	12 (19.0)	15 (27.8)	
≥35	37 (17.4)	10 (10.5)	11 (17.5)	16 (29.6)	
English language proficiency[a]					**<0.0001**
Adequate	157 (74.1)	94 (98.9)	10 (15.9)	53 (100)	
Language spoken at home					**<0.0001**
English	157 (75.1)	94 (100)	10 (16.1)	53 (100)	
Marital status					**<0.0001**
Married/live-in partner	153 (68.6)	50 (52.6)	54 (85.7)	43 (79.6)	
Childcare[b]					**0.04**
Yes	43 (20.3)	46 (48.4)	16 (25.4)	24 (44.4)	
Not required	86 (40.6)	31 (32.6)	31 (49.2)	19 (35.2)	
No	81 (38.2)	18 (19.0)	14 (22.2)	11 (20.4)	
Child under 5 years old					0.28
Yes	139 (65.6)	63 (66.3)	45 (71.4)	31 (57.4)	
Education					**<0.0001**
≤grade 11	53 (25.2)	13 (13.8)	33 (53.2)	7 (13.0)	
High school/GED	73 (34.8)	45 (47.9)	19 (30.7)	9 (16.6)	
≥1-year college	84 (40.0)	36 (38.3)	10 (16.1)	38 (70.4)	
Employment					**<0.0001**
Employed full/part time	75 (36.6)	34 (37.0)	14 (23.7)	27 (50.0)	
Unemployed	52 (25.4)	31 (33.7)	12 (20.3)	9 (16.7)	
Maternity leave	12 (5.89)	10 (10.9)	0 (0.0)	2 (3.7)	
Disability	10 (4.9)	6 (6.5)	1 (1.7)	3 (5.5)	
Homemaker	46 (22.4)	6 (6.5)	30 (50.8)	10 (18.6)	
Student	10 (4.9)	5 (5.4)	2 (3.5)	3 (5.5)	
Income					**<0.0001**
<10,000	49 (23.1)	33 (34.7)	11 (17.5)	5 (9.3)	
10,000–19,999	41 (19.3)	18 (18.9)	16 (25.4)	7 (13.0)	
20,000–34,999	23 (10.9)	13 (13.7)	7 (11.1)	3 (5.5)	
35,000–49,999	10 (4.7)	5 (5.3)	2 (3.2)	3 (5.5)	
>50,000	38 (17.9)	4 (4.2)	4 (6.3)	30 (55.6)	
Declined to answer	51 (24.1)	22 (23.2)	23 (36.5)	6 (11.1)	
Financial strain					**0.003**
Yes	92 (41.3)	46 (48.4)	29 (46.0)	12 (22.2)	
No	127 (56.9)	48 (50.5)	31 (49.2)	42 (77.8)	
Access to care					
Insurance					**<0.0001**
Private	51 (25.3)	14 (15.1)	5 (8.9)	32 (60.4)	
Medicaid	110 (54.5)	74 (79.6)	15 (26.8)	21 (39.6)	
Medicare	4 (2.0)	3 (3.2)	1 (1.8)	0 (0.0)	
Uninsured	37 (18.3)	2 (2.1)	35 (62.5)	0 (0.0)	
Primary care physician					**<0.0001**
Yes	131 (58.7)	69 (72.6)	12 (19.0)	45 (83.3)	
No	90 (40.4)	25 (26.3)	50 (79.4)	9 (16.7)	
Do not know	2 (0.9)	1 (1.1)	1 (1.6)	0 (0.0)	
Medical status					
Pregnancy status					0.1
Pregnant	179 (84.4)	83 (87.4)	48 (76.2)	48 (88.9)	
Postpartum	33 (15.6)	12 (12.6)	15 (23.8)	6 (11.1)	

Table 1: Continued.

	Overall $n = 212$ Number (%)	Black $n = 95$ Number (%)	Hispanic $n = 63$ Number (%)	Caucasian $n = 54$ Number (%)	P value
Prepregnancy BMI[c]					**<0.0001**
<18.5	5 (2.3)	2 (2.1)	1 (1.6)	2 (3.7)	
18.5–24.9	50 (23.6)	17 (17.9)	9 (14.3)	24 (44.4)	
25–29.9	49 (23.1)	22 (23.2)	15 (23.8)	12 (22.2)	
30–39.9	60 (28.3)	37 (38.9)	10 (15.9)	13 (24.1)	
>40.0	15 (7.1)	11 (11.6)	2 (3.2)	2 (3.7)	
NR	33 (15.6)	6 (6.3)	26 (41.2)	1 (1.9)	
Medical comorbidities					
Any medical comorbidity	122 (57.6)	57 (60.0)	41 (65.1)	24 (44.4)	0.06
Overweight or obesity	157 (74.1)	76 (80.0)	53 (84.1)	28 (51.9)	**<0.0001**
Obesity	108 (50.9)	54 (56.8)	38 (60.3)	16 (29.6)	**0.001**
Type II diabetes	15 (7.1)	10 (10.5)	3 (4.8)	2 (3.7)	0.21
Hypertension	24 (11.3)	12 (12.6)	4 (6.3)	8 (14.8)	0.31
Pregnancy complications					
Gestational diabetes	26 (12.3)	8 (8.4)	6 (9.5)	12 (22.2)	**0.04**
Smoke					0.9
Yes	19 (9.0)	9 (9.5)	2 (3.2)	8 (14.8)	0.09
Self-reported health status					**0.005**
Good	177 (83.5)	76 (80.0)	47 (74.6)	54 (100.0)	
Fair/poor	33 (15.6)	18 (18.9)	15 (23.8)	0 (0.0)	
Sleep quality					
Good	114 (53.8)	60 (63.2)	28 (44.4)	26 (48.1)	**0.04**

*Numbers not adding to N in sample and percentages not leading to 100% are due to nonresponses.
[a]English language proficiency defined as adequate versus not adequate.
[b]Childcare: yes, defined as childcare other than parents obtained, not needed, defined as no children in need of childcare, and no, defined as childcare provided by parents.
[c]Based on respondents only.
GED = graduate equivalency degree.

3.1. Adjusted Analyses to Assess Racial and Ethnic Differences in the Odds of Fast Food and Sugar-Sweetened Beverage Intake. Table 2 shows the results of our adjusted logistic regression models. With respect to fast food intake, Black women had 2.38 times higher odds of consumption once or more weekly, when compared to White women (CI = 1.08 and 5.23). We did not detect differences in fast food frequency between Hispanic and White women (CI = 0.45 and 2.70). Women aged 30–34 had 2.6 times higher odds when compared to women 18–24 years old (CI = 1.02 and 6.62). There were no other differences in intake by age group. Women reporting financial strain had 1.4 times greater odds of fast food intake than those who did not report financial strain (CI = 1.01 and 1.93). Women who were married or lived with a partner had 0.4 reduced odds of consuming fast food (CI = 0.21 and 0.85), when compared to those without a spouse or live-in partner.

In adjusted analyses, we did not detect racial/ethnic differences in sugar-sweetened beverage intake. Compared to those without young children at home, women with a child under age 5 at home were 3.0 times more likely to drink sugar-sweetened beverages once or more weekly (CI = 1.54 and 6.00). Married women and those living with a partner had reduced odds of drinking sugar-sweetened beverages (OR = 0.30 and CI = 0.13, 0.68) compared with unmarried and single women. Lastly, women aged 35 years or older had lower odds of sugar-sweetened beverage intake when compared to women 18–24 (CI = 0.15 and 0.99).

In stratified analyses, we did not detect racial/ethnic differences in fast food intake among obese women. However, nonobese Black women had 4.66-fold greater odds of fast food intake once or more weekly, when compared to nonobese White women (CI = 1.49 and 14.5). There were no significant racial/ethnic differences in sugar-sweetened beverage intake in the stratified obese or nonobese subgroups. Results were otherwise very similar to those seen in the analysis of the entire cohort.

The first sensitivity analysis, in which we excluded postpartum women and examined the adjusted odds of fast food and sugar-sweetened beverage intake, showed that Black women had 2.6 times higher odds of fast food intake once or more weekly when compared with White women (CI = 1.10 and 6.06), confirming our findings from the entire sample. Results were also similar for the other variables (data not shown).

In the second sensitivity analysis, we assessed a daily cut-point for sugar-sweetened beverage intake, comparing the 18% of our sample that reported daily versus nondaily sugar-sweetened beverage intake. Even with this different cut-point,

Table 2: Adjusted odds of fast food and sugar-sweetened beverage intake.

Sociodemographic covariates	Fast food intake ≥ 1 time weekly OR (CI)	Sugar-sweetened beverage intake ≥ 1 time weekly OR (CI)
Maternal race, White (REF)		
Black	**2.38 (1.08, 5.23)**	0.91 (0.38, 2.17)
Hispanic	1.10 (0.45, 2.70)	0.57 (0.20, 1.49)
Maternal age, 18–24 (REF)		
25–29	1.09 (0.53, 2.25)	1.08 (0.49, 2.38)
30–34	**2.60 (1.02, 6.62)**	1.01 (0.39, 2.63)
≥35	1.03 (0.41, 2.59)	**0.38 (0.15, 0.99)**
Marital status		
Married/living with partner	**0.43 (0.21, 0.85)**	**0.30 (0.13, 0.68)**
Child under 5 years old, yes	1.20 (0.64, 2.26)	**3.04 (1.54, 6.00)**
Education		
<grade 12	1.73 (0.74, 4.07)	1.42 (0.56, 3.59)
High school graduate/GED	1.13 (0.47, 2.73)	0.52 (0.20, 1.32)
≥1-year college	1.32 (0.06, 26.9)	0.27 (0.01, 6.17)
Financial strain, yes	**1.40 (1.01, 1.93)**	1.04 (0.79, 1.38)
	$n = 75$	$n = 75$
Subsample with BMI ≥ 30		
Maternal race, White (REF)		
Black	0.46 (0.10, 2.00)	0.28 (0.05, 1.47)
Hispanic	0.27 (0.05, 1.33)	0.25 (0.04, 1.38)
	$n = 99$	$n = 99$
Subsample with BMI < 30		
Maternal race, White (REF)		
Black	**4.66 (1.49, 14.5)**	1.85 (0.57, 6.03)
White	1.39 (0.36, 5.33)	0.71 (0.18, 2.87)

Boldface denotes statistical significance.
BMI = body mass index, CI = confidence interval, GED = graduate equivalency degree, OR = odds ratio, and REF = reference.

we confirmed a null association between race and ethnicity and the odds of drinking one or more sugar-sweetened beverages daily.

4. Discussion

In a cross-sectional analysis of 212 pregnant and postpartum women, 47.7% of women reported eating fast food one or more times weekly, but only 1.9% consumed it one or more times daily. In contrast, 59% reported drinking one or more sugar-sweetened beverages per week, with 15.6% drinking at least one can daily. We found significant racial and ethnic differences in fast food, but not sugar-sweetened beverage, intake. Black women had 2-fold greater odds of fast food intake once or more weekly when compared with White women. The increased strength of the association among nonobese Black women was interesting in light of previous studies demonstrating that normal and overweight women are at greater risk of excess gestational weight gain than obese women [2, 16]. This emphasizes the need for inclusion of nonobese women in discussions around dietary habits, healthy gestational weight gain, and postpartum weight loss. Our data provides new information about racial differences in dietary behaviors and highlights the need for interventions to target obesogenic dietary behaviors in pregnancy and postpartum, as failure to lose gestational weight during the first year postpartum is associated with worsened cardiovascular risk markers [31] and overweight at 15 years postpartum [32, 33].

Marriage or living with a partner was associated with reduced odds of both fast food and sugar-sweetened beverage intake [34–36]. Our finding may represent increased financial means, improved social support, or factors not measured in our study. This data adds new information to existing literature on marriage and pregnancy related health behaviors. Prior data has shown decreased use of tobacco and drugs during pregnancy [34], increased prenatal care [35], and improved pregnancy outcomes [36] among women who have a good relationship with the father of their child, when compared to those without such a relationship.

Financial strain was associated with increased odds of both fast food and sugar-sweetened beverage intake when compared with women who did not report financial strain. This finding was expected given that healthier foods are often more expensive and less available in lower income neighborhoods lacking a grocery store with healthy food options. Fast food and sugar-sweetened beverages may represent less expensive alternatives to grocery purchased food for low-income families.

The finding that women having children under age 5 in the home were more likely to drink sugar-sweetened beverages was counter-intuitive. One possible explanation might be parental fatigue, leading to higher intake of caffeinated beverages that contain sugar. Another possible explanation might be having the sugary drinks on hand for children, leading to increased intake on the part of the parent.

The findings of increased fast food intake among women 30–34 and decreased sugar-sweetened beverage intake per month among women 35 and over were unexpected. Further study is needed to confirm and further evaluate these findings.

While the majority of data on postpartum weight loss interventions have focused on middle class White women [37–40], studies in the general population have shown that culturally tailoring interventions can result in significant weight loss in low-income and racial and ethnic minority groups [41–44]. Concern exists, however, that Black women lose less weight than their White counterparts [45] and drop-out rates for all participants remain high [40, 46]. Several qualitative studies have examined barriers to, and facilitators of, healthy lifestyles in pregnant and postpartum populations, and these results should be considered when designing dietary interventions [47–49].

Our results highlight the need to address sugar-sweetened beverage intake in all pregnant and postpartum women, while specifically targeting reduction in fast food intake among Black women. A successful approach to changing high risk dietary behaviors among Black women could involve recruitment from trusted community sources, such as churches and community centers, which have been shown to be helpful in weight loss [50]. Further study would be needed to see if this improves recruitment as well as retention in interventions. Educational interventions, such as nutritional seminars or guided grocery shopping, could be practical methods to address educational barriers and enhance awareness of what constitutes a healthy diet and healthy body weight and healthy available alternatives to fast food [12, 51, 52]. Finally, cultural adaptations of dietary recommendations have resulted in weight loss among African Americans in nonpregnant populations [53, 54]. Further study is needed to determine what specific cultural adaptations would be most helpful in changing dietary habits among pregnant and postpartum women.

In addition to interventions specifically for Black women, we would also recommend broad interventions that would improve nutrition among all pregnant and postpartum women, regardless of race or ethnicity. These would include interventions to address time constraints and lack of social support [41, 55, 56], as well as family preferences. Online follow-up allows women to participate in their schedule. This format could reinforce person educational activities and serve as a forum for recipe sharing and meal planning and provide ongoing motivation and peer support [55]. Concurrent policy initiatives should be employed to complement the clinical interventions, ensuring access to healthier, more affordable foods [57–60] and decreasing access to unhealthy foods such as sugar-sweetened beverages and fast food through taxation [61] as well as insurance reimbursement for successful weight loss programs [62–65].

The major strengths of our study were in the diverse sample of Black, Hispanic, and White participants to evaluate racial and ethnic differences, while controlling for key socioeconomic variables and preconception BMI. This study has several limitations. This was a small study. Our survey was based on a convenience sample. Some groups may have been under- or overrepresented as a result of not using probability samples. We are unable to report how many women declined to participate or how those who chose to participate differ from those who did not. This can introduce bias; however, this also allowed us to evaluate real-world clinical populations. High nonresponse rates occurred with some of our key variables. Higher percentages of Hispanic (41%) and Black (6.5%) women did not answer the self-report question pertaining to preconception weight and height, as compared to 1.9% of White women. Hispanic women were also less likely to be insured or have a PCP, which may lead to a lack of knowledge of weight and preconception medical diagnoses. These results suggest that the preconception rates of overweight and obesity may be higher in both groups than reported. To address this limitation, we compared our results to national survey data on obesity for women aged 20–39 years [66] and found similar obesity rates for Black and White women but underestimated rates for Hispanic women, likely as a result of missing data. Likewise, incomplete responses to certain socioeconomic variables limited their use as covariates in our study. Notably 36.5% of Black women, 23.2% of Hispanic women, and 11.1% of White women declined to answer the question about income. We thus used financial strain as a measure of wealth in its stead.

5. Conclusions

We found significantly increased odds of fast food intake among pregnant and postpartum Black women when compared to White women, with an even stronger association among nonobese Black women. We found high intake of sugar-sweetened beverages among all women. These results suggest the need for nutritional counseling about fast food intake targeted at Black women, including nonobese women, and about sugar-sweetened beverage intake in all women.

Disclosure

The study sponsor did not have a role in study design, collection, analysis, interpretation, writing, or decision to submit.

Competing Interests

The authors declare that they have no competing interests. No financial disclosures were reported by the authors of this paper.

Authors' Contributions

Ashley Harris assisted in data analysis and interpretation, write up, and submission of the paper. Nymisha Chilukuri assisted in the coding of the data and reviewed the paper. Meredith West assisted in the data collection and data organization and reviewed the paper. Janice Henderson assisted in survey design, study development, and reviewed the paper. Shari Lawson assisted in survey design study development and reviewed the paper. Sarah Polk assisted in survey design, study development, and reviewed the paper. David Levine assisted in data interpretation and reviewed the paper. Wendy L. Bennett developed the survey design and developed the study, assisted with data interpretations, and reviewed the paper.

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Review Article

An Analysis of Behaviour Change Techniques Used in a Sample of Gestational Weight Management Trials

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Introduction. Maternal obesity and excessive gestational weight gain are associated with multiple adverse outcomes. There is a lack of clarity on the specific components of effective interventions to support pregnant women with gestational weight management. *Method*. All 44 studies within a preexisting review of lifestyle interventions, with a potential to impact on maternal weight outcomes, were considered for content analysis. Interventions were classified using Behaviour Change Technique (BCT) taxonomy clusters to explore which categories of BCT were used in interventions and their effectiveness in managing gestational weight gain. *Results*. The most commonly used BCTs were within the categories of "feedback and monitoring," "shaping knowledge," "goals and planning," "repetition and substitution," "antecedents," and "comparison of behaviours." For diet and mixed interventions "feedback and monitoring," "shaping knowledge," and "goals and planning" appeared the most successful BCT categories. *Conclusions*. Poor reporting within studies in defining the BCTs used, in clarifying the differences in processes between intervention and control groups, and in differentiating between the intervention and research processes made BCT classification difficult. Future studies should elaborate more clearly on the behaviour change techniques used and report them accurately to allow a better understanding of the effective ingredients for lifestyle interventions during pregnancy.

1. Introduction

Maternal obesity and excessive gestational weight gain are associated with adverse outcomes (such as macrosomia, shoulder dystocia, and gestational diabetes [1, 2]) and are on the rise. Despite an urgent need for evidence based guidance to support pregnant women on gestational weight management, there is a lack of clarity about effective interventions and their specific components. Interventions developed to reduce excessive gestational weight gain and its associated outcomes generally fit into the broad categories of dietary only, physical activity only, and mixed approaches utilising both diet and physical activity components [3]. It is important to identify which components and specific behaviour change techniques within these complex interventions are most effective, since this is needed to inform the development of future interventions and guidance.

Michie et al. have reported a consensually agreed structured taxonomy of behaviour change techniques which provides a framework for a more precise reporting of complex interventions [4]. The Behaviour Change Technique (BCT) taxonomy [4] is a useful tool to extract the active components of interventions, allowing comparisons between the component parts of successful and unsuccessful behaviour change interventions. Several studies [5–7] have used the behaviour change technique taxonomy described by Michie et al. [8] to define gestational weight gain management interventions. However only Currie et al. [9] have used the most up-to-date clustered BCT taxonomy [4] to code lifestyle interventions during pregnancy or the postnatal period, in their systematic review of 14 studies aimed at reducing the decline in physical activity during pregnancy.

Gestational weight management strategies often rely on complex interventions involving various interacting components. Identification of active components of these interventions would help in better understanding and interpreting the results of the existing systematic reviews. It would also be helpful to inform the design of new interventions and their evaluations.

Numerous systematic reviews have evaluated the efficacy of interventions designed to improve weight outcomes for mothers [3, 5, 6, 10–14]. Of these most included 9 to 11 interventional studies [5, 10, 11, 13], with one review [14] only including 5 studies, two reviews including 19 studies [6, 12], and the final review by Thangaratinam et al. [3] of 44 studies. The reviews by Brown et al. [14], Thangaratinam et al. [3], and Choi et al. [13] focused exclusively on randomised controlled trials. Results across the reviews have varied. Streuling et al. [10] found that physical activity or diet alone interventions were not effective at reducing gestational weight gain but interventions based on physical activity and dietary counselling combined with weight monitoring appeared to be successful. In comparison Choi et al. [13] found that obese and overweight women allocated to physical activity or physical activity plus diet interventions in pregnancy had lower gestational weight gains, with supervised physical activity being especially effective. Thangaratinam et al. [3] showed some evidence of effectiveness across all interventions in reducing gestational weight gain (mean difference (MD) −1.42, 95% confidence interval (CI) −1.89 to −0.95). They also reported significant reductions in weight gain in pregnancy in subgroup analysis for dietary interventions (MD −3.84, 95% CI −5.22 to −2.45), physical activity interventions (MD −0.72, 95% CI −1.20 to −0.25), and interventions with a mixed approach (MD −1.06, 95% CI −1.67 to −0.46).

Due to the comprehensive approach in inclusivity and rigour in Thangaratinam et al.'s [3] review and due to it being the most highly accessed and cited article within the field of research of gestational weight management, this was selected as the source of literature for content analysis in our review. The aim of this study was therefore to evaluate the behaviour change techniques included in diet, physical activity, or mixed interventions with a potential to impact on maternal or fetal outcomes related to weight and to identify the categories of behaviour change technique of those interventions which were effective. To our knowledge, this is the first study to use the BCT taxonomy to identify techniques used in a wide range of gestational weight management lifestyle interventions.

1.1. Objectives. To explore the patterns of behaviour change techniques used in interventions with a potential to impact maternal and fetal outcomes related to gestational weight gain.

2. Methods

2.1. Data Selection. This study was based on the 44 randomised controlled trials of interventions with a potential to impact maternal or fetal outcomes related to weight which were included in the HTA commissioned systematic review [3]. The studies included in the review were focused on diet only ($n = 13$), physical activity only ($n = 18$), or mixed ($n = 13$) diet and physical activity interventions for a range of pregnant women, focussing specifically on overweight and or obese women in 11 studies. The study selection criteria and assessments of quality and bias have all been reported by Thangaratinam et al. [3]. They found that the quality of studies included in the analysis for gestational weight gain was moderate, but quality for other outcomes such as preterm delivery and hypertension was low, where there may have been a risk of publication bias.

2.2. Data Extraction and Synthesis. Michie et al.'s [4] health behaviour change technique taxonomy was used to identify the behavioural components of the intervention within each included study. This taxonomy contains 93 itemised health behaviour change techniques which are clustered into 16 groupings (see the following list), with each group containing between 3 and 11 clustered behaviour change techniques. For practicality of reporting the category groupings were used for the purpose of this review.

Groupings within Michie et al.'s [4] Hierarchically Clustered Behaviour Change Technique Taxonomy. Consider the following:

(1) Goals and planning.
(2) Feedback and monitoring.
(3) Social support.
(4) Shaping knowledge.
(5) Natural consequences.
(6) Comparison of behaviour.
(7) Associations.
(8) Repetition and substitution.
(9) Comparison of outcomes.
(10) Reward and threat.
(11) Regulation.
(12) Antecedents.
(13) Identity.
(14) Scheduled consequences.
(15) Self-belief.
(16) Covert learning.

Three researchers (H. Soltani, M. A. Arden, and A. M. S. Duxbury) independently extracted and coded the data, to improve reliability of the data categorisation. Where there were differences in coding, the research team had a discussion to reach consensus regarding the codes and categories.

Behaviour change technique categories were classified as successful or unsuccessful within each study dependent upon whether a significant difference was found between the intervention and control group on gestational weight gain. Due to the heterogeneity of the included studies data was synthesised narratively and presented in tables and graphs as statistical synthesis was not possible.

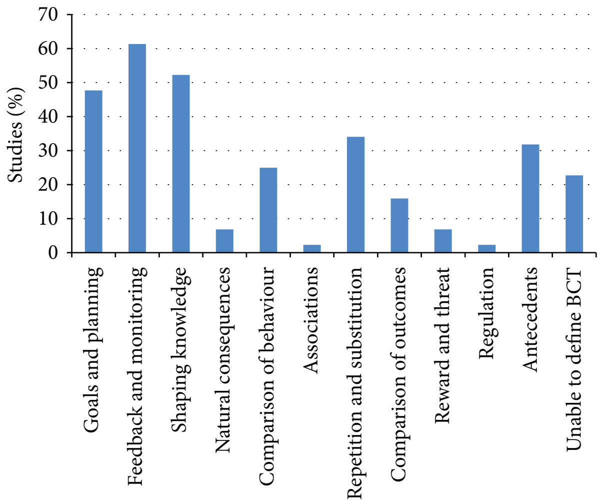

Figure 1: Behaviour change technique taxonomy categories of the interventions in included studies ($n = 44$ studies).

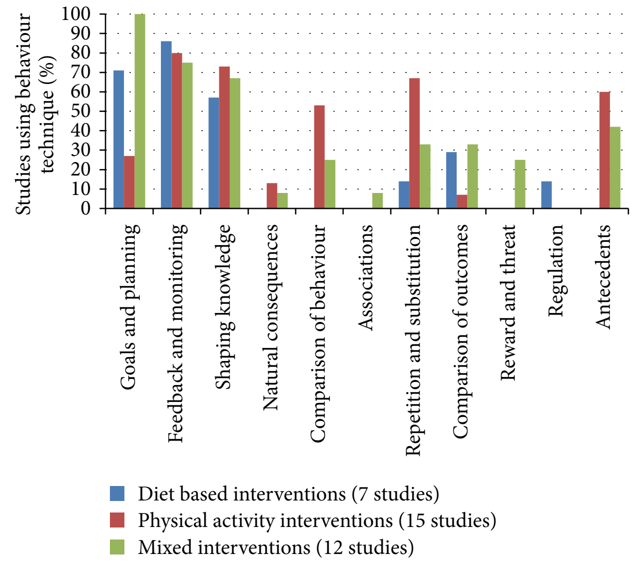

Figure 2: Behaviour change technique taxonomy categories according to intervention type ($n = 34$ studies).

3. Results

Of the original 44 papers included within the Thangaratinam et al. review [3], one study only consisted of a conference abstract [26]. Full-text versions of all of the other articles were obtained. The 44 trials included 7627 women who had been randomised. Healthcare professionals delivering the interventions varied across the studies and included dieticians, nutritionists, clinical psychologists, doctor, nurses, and midwives.

Table 1 contains study characteristics and the behaviour change technique categories agreed by the researchers for each of the included studies [15–59]. It was not possible to apply any behaviour change taxonomy code to 10 of the studies. Figure 1 shows the distribution of BCT categories within the studies. The most commonly used behaviour change technique clusters were "feedback and monitoring," "shaping knowledge," "goals and planning," "repetition and substitution," "antecedents," and "comparison of behaviours."

There were many studies where the authors could not agree on the behaviour change techniques involved within the intervention. The disputed techniques are shown in Table 2. Eight of the 10 studies for which no behaviour change technique code was recorded had potentially included BCTs but the research team could not reach agreement on them. Two studies [27, 56] included no discernible BCTs. The most common category where a disagreement occurred between the authors was "goals and planning," with 21 of the 22 studies with a disputed behaviour change technique being discrepant within this cluster. In only 2 of these 21 studies [21, 23] was the discrepancy not within the subcategory "goal setting (behaviour)."

For the studies where it was possible to categorise the type of behaviour change, BCT category according to type of intervention was plotted (Figure 2). While all types of intervention made use of "feedback and monitoring" and "shaping knowledge" techniques physical activity based interventions utilised "comparison of behaviours" and "repetition and substitution" more than dietary or mixed lifestyle interventions. In comparison dietary based and mixed interventions incorporated "goals and planning" more often.

Gestational weight gain was reported in 34 studies; however for 6 of these studies no agreement was obtained for applying a BCT code. The success of each behaviour change technique according to type of intervention in the resulting 28 studies is shown in Figure 3. In studies where a BCT classification could be applied a significant difference in gestational weight gain between the intervention groups and control groups was found more often for diet based ($n = 5$) or mixed interventions ($n = 6$) compared to physical activity based interventions ($n = 1$).

The prevalence of each BCT category in both successful and unsuccessful interventions for reducing gestational weight gain is shown in Table 3. The BCT categories present in 50% or over of the studies with successful interventions were "feedback and monitoring," "goals and planning," and "shaping knowledge."

4. Discussion

We have used the Thangaratinam et al. [3] review as an example of a report incorporating diet, physical activity, and mixed lifestyle interventions with the potential to impact on maternal or fetal weight outcomes. Of the 44 studies included within that review, 34 reported total gestational weight gain.

The most commonly used behaviour change technique categories were "feedback and monitoring," "shaping knowledge," "goals and planning," "repetition and substitution," "antecedents," and "comparison of behaviours." To our knowledge there is only one other study [9] in which lifestyle interventions in pregnancy or the postpartum have been classified according to Michie et al.'s BCT taxonomy [4]. The behaviour change technique components of interventions in pregnancy aimed at reducing the decline in physical activity were categorised within that study by Currie et al. [9], with

Table 1: Study characteristics and definite Behaviour Change Technique categories.

Study	Intervention delivery	Number of participants randomised	Number of participants analysed	GWG in kg Intervention group mean (SD)	GWG in kg Control group mean (SD)	Significant difference	Agreed BCT categories
Diet based interventions							
Clapp 1997 [15]	Not stated	—	12	11.8 (5.6)	19.7 (2.9)	$p < 0.01$	—
Crowther et al. 2005 [16]	Dietician	1000	1000	8.1 (0.3)	9.8 (0.4)	Adjusted $p = 0.01$	Feedback and monitoring, shaping knowledge, comparison of outcomes
Landon et al. 2009 [17]	Clinician	958	931	2.8 (4.5)	5 (3.3)	$p < 0.001$	Feedback and monitoring
Ney et al. 1982 [18]	Not stated	20	20	11.8 (4.5)	15.9 (6.8)	$p < 0.05$	—
Quinlivan et al. 2011 [19]	Food technologist, clinical psychologist	132	124	7.0 (5.2)	13.8 (5.2)	$p < 0.001$	Goals and planning, feedback and monitoring, shaping knowledge, regulation
Thornton et al. 2009 [20]	Dietician, physician	257	232	4.99 (6.79)	14.06 (7.40)	$p < 0.001$	Goals and planning, feedback and monitoring
Wolff et al. 2008 [21]	Dietician	64	50	6.6 (5.5)	13.3 (7.5)	$p = 0.002$	Goals and planning, feedback and monitoring, comparison of outcomes
Bechtel-Blackwell 2002 [22]	Research nurse	60	46	6.87 (NR)	5.57 (NR)	NS	—
Briley et al. 2002 [23]	Nutritionist	27	20	11.9 (6.3)	15.2 (5.1)	NS	Goals and planning, feedback and monitoring, shaping knowledge
Khoury et al. 2005 [24]	Dietician	290	290	8.9 (3.1)	9.4 (3.0)	NS $p = 0.20$	Goals and planning, shaping knowledge, repetition and substitution
Rae et al. 2000 [25]	Research dietician	125	117	11.56 (10.48)	9.68 (10.66)	NS $p = 0.338$	—
Badrawi et al. 1992 [26]	Not stated	100	—	NR	NR	NR	—
Gomez et al. 1994 [27]	Not stated	60		NR	NR	NR	—

Table 1: Continued.

Study	Intervention delivery	Number of participants randomised	Number of participants analysed	GWG in kg Intervention group mean (SD)	GWG in kg Control group mean (SD)	Significant difference	Agreed BCT categories
Physical activity based interventions							
Sedaghati et al. 2007 [28]	Qualified instructor and midwife	100	90	13.55 (1.131)	15.1 (2.102)	$p < 0.000$	Feedback and monitoring, shaping knowledge, antecedents
Baciuk et al. 2008 [29] Cavalcante et al. 2009 [30]	Qualified instructor	71	70	14.3 (2.1)	15.1 (1.6)	NS $p = 0.38$	Feedback and monitoring, shaping knowledge, comparison of behaviour, repetition and substitution, antecedents
Barakat et al. 2009 [31]	Qualified fitness specialist	160	142	11.5 (3.7)	12.4 (3.4)	NS (but some difference in obese only group)	Feedback and monitoring, shaping knowledge, comparison of behaviour, repetition and substitution, antecedents
Barakat et al. 2012 [32]	Qualified instructor with obstetric assistance	100	83	12.5 (3.2)	13.8 (3.1)	NS $p > 0.05$	Feedback and monitoring, shaping knowledge, comparison of behaviour, repetition and substitution, antecedents
Clapp et al. 2000 [33]	Not stated	50	46	15.7 (4.7)	16.3 (3.4)	NS	—
Erkkola 1976 [34]	Not stated	76	62	11.8 (NR)	11 (NR)	NS	Feedback and monitoring, shaping knowledge, natural consequences
Garshasbi and Faghih 2005 [35]	Midwife	266	212	14.1 (3.8)	13.8 (5.2)	NS $p = 0.63$	Comparison of outcomes

Table 1: Continued.

Study	Intervention delivery	Number of participants randomised	Number of participants analysed	GWG in kg Intervention group mean (SD)	GWG in kg Control group mean (SD)	Significant difference	Agreed BCT categories
Haakstad and Bo 2011 [36]	Qualified instructor	105	105	13 (4)	13.8 (3.8)	NS $p = 0.31$	Goals and planning, feedback and monitoring, shaping knowledge, comparison of behaviour, repetition and substitution
Hopkins et al. 2010 [37]	Not stated	98	84	8.2 (3.5)	8 (3.7)	NS	Goals and planning, feedback and monitoring, antecedents
Marquez-Sterling et al. 2000 [38]	Qualified instructor	20	15	16.2 (3.4)	15.7 (4)	NS $p = 0.649$	Goals and planning, comparison of behaviour, repetition and substitution
Ong et al. 2009 [39]	Supervised	12	12	3.7 (3.4)	5.2 (1.3)	NS $p = 0.155$	Shaping knowledge, repetition and substitution, antecedents
Prevedel et al. 2003 [40]	Not stated	60	41	15 (NR)	12.7 (NR)	NS	Feedback and monitoring, shaping knowledge, comparison of behaviour, repetition and substitution
Santos et al. 2005 [41]	Not stated	92	72	5.7 (NR)	6.3 (NR)	NS $p = 0.62$	Feedback and monitoring, shaping knowledge, comparison of behaviour, repetition and substitution, antecedents

Table 1: Continued.

Study	Intervention delivery	Number of participants randomised	Number of participants analysed	GWG in kg Intervention group mean (SD)	GWG in kg Control group mean (SD)	Significant difference	Agreed BCT categories
Bell and Palma 2000 [42]	Not applicable	61	61	NR	NR	NR	—
Erkkola and Makela 1976 [43]	Not stated	103	103	NR	NR	NR	Feedback and monitoring, shaping knowledge, natural consequences
Khaledan et al. 2010 [44]	Not stated	39	—	NR	NR	NR	Goals and planning, feedback and monitoring, repetition and substitution, antecedents
Lee et al. 1996 [45]	Qualified instructor	370	351	NR	NR	NR	Feedback and monitoring, shaping knowledge, comparison of behaviour, repetition and substitution, antecedents
Yeo et al. 2000 [46]	Not stated	17	16	NR	NR	NR	—
Mixed interventions							
Asbee et al. 2009 [47]	Dietician, physician, nurse	144	100	13.02 (5.67)	16.15 (7.03)	$p = 0.01$	Goals and planning, feedback and monitoring, comparison of outcomes, reward and threat
Huang et al. 2011 [48]	Nurse trained in nutrition and fitness	240	189	14.02 (2.38)	16.22 (3.26)	$p < 0.001$	Goals and planning, feedback and monitoring, shaping knowledge, reward and threat
Jeffries et al. 2009 [49]	Medical student	286	236	10.7 (4.21)	11.5 (4.03)	$p = 0.01$ in overweight group but NS in underweight, normal weight or obese	Goals and planning, feedback and monitoring
Phelan et al. 2011 [50]	Research assistants, nurses, clinicians	401	363	Normal weight 16.2 (4.6) obese 15.1 (7.5)	Normal weight 15.3 (4.4) obese 14.7 (6.9)	significant increase in normal weight women exceeding IOM guidelines	Goals and planning, feedback and monitoring, shaping knowledge, associations, antecedents

Table 1: Continued.

Study	Intervention delivery	Number of participants randomised	Number of participants analysed	GWG in kg: Intervention group mean (SD)	GWG in kg: Control group mean (SD)	Significant difference	Agreed BCT categories
Polley et al. 2002 [51]	Nutritionist or clinical psychologist	120	110	Normal weight 15.4 (7.1) overweight 13.6 (7.2)	Normal weight 16.4 (4.8); overweight 10.1 (6.2)	significant increase in normal weight women exceeding IOM guidelines	Goals and planning, feedback and monitoring, repetition and substitution
Vinter et al. 2011 [52]	Dietician, physiotherapist	360	304	**median** {**range**} 7.0 (4.7–10.6)	**median** {**range**} 8.6 (5.7–11.5)	$p = 0.014$	Goals and planning, shaping knowledge, comparison of behaviour, repetition and substitution, antecedents
Guelinckx et al. 2010 [53]	Nutritionist	195	122	Active group 9.8 (7.6) Passive group 10.9 (5.6)	10.6 (6.9)	NS	Goals and planning, feedback and monitoring, shaping knowledge, reward and threat
Hui et al. 2011 [54]	Dietician and fitness trainer	52	45	14.2 (5.3)	14.2 (6.3)	NS $p = 1.00$	Goals and planning, feedback and monitoring, shaping knowledge, comparison of behaviour, repetition and substitution, comparison of outcomes, antecedents
Hui et al. 2006 [55]	Dietician and fitness trainer	224	190	15.2 (5.9)	14.1 (6.0)	NS $p = 0.28$	Goals and planning, feedback and monitoring, shaping knowledge, comparison of behaviour, repetition and substitution, comparison of outcomes, antecedents

Table 1: Continued.

Study	Intervention delivery	Number of participants randomised	Number of participants analysed	GWG in kg		Significant difference	Agreed BCT categories
				Intervention group mean (SD)	Control group mean (SD)		
Jackson et al. 2011 [56]	Video doctor simulating health care provider	321	289	15.15 (NR)	15.24 (NR)	NS $p = 0.95$	—
Bung et al. 1991 [57]	Not stated	41	34	NR	NR	NR	Goals and planning, feedback and monitoring, shaping knowledge, antecedents
Ferrara et al. 2011 [58]	Trained dietician, lactation consultant	197	197	NR	NR	NR	Goals and planning, shaping knowledge, natural consequences, comparison of outcomes
Kulpa et al. 1987 [59]	Nutritionist, exercise physiologist and obstetrician	141	85	Primigravida 14.3 (NR) Multigravida 12.5 (NR)	Prigravida 14.2 (NR) Multigravida 15.4 (NR)	NR	Goals and planning

GWG = gestational weight gain.
SD = standard deviation.
BCT = Behaviour Change Technique.
NR = not reported.
NS = not significant.
IOM = Institute of Medicine.

Table 2: Discrepant Behaviour Change Technique categorisation across the studies.

Study	Discrepant BCT categorisation	Type of intervention (D = diet; P = physical activity; M = mixed)
Badrawi et al. 1992 [26]	Goals and planning	D
Barakat et al. 2009 [31]	Goals and planning	P
Barakat et al. 2012 [32]	Goals and planning	P
Bechtel-Blackwell 2002 [22]	Comparison of outcomes	D
Bell and Palma 2000 [42]	Goals and planning	P
Briley et al. 2002 [23]	Goals and planning	D
Baciuk et al. 2008 [29] Cavalcante et al. 2009 [30]	Goals and planning	P
Clapp 1997 [15]	Goals and planning	D
Clapp et al. 2000 [33]	Goals and planning	P
Erkkola 1976 [34]	Goals and planning	P
Erkkola and Makela 1976 [43]	Goals and planning	P
Garshasbi and Faghih 2005 [35]	Goals and planning Shaping knowledge	P
Lee et al. 1996 [45]	Goals and planning	P
Marquez-Sterling et al. 2000 [38]	Goals and planning Shaping knowledge	P
Ney et al. 1982 [18]	Goals and planning	D
Ong et al. 2009 [39]	Goals and planning	P
Prevedel et al. 2003 [40]	Goals and planning	P
Rae et al. 2000 [25]	Goals and planning	D
Santos et al. 2005 [41]	Goals and planning	P
Sedaghati et al. 2007 [28]	Goals and planning	P
Wolff et al. 2008 [21]	Goals and planning	D
Yeo et al. 2000 [46]	Goals and planning Feedback and monitoring Shaping knowledge Repetition and substitution	P

the 6 most commonly used BCT categories being the same as those found within this study. Others have used Michie's previous taxonomy [8] to code pregnancy and postpartum lifestyle interventions. All of these found behaviour change techniques within the categories of "goals and planning" and "feedback and monitoring" were the most frequently used [5–7]. Hill et al. [6] and Gilinsky et al. [7] both also noted "instruction on how to perform the behavior" was often utilised which sits within the "shaping knowledge" cluster in the Michie et al. BCT taxonomy [4]. Gilinsky et al. [7] also identified "set graded tasks" which is often used in physical activity trials and is classified under the "repetition and substitution" cluster. Hill et al. [6] found studies often provided "information on the consequences of behavior" which corresponds with behaviours in the "natural consequences" cluster. With the exception of Hill et al.'s [6] "natural consequences" category, these behaviour change techniques correspond closely with those found in our study.

When assessing BCT taxonomy categories, there were disputes among the authors (Table 2), mostly around the "goal setting (behaviour)" technique. This categorisation was disagreed on for 15 out of the 18 physical activity interventional studies which could account for "goals and planning" appearing to be more often incorporated into dietary based and mixed interventions compared to physical activity interventions. In the majority of these disputed studies there was no explicit reference to goal setting within the descriptions of the intervention procedures provided according to the BCT taxonomy definition: "set or agree on a goal defined in terms of the behaviour to be achieved" [4]. Participants had been assigned to the intervention condition as part of the research protocol. Although the intervention description included exercise classes or similar, it was not clear whether or not a goal had been set or agreed to attend/engage in these classes, even though this seemed likely to have occurred. These disagreements may reflect health psychologists stricter

TABLE 3: Prevalence of BCT categories within successful and unsuccessful interventions at reducing gestational weight gain.

	BCTs present in successful intervention (% of 12 studies)	BCTs present in unsuccessful intervention (% of 16 studies)
Goals and planning	75.0	50.0
Feedback and monitoring	91.7	75.0
Shaping knowledge	50.0	81.3
Natural consequences	0	6.3
Comparison of behaviour	8.3	56.3
Associations	8.3	0
Repetition and substitution	16.7	68.8
Comparison of outcomes	25.0	18.8
Reward and threat	16.7	6.3
Regulation	8.3	0
Antecedents	25.0	50.0

BCT = Behaviour Change Technique.

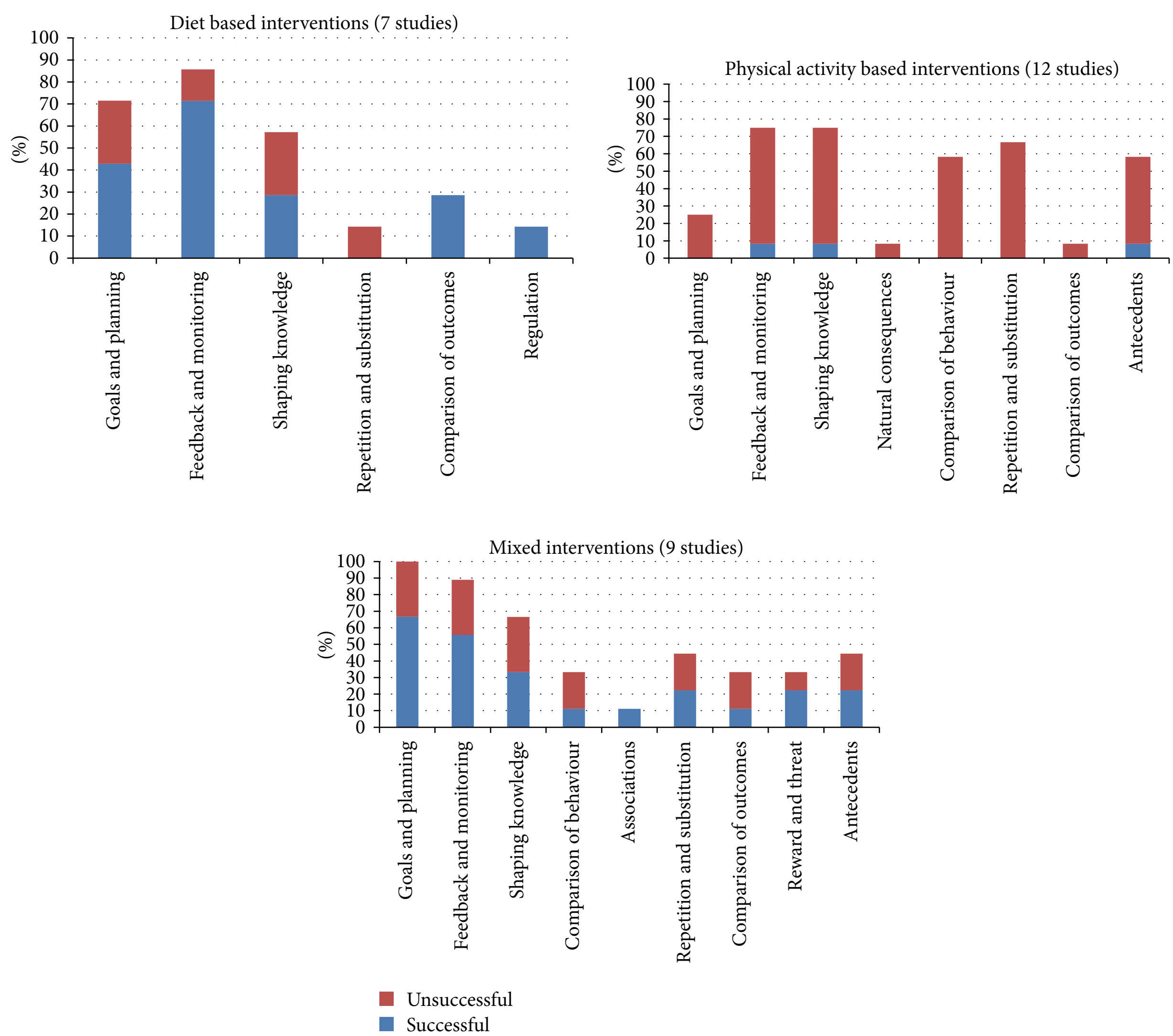

FIGURE 3: Success of intervention on gestational weight gain across intervention type.

understanding and interpretation of BCT coding, which does not necessarily match the understanding of clinicians and emphasises the potential difficulties of translating BCT's into practice. Clarification of these ambiguities is required to enhance the implementation and reporting of BCT's in research and practice.

Categories of behaviour change techniques were present in both effective and ineffective interventions, except for "regulation" which was only present in one successful diet based intervention and "association" which was within one successful mixed intervention. Others who have assessed behaviour change techniques utilised within interventions have similarly found behaviour change strategies to be present in both effective and ineffective studies [5]. Within this current study physical activity interventions were largely unsuccessful at managing gestational weight gain, whereas individual behaviour change techniques within diet based or mixed interventions were of varied success. However the success or failure of an intervention could be a result of a number of factors beyond the specific BCT's, for example, the study design, insufficiency of the sample size, or poor fidelity to intervention processes and attrition rates in the original studies.

The success or failure of the interventions may have been influenced by individual BCTs or by the specific combination of BCTs within the intervention. It was not possible to statistically analyse the individual effectiveness of BCTs or to assess the effectiveness of different combinations of behaviour techniques due to the number of different combinations of BCTs present within studies, which is a limitation of this review. However it was noted that successful interventions always included BCTs from one or both of "goals and planning" or "monitoring and feedback". This is in line with Michie et al.'s [60] findings with regard to healthy eating and physical activity interventions in the general population, with what Gilinsky et al. [7] found for interventions effective at increasing postnatal physical activity and with Harkin et al. [61] who found larger effect sizes in interventions incorporating monitoring of goal progress. When specifically looking at gestational weight gain studies utilising explicit goal setting Brown et al. [14] found a difference in the types of interventions which were effective at different body mass indexes (BMIs) with some interventions working best for women of normal weight and others for women who were overweight or obese. Future research into effective behaviour change techniques will need to take account of potential differential effects across various BMI categories.

The lack of clear and consistent reporting of which behaviour change techniques were undertaken within each intervention was a recurrent theme across this study. Poor reporting, making classification of BCTs difficult, was noted to occur within three main areas: lack of differentiation between the intervention processes and the research processes of the study; difficulties in determining which components were delivered only to the intervention group rather than to both the intervention and control groups; and finally poor or vague definitions of the behaviour change components used. Each of these areas will be discussed in turn.

Some studies were noted to lack clarity over whether the incorporated behaviours were part of the intervention or just part of the study design, for example, glucose monitoring, blood pressure measurements, and completing questionnaires. If these activities were purely for the researchers own benefit to determine clinical outcome measures for the study they would not be part of the intervention and therefore should not be part of the behaviour change technique classification; however if participants were given feedback on the results of blood pressure readings or their current weight in order to promote behaviour change then these procedures would be part of the intervention and their component techniques should be classified This lack of clarity across the studies made BCT classification difficult. The importance of clear reporting was also highlighted due to difficulties in determining which behavioural processes were solely applied to the intervention group. For example, statements such as "participants were weighed at each appointment" did not make it clear if everyone was weighed or just the intervention group.

Behaviour change technique coding was difficult as some studies used vague phrases such as "nutrition counselling" or "education" to describe their interventions and did not clearly specify what techniques these interventions included. Furthermore interventions such as water aerobics sessions or gym access where a fitness instructor was present would most likely include "how to perform the behavior" or "demonstrating the behaviour"; however when this was not explicitly stated it was difficult to identify the techniques and their effectiveness in a standardised and consistent manner. Others have also described the difficultly of applying behaviour change codes to intervention components due to a lack of specificity within reports [5].

One study noted by the authors to provide a clear description which allowed rigorous behaviour change technique codes to be applied was Jeffries et al. [49]. Codes included "goal setting the outcome" as intervention women were informed of their optimal weight gain based on their BMI and Institute of Medicine (IOM) guidelines and given personalised weight gain charts and "self-monitoring the outcome" as intervention group women were asked to weigh themselves every 4 weeks and record it on their chart. In contrast an example of reporting which made BCT classification difficult is Bechtel-Blackwell et al. [22]. They conducted an education based intervention where the intervention group had three 20 minute group sessions which covered: *"nutritional needs specific to the woman's stage of her pregnancy."* It was not clear whether these sessions just provided information or worked through problems to provide solutions (i.e., if you feel sick, then drink water or go for a walk). No code could therefore be applied.

When developing intervention studies researchers should "clearly define and provide a rationale for all behaviour change techniques that have been included" [62]. Future studies should use frameworks for intervention design such as the Behaviour Change Wheel [63] that guide developers through the process of developing a clear rationale based on evidence. Reporting behaviour change interventions stating what has been done using the standardised terms found in the behaviour taxonomy would enable other researchers to understand exactly what the intervention included and would allow statistical analysis to evaluate the effectiveness of specific study components. This would provide a more robust conclusion of the effectiveness of specific BCT categories at preventing excessive gestational weight gain, facilitating the replication of successful interventions or intervention components. The lack of standardised terms in the maternal obesity intervention literature, and the use of vague terms such as "nutrition counselling" means that we cannot understand what aspects of the intervention made it successful and that we cannot properly replicate it in future research. Without the ability to build on knowledge in this way researchers will not be able to improve intervention design in the future.

5. Conclusions

Coding interventions using the BCT taxonomy is valuable in the field of gestational weight management. However a better understanding of these techniques, clarity in their implementation, and reporting in a standard format are necessary to allow a robust and reliable evaluation of their efficacy.

Disclaimer

The views and opinions expressed are those of the authors, and not necessarily those of the NHS, the NIHR, or the Department of Health.

Conflict of Interests

The authors declare that there is no known conflict of interests.

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Research Article

Implementation of the International Association of Diabetes and Pregnancy Study Groups Criteria: Not Always a Cause for Concern

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Background. Controversy surrounds the decision to adopt the International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria for the diagnosis of gestational diabetes mellitus (GDM) as fears that disease prevalence rates will soar have been raised. *Aims*. To investigate the prevalence of pregnancy complicated with GDM before and after the introduction of the IADPSG 2010 diagnostic criteria. *Materials and Methods*. A prospective audit of all women who delivered from July 1, 2010, to June 30, 2014, in a predefined geographic region within the North Metropolitan Health Service of Western Australia. Women were diagnosed with GDM according to Australian Diabetes in Pregnancy Society (ADIPS 1991) criteria until December 31, 2011, and by the IADPSG 2010 criteria after this date. Incidence of GDM and predefined pregnancy outcomes were audited. *Results*. Of 10,296 women, antenatal oral glucose tolerance test (OGTT) results and follow-up data were obtained for 10,103 women (98%), of whom 349 (3.5%) were diagnosed with GDM. The rate of GDM utilising ADIPS criteria was 3.4% and the rate of utilising IADPSG criteria was 3.5% ($p = 0.92$). *Conclusion*. IADPSG diagnostic criteria did not significantly increase the incidence of GDM in this low prevalence region.

1. Introduction

Gestational diabetes mellitus (GDM) is a common medical complication of pregnancy defined as "any degree of glucose intolerance with onset or first recognition during pregnancy" [1, 2]. The initial criteria for diagnosis were established more than 40 years ago [3]; however, these criteria did not necessarily identify pregnancies with increased risk of adverse pregnancy outcome [4].

The hyperglycaemia and adverse pregnancy outcome (HAPO) study was conducted to clarify the associations between maternal hyperglycaemia and adverse outcomes. The study showed associations between increasing levels of fasting blood glucose (FBG), 1-hour and 2-hour plasma glucose obtained following an oral glucose tolerance test (OGTT), and birthweight >90th centile and cord-blood serum C-peptide level >90th centile [5]. The secondary outcomes of premature delivery, shoulder dystocia or birth injury, admission to intensive neonatal care unit, hyperbilirubinemia, and preeclampsia were also increased by maternal hyperglycaemia [5].

The consideration of HAPO data led to a recommendation in 2010 by the International Association of Diabetes and Pregnancy Study Groups (IADPSG) for the FBG and 1 h and 2 h glucose levels to diagnose GDM [4]. The diagnostic threshold values were the average glucose values at which the odds for birthweight >90th centile, cord C-peptide >90th centile, and percent body fat >90th centile reached 1.75 times the estimated odds of the outcomes at mean glucose values [4, 5].

However, concern has been expressed that adoption of the new diagnostic criteria would lead to a dramatic increase in the incidence of GDM. One Australian study reported that the change in diagnostic criteria from the previously utilised Australasian Diabetes in Pregnancy Society (ADIPS) 1999 criteria [6] to the new IADPSG 2010 criteria [4] would increase the prevalence of GDM from 9.6% to 13.0% [7]. A NZ study reported that the incidence might rise from 6% to 10% [8]. National debate continues on the workforce implications of the revised criteria and their clinical impact [9, 10].

The aim of this study was to audit the impact of the change from the ADIPS 1999 criteria [6] to the IADPSG 2010 diagnostic criteria [4] within a geographically defined region.

2. Methods

A prospective audit of all pregnancies diagnosed with GDM commenced from July 1, 2010, following publication of HAPO and the IADPSG recommendations. The Institutional Ethics Committee determined that the project fulfilled the criteria of an audit project as pregnancy outcomes were being audited and no intervention other than routine care according to existing clinical protocols was planned. Therefore, the project was exempted from formal ethics committee approval.

All pregnant women greater than 20-week gestation referred for public maternity care who resided within the postcodes 6001–6007, 6147, 6148, 6151, 6152, and 6155 within the North Metropolitan Health Service of the Western Australian Department of Health between July 1, 2010, to June 30, 2014, were included in the audit. Women with a history of preexisting diabetes mellitus (type 1 or 2) were specifically excluded from the project.

All women had an OGTT between 24 and 28 weeks of gestation in accordance with the existing clinical protocol [11].

The ADIPS 1999 criteria were used to diagnose GDM in the period from July 1, 2010, to December 31, 2011 [6]. Women had a 75-gram OGTT with glucose samples taken after an overnight fast and at 2 hr postprandially. GDM was diagnosed if the fasting glucose was $\geq$5.5 mmol/L (100 mg/dL) and/or the 2 h glucose was $\geq$8.0 mmol/L (~145 mg/dL) [6].

From January 1, 2012, to June 30, 2014, all patients were diagnosed with GDM using the IADPSG 2010 diagnostic criteria [4]. Women had a 75-gram OGTT with glucose samples taken after an overnight fast and at 1 hr and 2 hr postprandially. One or more abnormal values were needed for a diagnosis of GDM to be made: FBG > 5.0 mmol/L and/or 1-hour BSL > 10 mmol/L and/or 2-hour BSL $\geq$ 8.5 mmol/L.

The majority of OGTT in the audit period was performed at the Western Diagnostics Pathology laboratories. A small number (2.8%) was performed at other private accredited pathology providers.

All patients had their weight (kg) and height (m) recorded at their booking visit to calculate their body mass index (BMI). Patients with a BMI greater than 40 had their antenatal care at the local maternity hospital but were referred for delivery to the regional tertiary hospital. These patients remained within the audit study.

All pregnancies diagnosed with GDM across the audit period received identical clinical care according to a written protocol. This involved an initial consultation with a diabetic educator, dietician, and obstetric doctor. Patients commenced self-monitoring of blood sugar levels and adopted a diabetic diet. A review visit a fortnight later determined if medication was required in addition to diet.

Delivery outcomes were entered into a computerized database called Meditec by attending midwifery staff as part of routine practice. Delivery outcomes were subsequently extracted from Meditec, case note audit, and a postnatal clinical service for all women with GDM conducted by one author (Julie Quinlivan).

Predefined maternal outcomes were audited. These were mode of delivery, elective or emergency caesarean section, estimated blood loss, and 3rd or 4th degree perineal tear. Predefined newborn outcomes were audited. These were gestational age at birth, birthweight, birthweight >90th centile adjusted for gestational age, Apgar at 1 and 5 minutes, umbilical artery and vein pH, admission to Special Care Unit, and serious perinatal complications such as stillbirth, neonatal death, or birth trauma including shoulder dystocia.

A power calculation assumed that the change in incidence of GDM would be 30%, a conservative estimate based on the previous Australian and New Zealand studies [7, 8]. The baseline rate of GDM in the audit region was approximately 3.5%. Assuming a power of 80% and alpha error of 0.05, a sample of 10,994 women was required across the audit period to detect a change in incidence from 3.5 to 4.6%.

Data were presented as number and percentage for the incidence of GDM. Descriptive statistics of predefined clinical outcomes were compared using Student's t-test for continuous variables and Chi Square test or Fisher exact test for discrete data. A p value of 0.05 was considered significant.

3. Results

Of 10,296 women delivering in the audit period, antenatal OGTT results could be traced for 10,277 women (99.8%). The remaining 19 (0.2%) women did not have an antenatal OGTT, in violation of national clinical protocol. Of these women, 5 attempted an OGTT and were unable to complete the test due to nausea and/or vomiting. They subsequently declined a repeat test. The other 14 women either presented for care too late for testing or declined testing.

Table 1 summarizes the incidence of GDM under the two diagnostic criteria. The overall incidence was not significantly different with 3.4% diagnosed under the ADIPS 1999 criteria and 3.5% under the IADPSG 2010 criteria. In the subgroup of 342 women with a BMI > 40 (representing 3.3% of the study population) the incidence of GDM was 3.7% using ADIPS 1999 criteria and 8.5% using IADPSG 2010 criteria. This difference was not statistically significant ($p = 0.11$); however, the audit was not adequately powered to detect a difference in the subgroup of women with high BMI.

Table 1: Incidence of GDM under ADIPS 1999 and IADPSG 2010 criteria.

	ADIPS	IADPSG	p value
All women	$N = 3{,}553$	$N = 6{,}724$	
GDM	121 (3.4%)	236 (3.5%)	0.78
No GDM	3,432 (96.6%)	6488 (96.5%)	
Women with BMI ≤ 40	$N = 3446$	$N = 6489$	
GDM	117 (3.4%)	216 (3.3%)	0.86
No GDM	3,329 (96.6%)	6,273 (96.7%)	
Women with BMI > 40	$N = 107$	$N = 235$	
GDM	4 (3.7%)	20 (8.5%)	0.11
No GDM	103 (96.3%)	215 (91.5%)	

Across the audit period the proportion of women with GDM who required management with medication (metformin or insulin) in addition to diet was not significantly different (25% in women diagnosed by ADIPS 1999 criteria and 28% in women diagnosed by IADPSG 2010 criteria, resp.).

Delivery data for 10,277 (98%) women were available for audit through Meditec, case note audit, or the postnatal clinical service.

Table 2 summarizes predefined delivery outcomes. Babies born to women diagnosed with GDM according to the IADPSG 2010 criteria had significantly higher umbilical artery pH (7.28 versus 7.21; $p = 0.01$). They had a significant lower birthweight (3360 gms versus 3470 gms; $p = 0.02$) and birthweight above the >90th centile adjusted for gestational age (11% versus 18%; $p = 0.04$). Other predefined maternal and newborn outcomes were not significantly different between groups.

4. Discussion

The audit found no significant difference in the incidence of GDM before and after the introduction of the IADPSG 2010 criteria, with the overall incidence being low at 3.5%. Our results differ from the previous Australian and New Zealand studies [7, 8].

One explanation may be that prevalence of GDM in our region is low compared to many other sites. Our rate of 3.5% contrasts higher background rates in the sites involved in the HAPO trial where incidences ranged from 8 to 25% [12]. However, HAPO study sites were specifically included because of their high rates of GDM. They were tertiary sites where women with high BMI and other pregnancy complications were referred for antenatal and delivery management [5, 12]. Our study was based upon a geographical region rather than a hospital cohort and thus captured women of all risk levels, including a majority who were of "normal" risk, unlike the patient population within a tertiary centre.

A second explanation for the observed difference in outcome between our study and previous ones may be the racial mix of the population. Although our geographic maternity cohort reflected the wider Australian public maternity cohort in terms of maternal age and parity [13], racial background was overwhelmingly English speaking Caucasian.

A third explanation may be due to maternal obesity levels. Our geographic catchment has a low prevalence of overweight and obese patients compared to many sites. Lower obesity levels mean that the underlying risk of metabolic hyperglycaemia is lowered. Of note, in our subgroup of women with a BMI > 40 the incidence of GDM rose from 3.7% to 8.5% under the IADPSG 2010 criteria, more in line with studies elsewhere [7, 8].

As a secondary consideration, the adoption of the IADPSG 2010 criteria did not adversely impact upon our predefined maternal and newborn outcomes. There was a significant improvement in three newborn outcomes, being an increase in umbilical artery pH and a reduction in birthweight and birthweight >90th centile adjusted for gestational age. There were no significant changes in maternal outcomes. This provides reassuring safety data for the change.

The study had several strengths. Firstly, data were extracted from a defined geographic region before and after implementation of the IADPSG 2010 diagnostic criteria. Secondly, all women received treatment using identical clinical protocols throughout the audit period. Thirdly, there was high compliance with screening for GDM (99.8%) and ascertainment of outcome (98% of women). A study limitation is the low background incidence of GDM that limits generalizability to regions where incidence rates are higher. A second limitation is that only 3.3% of women presented with a BMI > 40. In this subgroup of women, the incidence of GDM was higher at 8.5%. Centres where the obstetric population has a higher incidence of obesity may report an increase in the incidence in GDM utilising the new diagnostic criteria. However, it is likely that this reflects a genuine increase in metabolic pathology, as obesity is a major risk factor for GDM and adverse pregnancy outcome [14].

5. Conclusion

The IADPSG used a consensus process to redefine GDM based on its association with adverse pregnancy outcomes. There has been controversy about the adoption of the new guidelines. However, in our audit study of 10,296 women, we observed no significant increase in the incidence of GDM. The adoption of the new criteria was associated with improvements in three newborn outcomes.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Table 2: Delivery outcomes.

	GDM ADIPS $N = 121$	GDM IADPSG $N = 236$	p value
Maternal outcomes			
Maternal age (years) Mean (sd)	31.0 (5.3)	31.1 (5.6)	0.75
Parity Median (IQR)	1 (1–2.5)	1 (1–2.5)	0.34
Caesarean section N (%)	30 (25%)	64 (27%)	0.64
Blood loss (mL) Median (IQR)	300 (200–380)	300 (200–400)	0.25
Birth trauma (3rd/4th degree tear) N (%)	2 (2%)	5 (2%)	1.00
Newborn outcomes			
Gestational age (days) Mean (sd)	274 (7)	275 (6)	0.82
Birthweight (grams) Mean (sd)	3470 (345)	3360 (321)	0.02
Birthweight >90th centile for gestational age N (%)	22 (18%)	25 (12%)	0.04
Apgar 1 Mean (sd)	9 (8.25–9)	9 (9-9)	0.17
Apgar 5 Mean (sd)	9 (8.40–9)	9 (9-9)	0.21
Arterial cord blood Mean (sd)	7.21 (0.6)	7.28 (0.6)	0.01
Venous cord blood Mean (sd)	7.33 (0.2)	7.34 (0.2)	0.89
Admission to neonatal nursery N (%)	14 (12%)	28 (12%)	0.93

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