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EXCESS GESTATIONAL WEIGHT GAIN IN SIMCOE MUSKOKA

An Examination of the Issue
Using a Population Health Perspective

Literature Review

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ABSTRACT

Excess gestational weight gain (GWG) is a modifiable risk factor that has been found to be associated with a variety of adverse maternal and child health outcomes. In light of new research, increasing rates of overweight and obesity, and the contribution of excess GWG on this trend, the Institute of Medicine (IOM) released an updated report, *Weight Gain During Pregnancy: Re-examining the Guidelines (2009)*. Health Canada subsequently adopted the recommendations contained in the IOM report. Canadian overweight and obesity data sources for women of reproductive age as well as GWG studies are presented to provide a Canadian context to the IOM report. A population health approach to the issue of GWG is used.

Health Canada's new GWG Recommendations now include a recommended *rate* of weight gain by pre-pregnancy Body Mass Index (BMI), a specific recommended *range* of weight gain for those with a Body Mass Index ≥ 30, and a recommendation for women carrying twins. Caesarean sections, pre-term births, large for gestational age (LGA), macrosomia and postpartum weight retention are all moderately or strongly related to excess GWG. The role excess GWG plays in childhood obesity is emerging. Advice received from health care providers can influence the actual amount of weight women gain during pregnancy. Healthy weights counseling should take place during the preconception, prenatal and postpartum periods, and should include discussion regarding diet and physical activity, current BMI status and dieting history. Health care providers should be aware that there may be an association between social factors such as low income and low education and weight gain during pregnancy, and weight retention postpartum.

EXECUTIVE SUMMARY

Excess gestational weight gain (GWG) is a modifiable risk factor associated with caesarean section rates, postpartum weight retention, large for gestational age (LGA), macrosomia and pre-term birth.[1] In light of new research, increasing rates of overweight and obesity in our society since the 1990 guidelines[2] were released, and the contribution of excess GWG on this trend, the Institute of Medicine (IOM) released an updated report *Weight Gain During Pregnancy: Re-examining the Guidelines (2009)*.[1] Later in 2009, Health Canada (HC)[3] adopted the recommendations contained in the IOM report. In this narrative review, the authors apply Canadian and local statistics and research to the findings of the IOM report.

The Canadian Community Health Survey (CCHS) indicates that in 2011, 44.8% (42.9%, 46.8%) of women 18 years and older living in Ontario were either overweight or obese and that since 2003, the rate of obesity has been increasing.[4]

In 2009/2010, 46.6% (37.8%, 55.5%) of Simcoe Muskoka women of reproductive age (age 15-44) self-reported that they were either overweight or obese.[5] Considering the average age of first time mothers is 27 years, and the average age of all mothers is 29 years,[6] it is reasonable to estimate that nearly half of all local women may now be entering pregnancy as either overweight or obese.

In addition to this, a large proportion of pregnant women gain in excess of GWG recommendations. According to the Public Health Agency of Canada, 68% of women with a Body Mass Index (BMI) classified as overweight pre-pregnancy and 60% of women with a BMI classified as obese (60%)[7] were more likely to exceed their GWG recommendation. Forty-one percent (41%) of women who had a BMI classified as normal weight pre-pregnancy also gained more than is recommended.[7] Women who retain the excess weight gained during pregnancy enter a subsequent pregnancy at an increased BMI which then increases their risk of pregnancy and birth complications.[8] Postpartum weight retention may also contribute to the trend of women becoming heavier as they age. As a result of their increasing body mass index, their risk of developing a chronic disease may also increase.[9]

In Simcoe County and the District of Muskoka, the rates of several birth outcomes associated with excess GWG have changed over time. From 1986 to 2009, there has been a significant increase in the proportion of large for gestational age (LGA) infants (1986-8.9%; 2009-11.8%) while the proportion of small for gestational age (SGA) infants has significantly decreased (1986-13.3%; 2009-7.4%).[6;10] Experts have differing opinions on why these trends are occurring and whether maternal diet is a factor. There has also been a significant increase in the proportion of pre-term births(1986-5.2%; 2009-7.4%)[11] while the Caesarean delivery rate has remained stable (2003-28.6%; 2011-29.9%).[10]

The determinants of health are the social, cultural and environmental factors or conditions that impact health outcomes, including those associated with excess GWG during pregnancy.[12] For example, women living in urban areas are usually leaner than their rural counterparts; they are also more likely to eat more vegetables and fruit and be physically active, all of which are associated with healthy weights. Women who are experiencing food insecurity may preferentially choose high calorie (high fat) foods to ward off hunger[13] and Aboriginal women are much more likely to be obese as well as to have a low quality diet, compared to non-Aboriginal women.[14]

Recent literature has demonstrated that women of low income and education are more likely to enter pregnancy as obese.[15]

In addition, certain characteristics of the built environment such as safe neighborhoods with walking trails, parks, sidewalks[16], supermarkets[17] and few fast food outlets, [18;19] have been shown to support healthy weights overall as well as healthy GWG during pregnancy.

Factors that may contribute to excess GWG are evident for Canadian women. Sixty percent of women aged 19-30 and 55% women aged 31-50 ate fewer than the 5 servings per day of vegetables and fruit recommended by Eating Well with Canada's Food Guide (2007), and 28% of women 31-50 years eat more fat per day than recommended.[20] Overweight and obese women tend to have lower quality diets than women of normal weight. A history of dieting may also increase the risk of gaining more weight than is recommended.[21-23]

The physical fitness level of women of reproductive age is also of concern. The recent Canadian Health Measures Survey identified that 55% of women 20-39 years had trouble reaching their toes from a sitting position and one third of women in the same age group could not do one partial curl-up.[24]

Canadian Gestational Weight Gain Recommendations [3]

	Mean Weight Gain Rate in the 2nd and 3rd trimester		Total Weight Gain		Twin Pregnancy
Pre-pregnancy BMI	Rate in kg	Rate in lbs	Range in kg	Range in lbs	Recommended Weight Gain Ranges
underweight <18.5	0.5	1.0	12.5-18	28-40	Insufficient data
normal weight 18.5-24.9	0.4	1.0	11.5-16	25-35	17-25kg/37-54 lbs
overweight 25.0-29.9	0.3	0.6	7-11.5	15-25	14-23 kg/31-50 lbs
obese ⩾30.0	0.2	0.5	5-9	11-20	11-19 kg/25-42 lbs

*Calculations assume a 0.5-2 kg (1.1-4.4 lbs) weight gain in the first trimester[3]

These guidelines now include a recommended *rate* of weight gain by pre-pregnancy BMI, a specific recommended *range* of weight gain for those with a BMI ≥ 30, and a recommendation for women carrying twins. Caesarean section rates, pre-term births, LGA, macrosomia and postpartum weight retention are all moderately or strongly associated with excess GWG. Pre-pregnancy BMI was highly correlated with all of these outcomes except post-partum weight retention, which was independently associated with GWG.

Evidence related to the role of excess GWG in the development of childhood obesity is emerging. Recent research has shown an association between excess GWG and increased adiposity and BMI in the offspring that lasts into adulthood.[25]

Given that a large proportion of women enter pregnancy as either overweight or obese[2] and many Ontario women go on to gain in excess of their recommended weight gain range during pregnancy[7] a radical change in prenatal care is proposed (IOM, 2009).[1] Information provided by health professionals can influence the actual amount of weight women gain during pregnancy[26-29], and therefore the IOM recommends preconception counseling for overweight and obese women, and prenatal and postnatal counseling for *all* women, to encourage healthy GWG and appropriate postpartum weight loss.[1]

Furthermore, in addition to implementing the new GWG recommendations, the determinants of health impacting GWG must be addressed in order to improve health outcomes for women and their children. Unfortunately, barriers such as low literacy and the urgency of more pressing medical or psychosocial issues that disproportionately affect "at risk" populations may interfere with the capacity of practitioners to address the issue of weight gain during pregnancy.

There are conflicting results regarding the effectiveness of dietary and physical activity interventions in decreasing GWG. Nevertheless, antenatal care providers need to be supported to inform pregnant women of their recommended GWG range and rate as well as about healthy eating and active living during pregnancy to enable women to gain within their recommended GWG range. Training in motivational interviewing[30] may be especially beneficial to prenatal health care providers. The use of GWG plotting tools to track women's patterns of weight gain during pregnancy is considered by the IOM a key element in supportive discussions between health care providers and pregnant women.[1] Other than the opinion of the IOM committee and Health Canada[31], there is currently no evidence that weight gain plotting is effective in promoting healthy weights during pregnancy.

Clearly, more evidence is needed to determine the effectiveness of population-level intervention programs promoting healthy GWG. Therefore, any intervention strategy developed to address excess GWG should be rigorously evaluated.

INTRODUCTION

The average weight of Canadian women of reproductive age is greater than ever before.[2] As a result, more and more women are not at a weight that is considered optimal for health when they become pregnant. The research evidence is clear that obesity during pre-conception is related to numerous pregnancy complications that can negatively impact the health of both mother and fetus.[32] It is now understood that excess GWG poses additional risks to both maternal and child health outcomes.[33]

In 1990, the Institute of Medicine (IOM) released gestational weight gain (GWG) guidelines.[34] Based on evidence cited in this report (IOM, 1990), infant health was identified as the primary focus. The goal was to optimally nourish pregnant mothers to decrease the incidence of low birth weight babies.[1]

In 2009, in response to the growing obesity epidemic, the proportion of women thought to gain excess gestational weight and the expanding body of research literature examining the consequences of excess GWG on maternal and infant outcomes, the IOM released its revised report, *Weight Gain during Pregnancy: Reexamining the Guidelines* (IOM, 2009).[1] In the fall of 2009, Health Canada adopted these new guidelines.[3] The new IOM report identifies a need for a paradigm shift away from a focus on low birth weight babies towards balancing concern for the health of both mother and baby. In addition to risks related to fetal growth, it has been identified that excess GWG increases risk of caesarean section, pre-term birth and postpartum weight retention (PPWR).[33] Prenatal care needs to be approached from within the context of this broader understanding. The IOM report [1] clearly identifies that its focus is on outcomes specifically related to GWG and not maternal overweight/obesity.[i] This focus is important as GWG is modifiable during pregnancy with improved prenatal care, while women's pre-pregnancy body mass index (BMI) is not.[8]

Rates of overweight and obesity among women of reproductive age are of public health concern because women in high BMI categories are at increased risk of developing chronic diseases.[9] Excess GWG is also of public health importance because this excess weight tends to be retained postpartum.[1] This increases women's risk of starting subsequent pregnancies at a higher BMI[1;8] and contributes to increasing rates of overweight and obesity among women. Furthermore, evidence suggests that excess GWG may also be related to the development of childhood obesity.[36-41] Clearly, prenatal care providers have an important role to play in communicating GWG recommendations ranges to pregnant women to improve both maternal and child health outcomes.

This narrative review provides Canadian information and context to the 2009 IOM report. This review will describe the current epidemiology for women of reproductive age related to overweight and obesity in the Simcoe Muskoka District Health Unit (SMDHU) area. Using the determinants of health as a framework, this review will describe various factors known to impact overweight and obesity in women. The main maternal and infant outcomes related to GWG from the recent IOM report will be discussed, as will the current Health Canada GWG recommendations. Finally, GWG-

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[i] Several negative maternal and infant outcomes have been associated with maternal obesity. Examples of complications include spontaneous pregnancy losses, neural tube defects, gestational diabetes, gestational hypertension, complications from anesthesia, macrosomia, stillbirth, LGA babies, congenital abnormalities, ventral wall defects and other cardiac defects[35].

related professional policy statements and findings of intervention studies that address GWG will be presented.

BACKGROUND

About BMI

Body mass index (BMI)[42] is a ratio of weight compared to height. BMI is typically used to assess the level of risk of developing health conditions related to underweight and overweight. Using the equation below, a numerical value is produced. There are four general BMI categories, underweight, normal weight, overweight and obese. The obese category is subdivided into 3 classes, I, II and III. BMI can be calculated pre-pregnancy. BMI calculations are not valid during pregnancy or lactation. BMI values may be underestimated or overestimated in adults who are highly muscular, who are naturally lean and young adults who have not reached their full growth potential. The IOM (2009) asserts that BMI categories may be used for adolescents (< age 20) due to the impracticality of using growth charts in obstetrics practices.[1]

The Agency for Health Research and Quality (AHRQ) review[33] concluded there is insufficient evidence to judge whether alternative measures of maternal adiposity (versus pre-pregnancy BMI) are better at predicting maternal and child outcomes. This review will discuss GWG according to pre-pregnancy BMI.

Table 1: Health risk classification according to Body Mass Index[42]

Health Risk Classification According to Body Mass Index		
Classification	**BMI Category (kg/m2)**	**Risk of developing health problems**
Underweight	< 18.5	Increased
Normal Weight	18.5 - 24.9	Least
Overweight	25.0 - 29.9	Increased
Obese class I	30.0 - 34.9	High
Obese class II	35.0 - 39.9	Very high
Obese class III	>= 40.0	Extremely high

BMI = weight (kg)/height (m)[2]

Highlights of the IOM Report (2009)

This section focuses on the impact of GWG on maternal, infant and child health outcomes. Specifically, it focuses on the findings of the IOM report and the AHRQ systematic review.[33] Caesarian section (C/S) rates, postpartum weight retention (PPWR), large-for-gestational-age (LGA), macrosomia and pre-term birth were all moderately or strongly associated with excess GWG. Pre-pregnancy BMI was highly correlated with all these factors, with the exception of postpartum weight retention, which was independently associated with pre-pregnancy BMI. It should be noted that the IOM report emphasized that many studies examining gestational weight gain are observational in nature and cannot adequately address confounding factors, thus causal statements cannot be made linking the outcomes of interest with GWG.
Out of all the outcomes associated with GWG, pre-term birth (< 37 weeks completed gestation) is perhaps the most controversial. The AHRQ systematic review[33] found a strong association

between weight gain *below* the 1990 IOM recommendations and pre-term births. There was conflicting evidence in relation to excess GWG and pre-term births.[33] The IOM committee in 2009 examined the available evidence to date and had difficulty establishing biological plausibility to connect GWG and preterm birth. They concluded, " there is strong evidence for a U-shaped association between lower GWG and preterm birth among normal weight and underweight women, and moderate evidence for an association of higher GWG and preterm birth".[43] Health Canada[31] does not list preterm birth as an outcome associated with excess GWG in their current resource for health care providers. It does however address pre-term birth as an outcome associated with high pre-pregnancy BMI, citing a recent 2010 systematic review.[44]

Maternal Pre-pregnancy Weight, GWG and the Obesity Epidemic

Maternal Outcomes:

The Avon Longitudinal Study of Parents and Children (ALSPAC) cohort is a prospective birth cohort study from the United Kingdom. In 1991/1992, it recruited approximately 13,000 mother-offspring pairs. At the 16 year follow-up visit, approximately 4000 mothers were assessed for cardiovascular risk factors. Results revealed that women who had had excess GWG, now had a higher BMI, waist circumference, systolic blood pressure, diastolic blood pressure and a greater risk of overweight and obesity and central adiposity than did women who had gained the recommended amount of weight during pregnancy. The authors reported that the odds of overweight and obesity and central adiposity were three times greater in women with higher-than-recommended GWG than in those women who gained within their recommended weight gain range. Excess weight gain in early and late pregnancy was associated with overweight and obesity and central adiposity 16 years later.[45]

Child Outcomes:

Again using the ALSPAC cohort, 5154 mother-offspring pairs were examined. Using measures of adiposity, blood pressure (BP) and blood assays, Fraser et al. found offspring of women who gained more gestational weight than recommended by the IOM (1990) were more likely to have a higher BMI, larger waist circumference, higher fat mass and distorted metabolic cardiovascular risk factors at nine years of age.[25] The Project Viva study found mothers who gained excess gestational weight had children with a slightly elevated systolic blood pressure, 0.34 Hg (95% CI: -0.19, 0.87) (albeit not statistically significant) after controlling for child BMI.[39] Systolic blood pressure is a cardiovascular risk factor related to adiposity, even in young children.

Most of the studies investigating the role of excess GWG have been conducted in the United States. In a large, retrospective cohort study examining approximately 26,500 pairs of nurses and their mothers, Stuebe et al. (2009) found women who recalled having a high pre-pregnancy BMI and had excess GWG were more likely to have offspring who were at increased risk of adolescent and adult obesity, particularly when the mother was overweight. Gestational weight gain in excess of 40lbs was associated with a maternal BMI-adjusted 2.13-fold increase in odds of obesity in the offspring.[38]

Similarly, Oken et al (2009) found women who had adequate and excessive gains were associated with odds ratios of 3.77 (95% CI:1.38, 10.27) and 4.35 (95% CI:1.69, 11.24), respectively, for obesity at 3 years of age.[39]

Another similar study found a positive association between GWG and childhood BMI at age 7.[37] Only one study of 321 mother and infant pairs found no effect of GWG on childhood obesity.[46]

Similar results have been found in the United Kingdom when childhood BMI was measured at age six[40] and in Denmark[41] and in Australia[36] when BMI was measured in adult offspring.

Recently, another IOM report stated there was ample evidence that supports the association between excess GWG and increased childhood BMI.[47] They note however, that the question of causality remains outstanding and further research is needed. Studies examining the relationship between excess GWG and childhood obesity do not always control for the rate of infant weight gain, breastfeeding status, healthy dietary behaviours or physical activity of children when assessing the impact of GWG on childhood weight status.[47]

EPIDEMIOLOGY AND TRENDS

Women of Reproductive Age

Various national surveys have described how women continue to gain weight over time. The National Population Health Survey (NPHS) was a longitudinal survey that examined changes in self-reported weight of Canadian adult populations (ages 18-64). Results indicated that, during the eight years of the study, women ages 18-64 gained an average of 3.4 kg/7.5 lbs. In subsequent analyses, the trends that emerged in changes to women's weight between 1994/1995 and 2008/2009 include: a) proportionally more women self-reporting an increase in their BMI, b) a decrease in the proportion of women reporting that their BMI had been stable, and c) a decrease in the proportion of women reporting their BMI had decreased.[2]

Generally, as women age they tend to become heavier: 32.1% of women aged 20-34 have a BMI ≥25 and 40.3% of women aged 35-44 have a BMI ≥25 in 2010. This weight gain occurs until age 64 and decreases thereafter.[48]

Younger women, aged 18-33 years, have experienced significantly greater average weight gains compared to women in the 34-59 age grouping.[49] When focusing only on BMI ranges, the prevalence of obesity generally increases with each successive age group, until the age of 65. Usually obesity rates are higher among men than women except for the age group of 20-39 years where obesity rates were 21% for females and 19% for males.

The percentage of women aged 15-44 who self-reported being either overweight or obese in the Simcoe Muskoka District Health Unit is 46.6% (95% CI: 37.8%, 55.5%). This rate is higher than the Ontario average of 34.6% (32.8%, 36.4%).[5] This difference is statistically significant. However, it is not significantly different than the rates for our peer health units (B)[ii] in Ontario.

This trend of increasing BMI starting at a young age and continuing with advancing age is of concern when we consider that the average age of women giving birth in Simcoe Muskoka is 29 years and the average age of first time mothers is 27 years.[6]

[ii] According to Statistics Canada, the City of Ottawa, Durham Regional Health Unit, Halton Regional Health Unit, Waterloo Health Unit and Welllington-Dufferin-Guelph Health Units are also Ontario Health Units/Departments in Peer Group B. Peer groups are grouped by their similarity of 24 socioeconomic characteristics. Three broad categories for these variables are basic demographics, living conditions and working conditions[50;51].

The Maternity Experiences Survey (MES) was a national survey conducted in 2006/2007 by the Public Health Agency of Canada (PHAC) and Statistics Canada. The MES sampled 8,542 women 15+ years of age after a singleton live birth. According to the MES, younger women and women giving birth for the first time were more likely to gain excess gestational weight (47% vs. 37% multiparous women).[52]

Comparisons of self-reported height and weight with actual measurements have shown that women are inclined to underestimate their weight. Under-reporting of weight increases proportionally with BMI. When focusing only on measured heights and weights, 42.6% of Canadian women ages 18-39 were found to be either overweight or obese.[53] Measured BMI data is not available at the provincial or local levels.

Pre-Conception Weights

The MES reported that the average pre-pregnancy BMI was 24.4 (24.1-24.7). Approximately 33% of Ontario women were found to have a pre-pregnancy BMI defined as overweight or obese, 60% were in the normal weight category and 7% were considered underweight.[52]

Pregnancy Weight Gain

When looking at MES results specific to Ontario, 30% of underweight, 41% of normal weight, 68% of overweight and 60% of obese women gained in excess of their recommended gestational weight gain range for their pre-pregnancy BMI.[7] The MES reported the average weight gain for Ontario women was 16 kg/35.3 pounds (95% CI: 15.6-16.3/34.4-36.0).[54]

These findings are similar to other small Canadian studies. In 2009, over half the sample (52.3%) of pregnant women from Newfoundland (n=5377) gained too much weight and only 30.6% of this sample gained within their recommended weight gain range as defined by their pre-pregnancy BMI.[55]

For the current Canadian Gestational Weight Gain Recommendations, please see Table 2.

Postpartum Weight Retention

The MES found the average BMI increased from 24.4 (95% CI: 24.3-24.6) at pre-pregnancy to 25.4 (95% CI: 25.2-25.5) at 5-14 months postpartum.[54] These statistics are descriptive only and do not account for status of lactation.

Table 2:

A Comparison of pre-pregnancy and postpartum BMI among Ontario women (Maternity Experiences Survey).[54]

BMI	< 18.5 (95% CI)	18.5-24.9 (95% CI)	25.0-29.9 (95% CI)	≥ 30 (95% CI)
Pre-pregnancy BMI	6.8% (5.7-7.9)	60.2% (58.1-62.4)	18.9% (17.2-20.7)	14.1% (12.5-15.6)
Post-partum BMI*	3.5% (2.7-4.4)	54.6% (52.3-56.9)	25.2% (23.3-27.2)	16.7% (15-18.3)

* measured 5-14 months post-partum

When BMI was assessed at 5-14 months postpartum, fewer women were in the underweight and normal weight categories and more women were in the overweight and obese BMI categories.

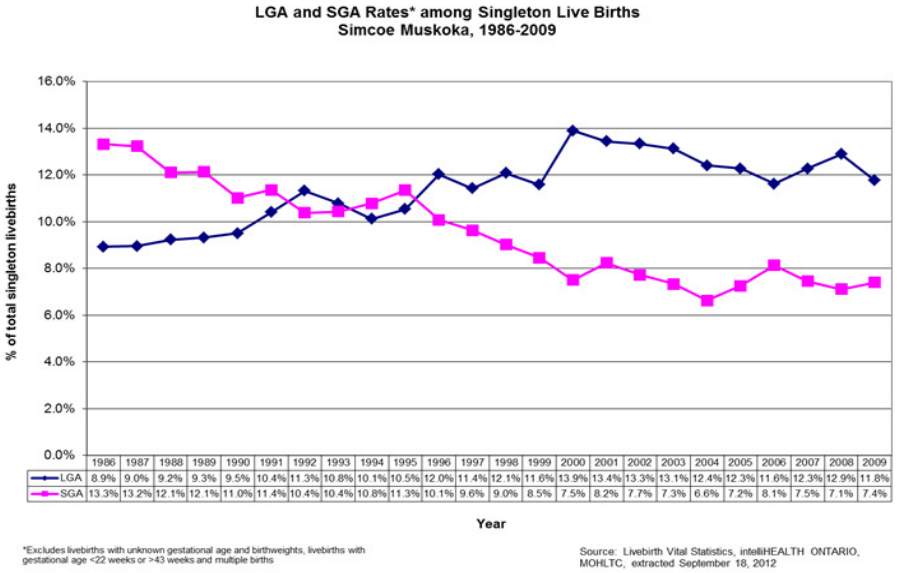
Birth Weight Outcomes

The IOM (2009)[1] noted that birth weights were strongly associated with GWG, and caesarian sections and pre-term births were moderately associated with GWG. The Canadian Perinatal Health Report notes increases in these pregnancy complications and birth outcomes.[56]

Noteworthy are changes in both the LGA and SGA rates. Historically, SGA infants have been the primary concern; however, in 2004/5 at the national level there were more LGA infants born (11.6/100 live births) than SGA infants (7.8/100 births).[56]

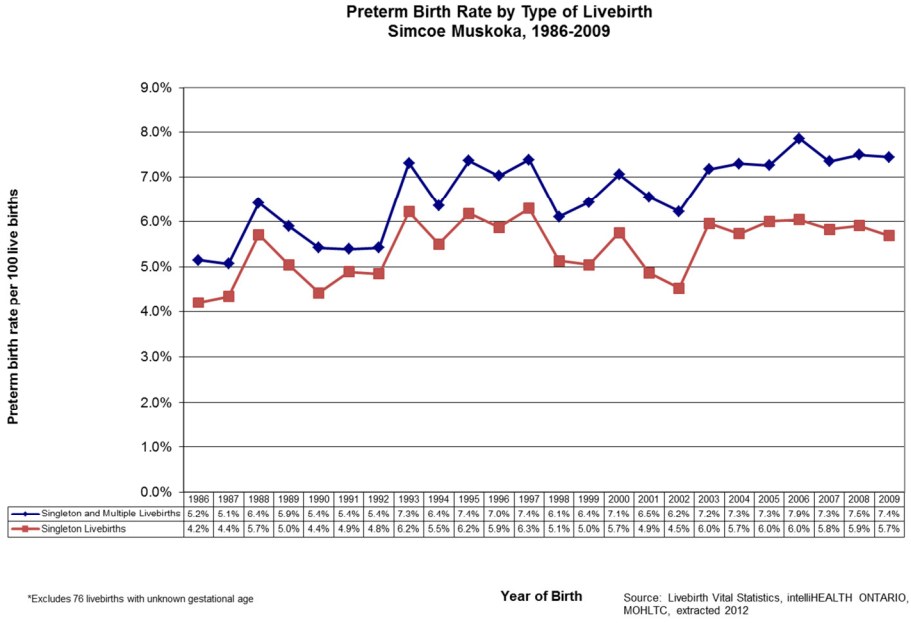
Locally, the reversing trend in the rates of SGA and LGA infants is the most striking. In 1986, there were significantly more SGA infants (13.3%) born in Simcoe Muskoka compared to LGA infants (8.9%). A reversal of this trend began in the early 1990's. As of 2009, there were significantly more LGA infants born (11.8%) compared to SGA infants (7.4%).[6] Using a different data set with more current data, the reported rate of SGA was 5.8% and LGA was 10.6% in 2010 (data not shown).[10] According to the Public Health Agency of Canada (PHAC),[56] evidence of contributing factors to explain increased rates of LGA infants is minimal. They cite maternal diabetes, genetic predisposition and possibly maternal diet as possible factors. Others have found increases in maternal BMI and decreases in maternal smoking to explain the rising trend of LGA infants.

Figure 1:



In addition, the preterm birth rate (including multiple births) in Simcoe Muskoka has increased significantly from 5.2 in 1986 to 7.4 in 2009 (Figure 2). When considering singleton live births only, the preterm birth rate was 4.2% in 1986 and also significantly increased to 5.7% in 2009.[11] Caesarian section rates in Simcoe Muskoka appear to be stable, being just under 30% of all births from 2003 (28.6 %) to 2011 (29.9%) (data not shown).[10]

Figure 2:



POPULATION HEALTH APPROACH TO HEALTHY WEIGHTS FOR WOMEN OF REPRODUCTIVE AGE

A population health approach is comprised of eight key elements. Two that are central to the definition of population health and this paper are:

1) the health of populations, and
2) the determinants of health and their interactions.[57]

The determinants of health include the social, economic, cultural and physical environments, their interactions with individual biology and behaviours, and the quality and accessibility of health services. By reflecting on the determinants of health we are able to identify how individual and environmental factors impact health outcomes.[12] The World Health Organization states that **poverty is the single largest determinant of health**.[58] For a complete list of the 12 determinants of health, please see appendix A.

Health professionals with knowledge of the determinants of health better understand the potential causes of health disparities in their practice.

Using selected determinants of health as the framework, this section of the narrative review describes factors known to affect the weight of women of reproductive age and pregnant women. This information can help health care professionals understand current weight gain trends of this group. Secondly this information can be used to inform the development and implementation of policies and actions aimed at improving the health and well-being of women of reproductive age and their families.

Physical Environments

The Built Environment:

The physical environment not only refers to the urban/rural context but also includes the specifics of the actual built environment of communities. Only one study identified by the IOM (2009)[1] examined the relationship between the built environment of a neighbourhood and GWG. Laraia et al. (2007) looked at neighbourhood factors associated with physical activity and weight gain during pregnancy. The presence of social spaces, defined as parks, sidewalks, and porches, as well as the presence of people, including nonresidential visitors, helped women achieve healthy weight gain during pregnancy.[16] The IOM (2009) concluded that neighbourhood environments influence GWG by providing access to healthy foods and opportunities for physical activities.[1]

Laraia et al. (2004) investigated whether the distance from a supermarket impacted the diet quality of pregnant women, as measured by a Diet Quality Index (DQI). Investigators found women who lived more than 4 miles/6.4 km from a supermarket had twice the risk of falling into the lowest level of the DQI compared to women who lived less than 2 miles/3.2 km from a supermarket.[17]

The location of fast food restaurants is also of interest to researchers. The CCHS (2004) reported 1 in 4 Canadians visited a fast food outlet the day before the survey.[20] This is an area of public health concern as foods available from fast food restaurants tend to be high in calories.

Many American cross-sectional studies have shown a positive association between fast food consumption and poor dietary intake (high calorie intake and high fat intake);[19;59] however, the link between the number of neighborhood fast food outlets and obesity remains inconclusive.[60;61]

Income, Social Status and Education

Income and Education:

Certain characteristics of the residents of a neighborhood have been found to impact overweight status. For women living in a neighborhood with residents who have low educational levels, there is a tendency to have significantly higher body mass index, regardless of their own level of education. This finding may reflect norms and practices about diet and exercise in those neighborhoods, but could also be related to issues of neighborhood safety and the availability and quality of recreational opportunities.[62] Conversely, Kuhle & Veuglers (2008) found the socio-economic status (SES) of a neighbourhood had little impact on overweight status.[63] The authors speculated that other (yet to be determined) indicators may impact weight and weight gain behaviors better than SES, thus explaining the lack of a significant finding.[63]

The Public Health Agency of Canada (2011) states that the relationship between income and obesity varies by gender.[15] The accumulated evidence suggests an inverse association between both income and obesity and education and obesity among women.

The MES reported those with lower education were more likely to exceed their GWG range. Interestingly, women with high incomes were just as likely to gain an excess amount of weight during pregnancy as low income women. However, low income women were also more likely to gain an inadequate amount of weight.[64] In contrast, American women with family incomes below the federal poverty line were approximately 2.6 times more likely to exceed the top of the IOM GWG range than women with higher incomes.[65]

Limited evidence also suggests that specific health care provider (HCP) practice related to low income women may impact the amount of weight women gain during pregnancy. Phelan et al. (2011) hypothesized that for low-income pregnant women, lack of practitioner advice may reflect educational barriers such as low literacy. Practitioners may also be spending available time addressing more urgent medical or psychosocial issues that disproportionately affect “at risk” populations.[66]

Food Insecurity and Obesity:

In addition to the commonly recognized link between food insecurity and underweight, there also may be a direct association between food insecurity and obesity among women. Academics now argue that the association between obesity and food insecurity can be explained by the over-consumption of low cost, energy-dense foods as a strategy to save money. The consumption of energy-dense foods leads to higher total energy intake, which in turn leads to overweight and obesity if energy expenditure (physical activity) is low. Energy-dense foods also tend to be well-liked, even perceived as a reward, a factor that would reinforce their selection and repeated consumption.[13]

Today’s retail food environment is such that prices for foods with a stable shelf life are generally less costly than perishable foods like meat or fresh produce. Larger portion sizes are another example of how the food industry provides inexpensive extra energy at a lower cost. Foods most commonly available in ‘super sizes’ tend to be made from refined grains, and have added sugars and fat. Some nutrition professionals have noted that diets of persons of lower SES provide cheap, concentrated energy from fat, sugar, cereals, potatoes, and meat products but very little intake of vegetables, fruit and whole grain products.[13]

In 2009-2010, the Canadian Community Health Survey reported 8.5% of Ontario households were either moderately or severely food insecure.[67]

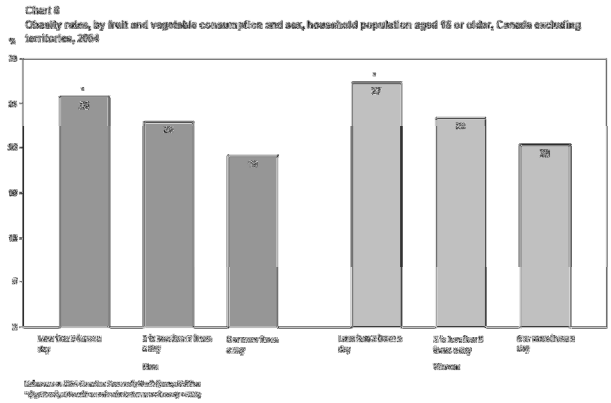
Overall, there is agreement that a healthier diet costs more and is beyond the reach of many low-income families.[68] In SMDHU, females of reproductive age (15 to 44 years) living in the lowest income households eat fewer servings of vegetables and fruit daily (37.2%, [95% CI: 28.1%, 46.3%]), compared to those living in the highest income category (50.6% [95% CI: 44.2%, 57.0%]), although the difference is not statistically significant.[69]

Personal Health Practices and Coping Skills

Nutrition for Women of Childbearing Age

Many Canadians have room for improvement in the nutritional quality of food eaten. The average Canadian gets 22% of daily calories from the "other foods" category. Of the commonly consumed "other foods" soft drinks ranked first, followed by salad dressing, sugars/syrups/preserves, beer, and oils/fats. [20]

Twenty-eight percent (28%) of women between the ages of 31-50 eat more calories from fat than recommended by Health Canada.[iii] The "sandwich" category, consisting of items such as pizza, sandwiches, submarines, hamburgers and hot dogs, contributed the greatest proportion of fat to the diet. Younger women are more likely to eat in fast food restaurants compared to their older counterparts. In 2004, 34% of women age 19-30 (vs. 28% of women age 31-50) ate food from a fast-food outlet the day before the survey.[20] There is evidence to suggest that women who eat the recommended number of servings of vegetables and fruit are less likely to be obese.[15]



According to the Canadian Community Health Survey, 60% of women aged 19-30 and 55% women aged 31-50 ate fewer than 5 servings per day of vegetables and fruit.[20]

In Simcoe Muskoka District Health Unit (SMDHU) in 2009/2010, nearly half of women of childbearing age (15 to 44 years) (48.8% [95% CI:41%, 56.7%]) reported eating vegetables and fruit five or more times per day. Vegetable and fruit consumption has stayed constant since 2003, and is similar to the provincial average in 2009/2010 (47.2% [95% CI: 45.4%, 48.9%]).[5]

[iii] The Acceptable Macronutrient Distribution Range for total dietary fat is 20-35% of total calories. This recommended range is the same for a non-pregnant women.

Nutrition Before and During Pregnancy

Little is known about the quality of Canadian women's diets as they prepare for pregnancy or during pregnancy. Research investigating the quality of pregnant women's diets generally comes from the United States, the United Kingdom and Australia. Limited evidence suggests that, women planning to become pregnant tend to marginally improve their diet.[70;71;72] In general, small increases in vegetable and fruit intake occurs preconception, and during, early and late pregnancy.[73]

Minimal changes have also been found when comparing nutrient intakes between the first and second trimester. Specifically, only skim or 1% dairy foods, whole fat dairy foods, red and processed meat, saturated fat and vitamin D increased by at least 5% from the first to second trimester.[74]

In a cross sectional survey of 409 mothers, Wen et al. (2010) found pregnant women consumed an average of 2 servings each of vegetables and fruit. One third of mothers (33%) reported having fewer than 2 servings of vegetables per day and those with lower incomes ate fewer vegetables when compared to those in higher income categories. About 40% of mothers reported consuming processed meat products such as sausages, frankfurters, salami, etc. more than once per week, regardless of maternal age, education or household income.[75] Other researchers have found pregnant women were more likely to consume the recommended number of servings of meat, fruit and dairy[72] versus consuming the recommended number of servings of grains and protein foods, especially nuts/beans/soy/eggs and fish.[71] In 2011, Blumfield et al noted that none of the pregnant women in their study met the recommendations of the Australian Guide to Healthy Eating for all food groups.[72]

When examining beverages, Wen et al. (2010) found pregnant women consumed 1.5 cups of fruit juice and 1.5 cups of soft drinks daily. Reported average daily milk consumption for all the mothers was 2.1 cups, with 40% consuming less than 1 cup per day. Those drinking soft drinks more often also tended to eat processed meat, fast food and potato chips more often.[75]

The best evidence examining the relationship between dietary components and risk of excess gestational weight gain comes from the Project Viva cohort study in which 1388 pregnant women were enrolled. This study found total energy (calorie) intake (OR, 1.11; [95% CI, 1.00-1.23 per 500 kcal/d]) and dairy product intake (OR, 1.08; [95% CI, 1.00-1.17 per serving per day]) to be associated with excess gestational weight gain. A vegetarian diet in the first trimester was also found to protect against excessive gestational weight gain.[76] There was no association found between overall vegetable and fruit consumption and excess GWG. There was also an increasing trend for an association between fried foods intake and the likelihood of gaining excess gestational weight but it was not statistically significant.

Limited research suggests that women with higher pre-pregnancy BMIs tend to have poorer quality diets during pregnancy compared to women whose pre-pregnancy BMIs are within the normal weight category.[77;78] Researchers have found that overweight women consumed significantly more calories as their pregnancy progressed compared to normal weight women. They also ate more fat and carbohydrates and less dietary fiber. There was no significant difference in overall protein intakes. Perhaps because of this trend there was a strong relationship between higher weight gain and eating more food in late pregnancy. When focusing on particular types of foods, eating more sweets early in pregnancy has been found to significantly increase the OR of gaining excessive weight.[79] Fast food consumption has also been positively associated with maternal weight gain rate[80] in a dose-dependent fashion.[81]

Physical Activity for Women at Preconception

Results from the landmark Canadian Health Measures Survey (CHMS)[24] were released in 2010. This survey described current fitness levels of Canadians age 20-69 years for three main constructs: cardiorespiratory, musculoskeletal and body composition. Results showed that over 1/3 of females age 20-39 years were unable to complete one partial curl-up, and over half (55%) of this age group scored "needs improvement" in the flexibility test. In fact, 51% of women age 20-39 years rated "needs improvement" for their overall musculoskeletal "health benefit" score. For females age 20-39, the mean BMI was 25.9, with 21% classified as "obese", and 31% with a waist-to-hip ratio that put them at "health risk".

The authors of the CHMS (2010) reported that the average 20-39 year old woman is overweight and has the same body composition profile as a woman aged 40 years or older in 1981.[24] Compared to the results of the Canada Fitness Survey (1981), muscular strength and flexibility scores have declined. Mean values for BMI, waist circumference and skinfold measurement rose for both sexes and age groups. The percentage in the fair/needs improvement category for flexibility rose in males and females age 20-39 years. For both sexes, the percentages of people who had a high waist circumference indicative of health risk, were obese, or had body composition scores in the fair/needs improvement category more than doubled. The percentage of women aged 20-39 years with a waist circumference classified as high risk more than quadrupled and the percentage with body composition classified as fair/needs improvement increased sevenfold.

In SMDHU, 57.3% (95% CI: [52.2%, 62.4%]) of the female population ages 15 to 44 years are considered moderately active or active during their leisure time. Unfortunately, 42.7% (95% CI: [37.6%, 47.8%]) do not engage in any physical activity during their leisure time and are considered sedentary.[69]

Physical Activity during Pregnancy

Very little is known about physical activity levels during pregnancy. Cohen et al. (2010), using a number of steps per day recommendation for non-pregnant adults, found the average number of steps taken by a sample of pregnant women was only 6118 (± 2187). Most of the women were classed as being sedentary or "low active". Weekly gestational weight gain was negatively associated with the average number of steps taken. There were no differences in the mean number of steps taken per day when women were classified by pre-pregnancy BMI, indicating that underweight and normal weight women took the same number of steps per day on average as overweight and obese women.[82]

These authors suggest that a large proportion of women of reproductive age will need nutrition and physical activity counseling early in pregnancy to help them achieve a healthy weight gain during the gestational period.[24]

Psychology and Weight Gain

Prevalence rates of disordered eating and obesity are difficult to estimate because of the lack of universally accepted definitions. A recent narrative review describes disordered eating as "habitual aberration in eating attitudes and behaviours. These include methods of unhealthy weight control and binge eating."[83] Disordered eating is more common in overweight, non-pregnant individuals. Overweight non-pregnant females report greater fear of binging, preoccupation with weight and use of unhealthy weight control behaviours. Emotional eating refers to eating for reasons independent of hunger (e.g. stress, loneliness, boredom) and is highly associated with both binge eating and obesity. For many individuals, food is a source of comfort which reinforces emotional eating. Longitudinal studies have shown dieting predicts future disordered eating and obesity. The

two most common mechanisms to explain why dieting leads to weight gain are a reduced metabolic rate and induced binge eating because of dietary restriction.[84]

Women who diet habitually prior to becoming pregnant tend to be less concerned about weight gain while pregnant, and tend to gain more weight during pregnancy. Previous research has found that women who constantly diet have trouble perceiving internal hunger and "fullness" cues. Not being able to interpret fullness cues often leads to overeating and a perceived "loss of control" of the ability to restrict or control what they are eating. This perceived "loss of control", in combination with the metabolic adaptations that occur among dieters, may explain why overweight and obese women are more likely to gain above recommended levels.[22] Mumford et al. (2008) found the effect of restrained eating on maternal weight gain varied by BMI status.[22] Restrained eaters[iv] and dieters in the normal, overweight, and obese categories tended to gain in excess of IOM weight gain recommendations, whereas those in the underweight category gained less than recommended when compared to women who did not display restrained eating behaviour.[21;22]

Herring et al., (2008) examined the Project Viva cohort and found misperception of pre-pregnancy body weight status impacted gestational weight gain.[23] This study revealed that women who were overweight or obese but thought they were a normal weight had an odds ratio of 7.6 (CI: 3.4-17.0) of gaining an excess amount of gestational weight.[23] Those who accurately assessed themselves as overweight or obese still had an odds ratio of 3 for gaining an excess amount of weight.[23] Authors suggest that health professionals could reduce the amount of weight many overweight/obese women gain simply by correcting their inaccurately perceived BMI status. The authors also noted that the data linking body dissatisfaction with weight gain in pregnancy are limited and inconsistent.[23]

Research also suggests that depression is more common among obese non-pregnant adults.[86] The prevalence rates of depression during pregnancy have been found to be 7.4% (95% CI: 2.2, 12.6%) in the first trimester, 12.8% (95% CI: 10.7, 14.8) in the second trimester and 12% (95% CI: 7.4, 16.7) in the third trimester.[87] One Canadian study of 402 at-risk antenatal women found a prevalence rate of 29.5% for major depression symptoms.[88]

Emerging research suggests that major depression symptoms during pregnancy are positively related to gaining more weight than recommended.[89] In fact, there may be a linear, dose-response relationship between maternal pre-pregnancy BMI and the likelihood of major depression during pregnancy.[90] Additional research is needed to support these preliminary findings.

[iv] Restrained eating is described as the tendency of people to restrict food intake to achieve weight loss or to prevent weight gain[85].

BIOLOGY AND GENETIC ENDOWMENT

The Origins of Chronic Disease

There are two theories related to the prevention of chronic disease that are relevant to GWG and SDOH. The *life course approach to chronic disease* and the *developmental origins of health and disease* have both evolved from the notion that environmental factors in utero and in early life influence lifelong health.[39] Central to these theories is the idea that risks for adverse health outcomes can be programmed at sensitive periods in human development.[91] This is referred to in the literature as developmental programming. Some experts have theorized that excess GWG in utero may pre-program the developing fetus to be overweight as a child and may increase the risk of developing a chronic disease later in life.

The proposed mechanism connecting GWG to child/adult obesity is based on the hyperglycemic environment of gestational diabetes mellitus. Specifically, insulin resistance and glucose intolerance during pregnancy may worsen the effects of GWG on future health outcomes. Weight gain during pregnancy is partly a gain in adiposity. This gain in adiposity is accompanied by a state of relative insulin resistance starting in mid-pregnancy. This adaptive response allows for the efficient transfer of fuels across the placenta to the growing fetus. In overweight and obese pregnant women these changes are magnified. This, in turn, raises the risk of impaired maternal glucose tolerance and gestational diabetes. If a pregnant woman is hyperglycemic, hyperglycemia is also present in the fetus. This fetal hyperglycemia leads to fetal hyperinsulinemia, followed by increased adiposity in the fetus. Increased adiposity is a defining characteristic of macrosomia which can lead to increased risks of labour and birth complications associated with macrosomic infants. It is theorized, through these programming mechanisms that increase fetal adiposity also results in increased adiposity in the growing child.[1] Therefore, excess GWG is theorized to impact childhood obesity by programming an excess amount of adipose cells in the fetus that would then lead to excess adiposity in the child.

Several researchers[37;38;92] have explored the effects of the intrauterine environment versus the genetic/environmental (i.e. dietary preferences and physical activity patterns) on the long-term health of the fetus in the context of excessive maternal bodyweight and weight gain during pregnancy. In their prospective cohort study, using a male Swedish sample, Lawlor et al,[93] explored whether associations between maternal BMI and gestational weight gain on offspring BMI could be explained by shared familial characteristics (e.g., genetics, socioeconomic status, diet and physical activity behaviours) and/or intrauterine mechanisms when offspring were measured at 18 years of age. Results indicated that women whose BMI was either normal weight, overweight or obese who gained too much weight during pregnancy were more likely to have offspring at a higher BMI when measured at 18 years. Authors speculated that the higher BMI of children of overweight and obese women may have been influenced by intrauterine mechanisms as well genetic and family environmental characteristics of the family. Intrauterine factors did not seem to impact the children of women of normal weight early in pregnancy. Shared familial characteristics appeared to be the main determinant of children's BMI for these women.

Culture

First Nations, Metis and Inuit Communities:

Over time more Canadians are identifying themselves as Aboriginal.[94] According to the 2006 Canadian Census, more residents of Simcoe Muskoka self-identify as Aboriginal (14,450 or 3.1% of the total population) compared to peer health units in Ontario.(v) It is important to note that Aboriginal women have a higher fertility rate compared to the general population.[95]

Aboriginal women living off-reserve have been found to have obesity rates 2.5 times greater than non-Aboriginal.[14] Among Canadian First Nations, Métis and Inuit populations, rates of overweight range from 35.4%-36.4% and rates for obesity range from 27.5-25.4%.[96] In Ontario, in 2000/2001, 64.0% of women with Aboriginal status living off-reserve were overweight/obese; 27.0% of this group was obese.[97] Using measured height and weight data for Aboriginals living on-reserve, Katmarzyk (2008) reported 57.7% of Aboriginal women 18 years and older were either overweight or obese.[98] In this study, Aboriginal ethnicity was associated with increased risk of obesity after controlling for demographic and lifestyle variables.[98] Statistics Canada has noted however, that current BMI cut-off categories may not be appropriate for the Aboriginal population, especially the Inuit.[96]

Some information is available about lifestyle behaviours in Aboriginal communities. In an Aboriginal sample, the odds ratios for obesity associated with physical inactivity was 3.0, after adjusting for age, sex, education, household income and smoking. This result has been noted by others.[99] Aboriginal women were found to be more physically inactive compared to Aboriginal men.[98] In 2004, CCHS reported that 56% of Aboriginal and non-Aboriginal women were inactive but state that the relationship between obesity and physical inactivity is stronger among those of Aboriginal decent.[100]

An analysis of pregnancy weight gain of 603 primiparous First Nations women revealed that almost 50% had gained excess weight during pregnancy and retained this weight postpartum.[97] Barriers to weight loss and maintenance identified in the First Nations group[101] included individual constraints such as a lack of time, cultural beliefs related to eating during lactation, and social barriers such as the lack of early childhood services and community programs for mothers.[97]

Aboriginal women living off reserve have a poorer quality diet compared to their non-Aboriginal counterparts. Specifically they:

- eat an average of 359 more calories per day
- eat one fewer serving of vegetables and fruit per day
- eat one fewer serving of grain products per day
- drink 3 times more regular soft drinks per day (ages 19-30)
- consume more calories from “snack” foods
- have more sodium and fat in their diet.[14]

[v] See footnote “ii” for description of peer health units.

Many factors or conditions identified as determinants of health are of significant concern for people of Aboriginal descent. Adelson[102] commented that public health professionals need to examine the role of changing diets, changing or limited work options, poverty, access to resources, societal stressors, and the cultural meaning of foodstuffs when attempting to address the complex range of factors associated with disease experienced by Aboriginal people.[102] Indeed, health professionals must come to understand that traditional contemporary Western approaches to disease prevention may not fit well with traditional indigenous values.[102] Although it has been reported that factors associated with overweight and obesity such as poverty and low education levels (both of which are common on Aboriginal reserves), the CCHS (2004) found no association between these two variables and risk for obesity in multivariate analyses.[14] Indeed, Garner et al. (2010) stated that factors typically associated with overall health among the general population do not necessarily have the same impact on Aboriginal populations. In fact, other factors yet to be measured may be important in promoting the health of Aboriginal populations.[96]

Health Services

The Role of Health Care Providers:

The association between receiving individual advice from a health care provider related to GWG and achieving within that weight gain range is well documented.[26-29;103] The most common experience of patients related to pregnancy weight gain recommendations is that either their physician does not address the issue at all or the advice received is inconsistent or erroneous.[66;104;105] Indeed, a recent cross-sectional survey in Hamilton, Ontario found low rates (5.7%-16.3%) of GWG counseling as reported by patients of obstetricians, midwives, family physicians and other health care providers.[106]

Women of lower income, younger age and multiparity are significantly less likely to report receiving health practitioner advice about weight gain than comparison groups, according to one study. In addition, overweight/obese women are much more likely (18 fold increased odds) to be advised to gain more weight than recommended by the IOM compared with normal weight women. Herring et al. (2010) discovered that there were no differences between physicians and nurses with regard to the likelihood of accurately conveying GWG guidelines.[107]

Barriers related to the communication of current GWG recommendations by health care providers are: lack of confidence in lifestyle counseling skills, health care provider (HCP) dissatisfaction with personal body weight,[107] lack of training, lack of time, inadequate staffing, absence of payment or insurance coverage for lifestyle counseling and availability of professional supports to which to refer patients,[108] lack of effective treatment options (for gestational obesity) and willingness of patients to comply with recommendations.[109] It has also been suggested that the large number of screening recommendations and the large number of patients in a practice can make it impractical for a physician to provide preventative services.[109] Please see Appendix B for a counseling paradigm for weight control during pregnancy.

Karen Glanz (1997) suggests that a multi-component strategy is effective to change system-level factors. Such strategies usually require changes in professional education, guidelines and health services policy. At the practitioner level, Glanz (1997) suggests lectures, co-counseling, checklists, and patient-specific feedback strategies to improve dietary counseling practices.[108]

There is growing evidence that engaging nurses and/or dietitians to assist with providing nutrition counseling is feasible and effective.[109]

Another author notes that health care providers seem to be more likely to provide brief nutrition messages than to measure, plot and explain BMI to patients. Physicians have identified using brief interventions during teachable moments and leveraging this with referrals to other resources, both within the practice and the community.[109]

Motivational interviewing (MI) is a behaviour change counseling strategy first proposed by Rollnick and Miller in 1995.[30] Recently, MI has been defined as a "collaborative, person-centred form of guiding to elicit and strengthen motivation for change."[110] There are two specific active components: a relational component focused on empathy and the interpersonal spirit of MI, and a technical component involving the differential evocation and reinforcement of client change talk.[111] MI was first developed for use in substance abuse counseling and has recently been adapted for use in weight loss, diet and physical activity counseling. MI has been shown to effectively reduce body weight in overweight and obese non-pregnant adults (WMD= -1.47 [95% CI: -2.05, -0.88]).[112] For pregnant women, MI has been shown to reduce GWG as well as levels of anxiety and depression.[113]

CURRENT GUIDELINES FOR GESTATIONAL WEIGHT GAIN

In 2009 the IOM released revised GWG recommendations in their document entitled *Weight Gain during Pregnancy: Reexamining the Guidelines*.[1] In November 2009, Health Canada adopted these new recommendations which include the following revisions:

1) the recommendations are now aligned with the World Health Organization's (WHO) definitions of underweight (BMI less than 18.5), normal weight (BMI of 18.5 to 24.9), overweight (BMI of 25.0 to 29.9) and obese (BMI of 30 or greater);

2) they include a suggested **rate** of weight gain[8] in addition to recommendations for **total** gain during pregnancy; and

3) they have a specific recommendation for a lower amount of total weight gain for obese women (Health Canada, 2009).[3]

Health Canada's previous GWG guidelines were primarily focused on reducing the incidence of low-birth weight babies. The recommendations needed to be revised in order to address the following trends and related health impacts:

- greater prevalence of women entering pregnancy as overweight or obese (IOM, 2009)[1]
- overweight and obese women are the most likely to gain the greatest amount of weight during pregnancy[33, 52]
- women are increasingly gaining weight during pregnancy outside the range recommended by the IOM (1990)[34]
- pregnancy complications associated with excess gestational weight gain, such as large for gestational age (LGA) babies and Caesarean deliveries have increased in prevalence
- many women retain some weight with each successive pregnancy, putting them at greater risk of overweight and obesity than their non-pregnant peers.[103]

Table 3:

Canadian Gestational Weight Gain Recommendations[3]

	Mean Weight Gain Rate in the 2nd and 3rd trimester		Total Weight Gain		Twin Pregnancy
Pre-pregnancy BMI	Rate in kg	Rate in lbs	Range in kg	Range in lbs	Recommended Weight Gain Ranges
underweight <18.5	0.5	1.0	12.5-18	28-40	Insufficient data
normal weight 18.5-24.9	0.4	1.0	11.5-16	25-35	17-25kg/37-54 lbs
overweight 25.0-29.9	0.3	0.6	7-11.5	15-25	14-23 kg/31-50 lbs
obese ⩾30.0	0.2	0.5	5-9	11-20	11-19 kg/25-42 lbs

*Calculations assume a 0.5-2 kg (1.1-4.4 lbs) weight gain in the first trimester

The IOM (1990) made recommendations regarding implementation of the GWG guidelines with individual patients.[34] The IOM (2009) endorsed what they called "key elements" which include, for example, measuring a woman's pre-pregnancy height and weight to determine pre-pregnancy BMI, and graphically plotting her rate of weight gain during pregnancy.[1] For the full list of key elements, please see appendix C. Health Canada currently provides prenatal weight gain graphs in their resources (one for each pre-pregnancy BMI category) for health care providers. The presence of these graphs implies Health Canada encourages weighing and plotting of pregnant women to assess GWG. Currently, Health Canada does not have a specific recommendation for health care providers to weigh and plot weight gain of pregnant women.[31]

In order for these recommendations to be achieved, the IOM (2009) recognized that the health care sector must consider:

- offering preconception services such as counseling related to diet and physical activity, as well as supporting all overweight and obese women to access contraception in order to assist them in achieving a healthy weight before conception
- offering services, such as counseling on diet and physical activity, to all pregnant women to assist them in achieving healthy weight gain during pregnancy
- offering services, such as counseling on diet and physical activity, to all postpartum women to assist them in returning to pre-pregnancy weight or achieving a healthy body weight.

NORTH AMERICAN NUTRITION RECOMMENDATIONS FOR PREGNANCY

Eating Well with Canada's Food Guide (CFG) is the current food guidance system for Canadian pregnant women. Rather than focusing specifically on increased calorie consumption, CFG recommends all pregnant women consume an extra 2-3 servings from 3 of the 4 food groups to meet the additional energy needs of the second (340 calories) and third trimesters (450 calories) of pregnancy.[114]

Interestingly, pregnant women aged 31-50 require 100 calories less per day (1800 calories) compared to their younger 19-30 counterparts (1900 calories). Health Canada's key message related to GWG and nutrition is: "pregnant women should eat a little more food every day from the four food groups of their choice".[114] Health care providers are advised to assess the pregnant woman's eating pattern to determine if she is following the recommendations of Eating Well with Canada's Food Guide so appropriate diet recommendations can be made.[115]

In contrast, the American pregnancy food guidance system, My Plate[116] does not recommend that all pregnant women consume extra calories. Instead, the United States Department of Agriculture gives a broad weight gain range. Then, a woman may enter her pre-pregnancy height and weight information to determine her own individualized GWG rate and range recommendations. Pregnant women are advised to seek advice from a health care provider if they conclude they are gaining weight too slowly or too quickly.

A recent American Dietetic Association statement (ADA, 2009) recommends that "during pregnancy, all overweight and obese women should be informed about current IOM gestational weight gain target goals, be advised not to lose weight during pregnancy and counseled about healthful foods during pregnancy".[117] The statement identifies that there is wide variability in metabolic energy expenditure during pregnancy which makes it difficult to set standards for energy intake for pregnant women of all BMI categories. They continue to note that healthy weight gain and appetite are better indicators of energy sufficiency than the number of calories consumed. The authors highlight that the current recommended increases in energy requirements for pregnancy (340 kcal/day in the second trimester and 452 kcal/day in the third trimester) are based on the energy needs of a normal weight woman. The actual energy requirements for overweight and obese pregnant women are unknown.[103] The ADA does not mention adding extra calories to an overall healthy diet.[118]

Dietitians of Canada does not have a statement related to pregnancy and weight gain; however, they will be a key partner for an upcoming Society of Obstetricians and Gynecologists of Canada (SOGC) project to develop a clinical guideline on the nutritional requirements of girls and women through their lifespan.[119]

The IOM (2009) is quite clear in stating that the safety of weight loss during pregnancy has not been determined. Kramer and Kakuma (2010) state that limited evidence from three studies suggests that energy/protein restriction in pregnant women who are overweight, or exhibit high weight gain, may negatively affect birth weight. Of the three studies, Campbell (1983), reported no effect of energy/protein restriction, Badrawi et al, (1993) reported a large significant adverse effect on birthweight (MD -450, [95% CI -625g to -275 g]), and Wolff (2008) demonstrated a smaller adverse effect (MD -138, [95% CI -450g to +174 g]).[120]

NORTH AMERICAN PHYSICAL ACTIVITY GUIDELINES FOR PREGNANCY

Canadian:

Canadian national guidelines for exercise during pregnancy and postpartum were developed by the Canadian Society for Exercise Physiology (CSEP) and the Society of Obstetricians and Gynaecologists of Canada (SOGC).

These guidelines were released in 2003 as the *Joint SOGC/CSEP Clinical Practice Guideline (CPG) No. 29*: *Exercise in Pregnancy and the Postpartum Period*. These evidence-based guidelines recommend that "all women without contraindications should be encouraged to participate in aerobic and strength-conditioning exercises as part of a healthy lifestyle during their pregnancy". The joint statement specifies that "previously sedentary women should begin with 15 minutes of continuous exercise three time a week increasing gradually to 30-minute sessions four times a week".[121]

The Physical Activity Readiness Medical Exam (PARmed-X) for Pregnancy[122] is a guideline developed for health screening prior to participation in prenatal exercise. The most current version of the PARmed-X for Pregnancy, released in 2002, was developed in collaboration with the Ontario Fitness and Safety Standards Committee and an Expert Advisory Committee of the Canadian Society for Exercise Physiology. It includes a checklist of absolute and relative contraindications for exercise, summary guidelines for the prescription of exercise and muscle conditioning, safety precautions and reasons to stop exercising, as well as advice for active living, healthy eating and maintenance of a positive self-image. The PARmed-X for Pregnancy is endorsed for use within the Canadian national guidelines. In 2011, the ePARmed-X+Online was developed as an alternative physical activity participation clearance option that can be completed by individual pregnant women online. The aim is to "reduce barriers for low to moderate intensity physical activity participation, and exact the identification of (those pregnant women) who may require additional screening prior to becoming more physically active".[123]

Though research has demonstrated the health benefits of regular physical activity in pregnant women who do not have contraindications to exercise, it is widely recognized that there is a gap in the literature related to adverse exercise-related events in pregnancy. In the future, CSEP will address this gap with the goal of reducing the barriers to participation in physical activity during pregnancy for women who are considered to be at higher risk for adverse exercise-related events.[124]

American:

In 1985, the American College of Obstetricians and Gynecologists (ACOG) released conservative exercise guidelines for pregnant women, as there was little evidence available at that time related to physical activity in this population. The ACOG guidelines have been updated twice, most recently in 2002. In 2009, ACOG's Committee on Obstetric Practice reaffirmed the 2002 guidelines for exercise during pregnancy and the postpartum period which recommend "30 minutes or more of moderate-intensity physical activity on most, if not all, days of the week" for healthy pregnant women.[125]

In 2008, the U.S. Department of Health and Human Services (HHS) released Physical Activity Guidelines for Americans[126] which included recommendations for pregnant women. The HHS Physical Activity Guidelines Advisory Committee stated that, "a pregnant woman can begin or continue a regular physical activity program throughout gestation, adjusting the frequency, intensity and time as her condition warrants", adding that "it is reasonable for women during pregnancy and the postpartum period to follow the moderate-intensity recommendations set for adults unless specific medical conditions exist".[127] Their recommendation of "at least 150 minutes of moderate-intensity aerobic activity per week during pregnancy and the postpartum period" is consistent with the current ACOG recommendations for pregnant women, and also with the recommendation for healthy adults in the 2008 Physical Activity Guidelines for Americans.

In the Summary and Conclusion of their review of the science related to physical activity during pregnancy and the postpartum period, the Physical Activity Guidelines Advisory Committee identifies that, “although the benefits of maternal physical activity have clearly been demonstrated…very little evidence exists for the dose of activity that confers the greatest health benefits to women during pregnancy and the postpartum period”.[127] They conclude that “prospective, randomized intervention studies in diverse populations are greatly needed”.[127]

CLINICAL PRACTICE GUIDELINES AND INTERNATIONAL POLICY STATEMENTS

The SOGC’s recent *Obesity in Pregnancy* Clinical Practice Guideline (2010)[32] affirms the importance of addressing gestational weight gain. The SOGC endorses the IOM gestational weight gain recommendations; however, the SOGC guideline recommends weight gain of 7 kg for all three classes of obesity (I-III) rather than a weight gain range of 5-9 kg for all pregnant women with a BMI ≥ 30, as recommended by the IOM. The SOGC recommends that obese pregnant women receive counseling about weight gain, nutrition and food choices during pregnancy. The Association of Ontario Midwives does not address the problem of excess gestational weight gain among women with normal or high pre-pregnancy BMI in their Clinical Practice Guideline, *The Management of Women with a High or Low Body Mass Index (2010).* [128] They do identify the importance of counseling pregnant women to help them to achieve their GWG goals in order to reduce obstetric risk and postpartum weight retention.

Similar to the recommendations of the IOM (2009), the National Institute of Health and Clinical Excellence (NICE) *Dietary Interventions and physical activity interventions for weight management before, during and after pregnancy*[129] recommend that all pregnant women, and especially those with a BMI ≥ 30, discuss their eating and physical activity habits with their health care provider. Interestingly, they recommend against the weighing of women repeatedly during pregnancy. An additional weighing should occur only if clinical management can be influenced or nutrition is a concern. A previous NICE document (2006), *Obesity: the prevention, identification, assessment and management of overweight and obesity in adults and children,* highlighted the period after pregnancy and child birth as a time when women are likely to gain weight. Therefore, recommendations were made to monitor the woman’s weight postpartum in preparation for another pregnancy.

The UK Public Health Interventions Advisory Committee notes that pregnancy and about a year after child birth are key periods in a woman’s life when she may gain excess weight. In fact, they claim the periods before, during and after pregnancy do provide an opportunity to give women practical advice to help them improve their diet, become more physically active or to help them manage their weight effectively. This same group also states that the IOM[1] (2009) recommendations were not validated by intervention studies and, while their recommendations apply to American population, the relevance to the UK population remains unknown.[129]

In a recent joint clinical practice guideline, the Centre for Maternal and Child Enquiries and the Royal College of Obstetricians and Gynaecologists (2010)[130] recommend that obese pregnant women are weighed once when pregnancy is confirmed and then again in the third trimester so “appropriate plans can be made for equipment and personnel required during labour and delivery”.[131] During postpartum, women with a BMI ≥ 30 “should continue to receive nutritional advice… from an appropriately trained professional, with a view of weight reduction”.[132]

They argue further that all health professionals involved in the care of pregnant women should receive education about maternal nutrition and its impact on maternal, fetal and child health.[133]

INTERVENTIONS

This section describes the effectiveness of clinical interventions that were designed to address excess GWG. Only one evaluation of one community level intervention could be found.

Campbell et al., in a systematic review of 5 randomized control trials (RCT) and quasi-randomized control trials of 390 women with a BMI ≥ 18.5, found no significant evidence that dietary interventions, with or without additional support to increase nutrition or physical activity, were effective in reducing GWG (-0.28 [95% CI: -0.64 to 0.09]); however, studies differed by SES, ethnicity, pre-pregnancy BMI and outcomes measured (weight outcomes, dietary and physical activity outcomes, pregnancy, birth or infant outcomes). Nutritionists, dietitians or fitness instructors delivered the interventions. Subgroup analysis found that pre-pregnancy BMI or particular aspects of the intervention contributed to its effectiveness. Overall, there was no clear evidence for an effect. Authors concluded that interventions should be designed that educate health care providers about the importance of healthy lifestyle behaviours, as well as inform the wider family and social network.[134]

In contrast, another systematic review[135] examining 13 RCTS found a lower total GWG in the dietary intervention group compared to control (WMD=-1.92 kg [95% CI=-3.65, -0.19, p=0.03]). The authors conclude that dietary interventions during pregnancy were effective in decreasing GWG and the incidence of caesarian sections. However, the interventions were not successful in increasing the proportion of women who gained within the recommended range, as defined by the 1990 IOM report. This finding is supported by two other meta-analyses that focused on women with a pre-pregnancy BMI ≥ 18.5. These included RCT only or randomized and non-randomized control trials combined. The weighted mean difference for these meta-analyses was -0.22 [95% CI: -0.38, -0.05)[136] to -1.19 [95% CI: -1.74, -0.650], P<0.0001).[94]

Two meta-analyses focused only on overweight and obese women. Dodd et al.[137], examined the effect of behavioural interventions on several birth outcomes, including LGA infants. They identified nine randomized control intervention trials that found no effect of behavioural interventions on the risk of having a LGA baby or the mean gestational weight gain. The authors reported that the intensity of the interventions was not consistent, ranging from a single dietitian consult to additional dietitian visits. The authors also reported the methodological quality of the studies was fair to poor. Other authors[138] have criticized this meta-analysis for pooling together trials with varying antenatal interventions which would dilute the effect of dietary counseling.

In contrast, a meta-analysis[138] also examining overweight and obese women found a weighted mean difference of -6.5 ([95% CI -7.6 to-5.4] P<.001)[138] demonstrating the combination of interventions were effective in reducing GWG without an impact on birth weights.

Some authors[139] explain the lack of effect of intervention trials on the absence of psychological interventions and failure to apply common behaviour change theories. Many studies reported a high degree of heterogeneity among intervention trials. Other authors[140] claim the methodological quality of the intervention studies addressing GWG are insufficient to create evidence-based recommendations.

The only community-level intervention plan that specifically addresses GWG was conducted in 2007 in the former Calgary Health Region, now known as Alberta Health Services.
The Healthy Pregnancy Weight project was a component of the *Three Cheers for the Early Years* campaign. A focus group[141] was originally conducted to inform the program design. The program goal was to "improve birth outcomes attributable to optimal maternal weight in the Calgary Health Region". There were three elements to this program: 1) prenatal health professionals, 2) pregnant women, and 3) the community.

The program activities for the prenatal health professionals were: a) the provision of reflective learning opportunities (e.g. presentations, written materials), b) the creation and use of maternal weight gain tools (e.g. BMI wheel, brochure and poster, weight gain graph, nutrition referral list), c) the development of relationships between the Calgary Health Region and health care providers, and d) the creation of a nutrition referral system. An awareness campaign was developed for pregnant women (e.g. You Tube video).

No evaluation was conducted to determine the impact of this program on maternal and child health outcomes related to GWG. However, a process evaluation of the intervention plan relating to the prenatal health professionals was conducted. It had a 23% response rate.[142] Results indicated that the program successfully increased their awareness of:

- maternal weight gain,
- maternal weight gain tools,
- nutrition referral resources,
- optimal maternal weight, and
- maternal weight gain and its association with birth outcomes.

Three quarters of respondents identified the paper copy of the maternal weight gain graph was somewhat useful.

In summary, there are conflicting results as to whether dietary and physical activity interventions are effective in decreasing GWG. The IOM 2009 report[1] stated it was possible to motivate obese pregnant women to limit their weight gain during pregnancy to 6-7 kg; individualized attention was a component of successful interventions. Only one community-based intervention could be located; a low response rate limits the ability to draw conclusions from the evaluation findings.

DISCUSSION

It has been identified that the obesity epidemic is having a significant impact on reproductive health outcomes. In 2009, the Institute of Medicine released their report, *Weight Gain During Pregnancy: Reexamining the Guidelines,*[1] and later that year Health Canada (HC) updated its gestational weight gain (GWG) recommendations[3] for Canadian women. The new recommendations emphasize the importance of healthy GWG in achieving optimal maternal *and* child health outcomes. Unfortunately, although there is evidence to show an association between excess GWG and increased rates of pre-term births, Caesarean sections, large for gestational age and macrosomic infants, and postpartum weight retention,[33] public health practitioners have limited evidence of health promotion strategies that are effective in supporting the achievement of healthy weight gain during pregnancy.

In order to develop an argument to support our assertion that excess GWG is a significant public health issue worthy of public health investment, we refer to Brownson et al. (2011)[143] who suggest three criteria to guide decision making:

1) Is the public health issue large and growing?
2) Are there effective interventions for addressing the problem?
3) Will a particular program or policy provide a satisfactory return on investment measured in health impacts?

Is the issue of gestational weight gain large and growing?

Academics and health care providers alike are concerned about the high levels of overweight and obesity among Canadian women of reproductive age and their impact on maternal and child health outcomes. According to the National Population Health Survey, during the eight years of the study (1994/1995 to 2002/2003), women ages 18-64 gained an average of 3.4 kg/7.5 lbs, and in subsequent analyses (1994/1995 to 2004/2005) proportionally more women self-reported an increase in their BMI.[2] Furthermore, just under half (46.6%) of women of reproductive age (15-44 years) living in the geographical area of the Simcoe Muskoka District Health Unit (SMDHU) are classified as overweight or obese (BMI >25).[5] In addition, there is growing concern about rates of excess weight gain during pregnancy. It has been estimated that between 40-44% of pregnant Ontario women exceed the upper limit of their gestational weight gain range as recommended by Health Canada[64] Considering these local and national statistics, it is clear that a high proportion of pregnant women and their offspring are at increased risk of a variety of adverse health outcomes.

Are there effective interventions for addressing the problem?

Although there is a lack of evidence of effective interventions to support health promotion planning related to healthy weight gain during pregnancy, there may be support to proceed with promising practices. For example, a recent Institute of Medicine report, *Bridging the Evidence Gap in Obesity Prevention: A Framework for Decision Making*[144] advises health care practitioners to proceed with planning population-based strategies despite a lack of evidence. Experts argue that the traditional evidence hierarchy works less well in public health, as the interventions are typically large scale, complex social interventions compared to more concrete clinical interventions. Population-based initiatives tend to rely on information extrapolated from clinical trials as well as weaker sources of evidence such as expert opinion, anecdotal evidence or promising practices. Often the evidence is suggestive rather than conclusive, leaving public health practitioners to weigh the risks and benefits of taking action.[143]

Addressing the determinants of health, “the entire range of individual and collective factors and conditions - and their interactions - that have been shown to be correlated with health status”,[145] is fundamental to a population health approach, and to the effectiveness of public health strategies which seek to support women to achieve a healthy weight before pregnancy and healthy weight gain during pregnancy. The Public Health Agency of Canada has described socio-economic status, Aboriginal identity, gender and geographic location as the most important factors associated with health disparities in Canada.[146] Income and education are also key determinants of health and are typical measures of socio-economic status.
Evidence identifies that women with low levels of income and education are more likely to be obese. Furthermore, women who are overweight or obese are at greater risk of excess gestational weight gain.[52]

Hence, a comprehensive approach to supporting healthy weight gain during pregnancy would include collaboration with others engaged in broader poverty reduction strategies in Simcoe County and the District of Muskoka, and partnering with the education sector to address barriers low-income women experience to staying in or re-entering school, including First Nations Métis and Inuit professionals and agencies.

The IOM report (2009)[1] highlights the importance of the primary care sector in addressing GWG. Limited evidence suggests that the recommendations made by a woman's primary care provider regarding healthy GWG may influence the amount of weight the pregnant woman actually gains.[26-29;103] Unfortunately, evidence also suggests that health care providers may not consistently address weight issues with their patients, and this may be particularly true for those who provide services to pregnant women.[66;104-106]

The research has identified several barriers to health care providers engaging their clients in healthy lifestyle/healthy weights conversations. Most health care providers will likely agree that skill and sensitivity are needed when advising or counseling pregnant women about eating, physical activity and weight gain; however, they may lack confidence in their ability to provide effective counseling.[107;108] Antenatal health care providers may be concerned that too much emphasis on achieving healthy weights may cause some women to restrict calorie intake which may inadvertently contribute to SGA or preterm infants.

Public health practitioners are best able to reach pregnant women by working in collaboration with primary care providers. Public health agencies have a role to play in educating the providers of primary health care regarding the impact of the determinants of health in order to engage them in developing and implementing solutions, both locally and systemically. For example, health care providers who understand the impact of the built environment on maternal behaviours and related health outcomes are able to advocate to local municipalities for by-laws which ensure equitable access to affordable, healthy food and recreational opportunities in all neighborhoods. Health care providers must also have knowledge of community resources which support healthy eating and active living during pregnancy, and where/how to access them.

Motivational interviewing is an effective approach to lifestyle counseling. It is defined as "a collaborative, person-centred form of guiding to elicit and strengthen motivation to change".[147] Training to support the application of principles, techniques and strategies of motivational interviewing in brief clinical interventions to support healthy weight gain during pregnancy should be considered when developing a comprehensive healthy weights strategy.

Knowledge translation experts engaged in research within the health care sector note that interventions aimed at health professionals such as educational programs, feedback, and reminders only change professional performance by 10%. They also note that written guidelines, lectures and conferences are unlikely to change professional behaviour if used alone. Active educational interventions, such as outreach visits or websites designed for self-study are more likely to induce change. Interventions that are targeted at the clinical decision making process itself, such as decision support tools are also likely to be effective.[148] Considering the available evidence, the process of developing an intervention strategy targeting health care providers must be collaborative in nature, and the strategy itself must be multi-faceted in order to have the desired impact on professional practice.

Ultimately, it is imperative that an intervention plan supports antenatal care providers to inform pregnant women of their recommended gestational weight gain range and rate as well as to

engage them in discussion about healthy eating and active living during pregnancy in order to enable women to gain within their recommended weight gain range.

One proposed practice for antenatal health care is the use of GWG plotting charts to track women's patterns of weight gain during pregnancy. Although the use of such visual tools is described by the IOM (2009) as a key element in supportive discussions between health care providers and pregnant women[1] and is implied for use in a Health Canada resource,[31] there is currently no evidence of the effectiveness of using such tools in the achievement of healthy weight gain. In theory, the line graph showing the weight gain pattern may alert the health care provider to problems such as erratic weight gain or excess (or inadequate) rate of weight gain, which may act as a prompt to engaging in a healthy lifestyle discussion or initiation of a referral for further professional counseling or support related to achieving a healthy pregnancy.

The Canadian food guidance system, reflected in Health Canada's Eating Well with Canada's Food Guide[149] may be inadvertently contributing to the proportion of women exceeding their GWG range. Canada's Food Guide reflects a broad, population-based message in its recommendation that **all** pregnant women consume two to three additional servings from any of the four food groups. This recommendation is based on the assumption that women are following the recommendations of Canada's Food Guide pre-pregnancy, and is in place to address the additional energy requirements of pregnancy. Health Canada's GWG recommendations[3] describe different weight gain rates and ranges according to pre-pregnancy BMI, but they do not address how overweight or obese women can expect to achieve lower weight gain by following the same population-based nutritional advice as women in the normal weight category. Since the actual energy requirements of overweight and obese women is unknown,[103] perhaps individual dietary advice related to energy intake during pregnancy should be provided by health care providers who have expertise in prenatal nutrition.

<u>Will a particular program or policy provide a satisfactory return on investment measured in health impacts?</u>

The only Canadian, population-level intervention program promoting healthy gestational weight gain evaluated short-term outcomes in terms of health care provider knowledge and awareness; effects on maternal and child health outcomes related to GWG were not assessed.[142] Evidence is lacking regarding the effectiveness of a comprehensive, multi-faceted intervention strategy aimed at improving maternal and child health outcomes by supporting the achievement of healthy weight gain during pregnancy.

Excess gestational weight gain is a significant concern as it contributes to the growing obesity epidemic and the associated financial burden for the Canadian health care system. The Canadian Institute for Health Information states the cost of caesarian sections is $1,432 per birth and costs the health care system sixty eight million dollars in 2002/2003 nationwide.[150] Using a chronic disease prevention example, people with a BMI categorized as obese are 2-4 times more likely to develop type 2 diabetes.[151]

The cost of treating and managing diabetes is estimated to be $4500 per year per person and Ontario spends approximately one billion dollars treating people with diabetes and its associated complications.[152] Therefore, moderating the amount of weight gain women gain during pregnancy has the potential to significantly decrease health care costs in Ontario.

Clearly, more evidence is needed to determine the effectiveness of population-level intervention programs promoting healthy gestational weight gain. Therefore, any intervention strategy developed to address excess gestational weight gain should be rigorously evaluated.

RECOMMENDATIONS FOR PUBLIC HEALTH PRACTICE

The following recommendations for Ontario public health agencies are presented below using selected Program Foundational Standards and Board of Health Requirements as described by the Ontario Public Health Standards (OPHS).[153] The Public Health Agency of Canada and the OPHS encourage the use of the Public Health Agency of Canada's population health approach framework[57] that emphasizes addressing the determinants of health.

The intent of these recommendations is to encourage lifestyle behaviour changes of pregnant women to support a greater proportion of pregnant women to gain within the weight gain range recommended for their pre-pregnancy BMI. Health promotion strategies will focus on pregnant women, emphasizing healthy lifestyle information tools and resources as opposed to focusing on weight gain. Information, tools and resources regarding gestational weight gain and healthy lifestyle supports will be emphasized with local health care providers.

PRIORITY POPULATIONS

Identify and strengthen linkages with:

a) First Nations/Metis/Inuit (FNMI) communities and
b) Women living in poverty.

RESEARCH AND KNOWLEDGE EXCHANGE

Collaborate with other public health agencies to gain further understanding of nutrition and physical activity behaviours of pregnant women. This could include applying for Public Health Ontario's Locally Driven Collaborative Projects funding opportunity.

DETERMINANTS OF HEALTH (DOH)

Income and Social Status

a) Collaborate with determinants of health staff related to poverty reduction strategies.

EDUCATION AND LITERACY

a) Collaborate with school health program staff to support existing physical activity and nutrition strategies in the preconception period.
b) Advocate for collaboration between DOH staff, school health program and education sector to support work related to increasing adolescent girls' educational attainment to decrease their risk of future overweight and obesity.

SOCIAL AND PHYSICAL ENVIRONMENTS

a) Collaborate with chronic disease and injury prevention programs to support the creation of "walkable communities".

HEALTH SERVICES

a) Work with the Ontario Ministry of Health and Long-Term Care and local health care providers to strategize and implement a preferred model of prenatal care.

b) Develop and implement an evidence-based comprehensive preconception health strategy that addresses pre-pregnancy body mass index (BMI).

c) Advocate to the Local Health Integration Networks to work collaboratively with public health agencies and local health care providers to identify comprehensive health care policies to address gestational weight gain as a priority health issue. Advocacy issues include:

- identification/ development of routine prenatal screening tools related to nutrition, physical activity (PA), mental health and disordered eating
- encouragement of referrals to allied health professionals, including registered dietitians and mental health professionals
- development of policies that support clinical practice related to healthy GWG and enable practitioners to:

    i. determine pre-pregnancy BMI of pregnant patients/clients

    ii. inform pregnant patients/clients early in pregnancy of their recommended GWG range and rate, according to pre-pregnancy BMI

    iii. discuss healthy eating and PA recommendations for pregnant women throughout pregnancy

    iv. plot GWG throughout pregnancy

    v. refer overweight/obese pregnant women to nutrition and PA professionals, including registered dietitians

    vi. refer pregnant women who are exceeding the recommended GWG rate and range to nutrition and physical activity professionals

    vii. refer all pregnant women to information and resources which support healthy eating, physical activity and healthy GWG.

d) Build capacity of local prenatal health care providers by providing community presentations and/or education outreach visits to prenatal health care providers.

e) Advocate to professional associations to create clinical practice guidelines and professional development opportunities.

f) Advocate with the mental health sector to increase availability of services specific to pregnant women.

PERSONAL HEALTH PRACTICES AND COPING SKILLS

a) Home and Family (pregnant women)

- Develop and implement an evidence-based health communication strategy to support healthy gestational weight gain. At a minimum, campaign should address nutrition, physical activity and sources of support for pregnant women. Consider partnering with the Best Start Resource Centre on this initiative as a next step to their preconception, prenatal obesity report.
- Add lifestyle behaviour tools and resources to consumer pages of public health agency web site.

SUMMARY

Excess gestational weight gain (GWG) is a modifiable risk factor associated with Caesarean section rates, pre-term births, LGA, macrosomia and postpartum weight retention. In light of increasing rates of overweight and obesity in our society since the 1990 guidelines were released, and the potential impact of excess GWG on this trend, the Institute of Medicine (IOM) released a report *Weight Gain During Pregnancy: Re-examining the Guidelines (2009)*. Later in 2009, Health Canada adopted the guidelines contained in the IOM report.

If women gain excess weight during pregnancy and do not return to their pre-pregnancy weight postpartum, they may begin subsequent pregnancies at a higher BMI and may be at increased risk of pregnancy and birth complications. Postpartum weight retention also contributes to the trend of women becoming heavier as they age, and the associated increased rates of chronic disease. Evidence related to the role of excess GWG and childhood obesity is also emerging.

There are conflicting results regarding the effectiveness of dietary and physical activity interventions in decreasing GWG. Nevertheless, antenatal care providers need to be supported to inform pregnant women about healthy eating and active living during pregnancy as well as to advise them of their recommended gestational weight gain range and rate to enable women to gain within their recommended weight gain range. More evidence is needed to determine the effectiveness of population-level intervention programs promoting healthy gestational weight gain; therefore, any intervention strategy developed to address excess gestational weight gain should be rigorously evaluated.

Appendices

APPENDIX A

The Determinants of Health:[12]

1. Income and Social Status
2. Social Support Networks
3. Education
4. Employment/Working Conditions
5. Social Environments
6. Physical Environments
7. Personal Health Practices and Coping Skills
8. Healthy Child Development
9. Biology and Genetic Endowment
10. Health Services
11. Gender
12. Culture

APPENDIX B

A counseling paradigm for women regarding weight control in pregnancy.[35]

1. Review optimal pre-pregnancy body weight
    a. Calculate BMI
    b. Define goals for achieving or maintaining normal BMI pre-conception
    c. Inform women of potential health hazards of maternal obesity, including pregnancy complications and effects on maternal and fetal health
    d. Promote healthful diets
    e. Promote physical activities
    f. Determine need for referral and identify availability of resources
    g. Follow progress and reassess need for modifying goals or referral

2. Review optimal weight gain during pregnancy
    a. Recommendations from the IOM
    b. Follow-up pre-conception and during pregnancy

3. Review potential competing issues in reproductive health and individualize plans for conception

4. Folic acid supplementation
    a. Discuss rationale and assess individual requirements for dose
    b. Review concomitant medications and avoid drug interactions

5. Other reproductive, medical or/and psychiatric issues

APPENDIX C

Listing of *key elements* for individual GWG counseling:[154]

1. Before conception, use consistent and reliable procedures to measure and record the women's weight and height without shoes in the medical record

2. Determine the women's pre-pregnancy BMI

3. Measure the woman's height without shoes and weight in light clothing at the first prenatal visit carefully by procedures that have been rigorously standardized at the site of prenatal care and use consistent, reliable procedures to measure weight at each subsequent visit.

4. Estimate the woman's gestational age from the onset of her last menstruation or from an early ultrasound examination

5. At the initial comprehensive prenatal examination, set a weight gain goal together with the pregnant woman that is based on her pre-pregnant BMI and other relevant considerations, and explain to her why weight gain is important

6. Monitor the woman's prenatal course to identify any abnormal pattern of weight gain that may indicate a need to intervene, displaying the results graphically for the woman. When abnormal gain appears to be real, rather than a result of an error in measurement or recording, try to determine the cause and then develop and implement corrective actions jointly with the woman

APPENDIX D

Population Health Approach: the Organizing Framework [57]

The eight steps of the organizing framework are:

1. Focus on the health of populations
2. Address the determinants of health and their interactions
3. Base decisions on evidence
4. Increase upstream investments
5. Apply multiple interventions and strategies
6. Collaborate across sectors and levels
7. Employ mechanisms for public involvement
8. Demonstrate accountability for health outcomes

Reference List

(1) IOM (Institute of Medicine). Weight gain during pregnancy: reexamining the guidelines. Washington, D.C.: National Academies Press; 2009.

(2) Statistics Canada. Body mass index, changes from 1994/1995 to 2002/2003 to 2004/2005, 2006/2007 and 2008/2009, by sex. Statistics Canada 2010 [cited 2012 Jan 12]; Available from: URL: http://www40.statcan.ca/l01/cst01/hlth68-eng.htm

(3) Health Canada. Canadian gestational weight gain recommendations. Health Canada 2009 [cited 2009 Dec 3]; Available from: URL: http://www.hc-sc.gc.ca/fn-an/nutrition/prenatal/qa-gest-gros-qr-eng.php

(4) CANSIM table 105-0501 [computer program]. 2011.

(5) Canadian Community Health Survey, 2009/2010 Share File [computer program]. 2011.

(6) intelliHEALTH ONTARIO. Ontario Livebirth Database. 2007. Ontario Ministry of Health and Long Term Care.

(7) Sharon Bartholomew. Email: Weight gain in pregnancy report. Becky Blair, editor. 1-17-2012.

(8) Rasmussen KM, Catalano PM, Yaktine AL. New guidelines for weight gain during pregnancy: what obstetrician/gynecologists should know. Current Opinion in Obstetrics & Gynecology 2009 Dec;21(6):521-6.

(9) Cancer Care Ontario, Ontario Agency for Health Protection and Promotion (Public Health Ontario). Taking action to prevent chronic disease: recommedations for a healthier Ontario. Toronto: Queen's Printer for Ontario; 2012.

(10) Inpatient Hospitalizations (2008-2010) [computer program]. Ontario Ministry of Health and Longterm Care; 2012.

(11) Vital Statistics, Livebirth and Stillbirth Databases, [computer program]. 2012.

(12) Public Health Agency of Canada. What Determines Health? Public Health Agency of Canada 2011 October 21 [cited 2012 Oct 9]; Available from: URL: http://www.phac-aspc.gc.ca/ph-sp/determinants/index-eng.php

(13) Drewnowski A, Specter S. Poverty and obesity: the role of energy density and energy costs. The American Journal of Clinical Nutrition 2004;(79):6-16.

(14) Garriguet D. Obesity and the eating habits of the aboriginal population. Statistics Canada; 2008 Mar. Report No.: Catalogue 82-003, Volume 19.

(15) Public Health Agency of Canada, Canadian Institute of Health Information. Obesity in Canada. A Joint Report for the Public Health Agency of Canada and the Canadian Institute of Health Research. Her Majesty the Queen in Right of Canada 2011 [cited 2012 Oct 9]; Available from: URL: http://www.phac-aspc.gc.ca/hp-ps/hl-mvs/oic-oac/index-eng.php

(16) Laraia B, Messer L, Evenson K, Kaufman J. Neighbourhood factors associated with physical activity and adequacy of weight gain during pregnancy. Journal of Urban Health 2007 Nov;84(6):793-806.

(17) Laraia BA, Siega-Riz AM, Kaufman JS, Jones SJ. Proximity of supermarkets is positively associated with diet quality index for pregnancy. Preventative Medicine 2004 Nov;39(5):869-75.

(18) Bennett G, Wolin K, Duncan D. Social Determinants of Obesity. In: Hu F, editor. Obesity Epidemiology.New York: Oxford University Press; 2008. p. 342-76.

(19) Rosenheck R. Fast food consumption and increased caloric intake: a systematic review of a trajectory towards weight gain and obesity risk. Obesity Reviews 2008;9:535-47.

(20) Garriguet D. Overview of Canadians' eating habits. Ottawa: Statistics Canada; 2006.

(21) Conway R, Reddy S, Davies J. Dietary restraint and weight gain during pregnancy. European Journal of Clinical Nutrition 1999 Nov;53(11):849-53.

(22) Mumford S, Siega-Riz A, Herring A, Evenson K. Dietary restraint and gestational weight gain. Journal of the American Dietetic Association 2008 Apr 4;108(10):1646-53.

(23) Herring S, Oken E, Haines J, Rich-Edwards J, Rifas-Shiman S, Kleinman K, et al. Misperceived pre-pregnancy body weight status predicts excessive gestational weight gain: findings from a US cohort study. BMC Pregnancy and Childbirth 2008 Dec;8(54).

(24) Shields M, Tremblay M, Laviolette M, Craig C, Janssen I, Gorber S. Fitness of Canadian adults: results from the 2007-2009 Canadian health measures survey. 2010. Report No.: 82-003-XWE, vol. 21 no. 3.

(25) Fraser A, Tilling K, Macdonald-Wallis C, Sattar N, Brion MJ, Benfield L, et al. Association of maternal weight gain in pregnancy with offspring obesity and metabolic and vascular traits in childhood. Circulation 2010;121(23):2557-64.

(26) Bish C, Shapiro-Mendoza C, Sharma A, Blanck H, Chu S. Trying to lose or maintain weight during pregnancy-United States, 2003. Maternal and Child Health Journal 2009 Mar;13(2):286-92.

(27) Olson C. A call for intervention in pregnancy to prevent maternal and child obesity. American Journal of Preventative Medicine 2007 Nov;33(5):435-6.

(28) Olson C, Strawderman M, Hinton P, Pearson T. Gestational weight gain and postpartum behaviors' associated with weight change from early pregnancy to 1y postpartum. International Journal of Obesity 2003;27:117-27.

(29) Taffel S, Keppel K, Jones G. Medical advice on maternal weight gain and actual weight gain. Results from the 1988 national maternal and infant health survey. Annals of The New York Academy of Sciences 1993 Mar;678:293-305.

(30) Rollnick S, Miller WR. What is motivational interviewing? Behavioural and Cognitive Psychotherapy 1995;23:325-34.

(31) Health Canada. Prenatal nutrition guidelines for health professionals-gestational weight gain. Health Canada; 2009 Nov.

(32) Davies GA, Maxwell C, McLeod L, Gagnon R, Basso M, Bos H, et al. SOGC Clinical Practice Guidelines: Obesity in Pregnancy. International Journal of Gynecology and Obstetrics 2010;110(2):167-73.

(33) Viswanathan M, Siega-Riz A, Moos M, Deierlein A, Mumford S, Knaak J, et al. Outcomes of Maternal Weight Gain, Evidence Report/Technology Assessment No. 168. Rockville, MD: Agency for Healthcare Research and Quality; 2008 May. Report No.: 08-E009.

(34) Institute of Medicine NAoS, Food and Nutrition Board, Committee on Nutritional Status During pregnancy, et al. Nutrition During Pregnancy, IOM 1990. Washington, D.C.: National Acdemy Press; 1990.

(35) Lee C, Koren G. Maternal obesity: effects on pregnancy and the role of pre-conception counselling. Journal of Obstetrics and Gynaecology 2010 Feb;30(2):101-6.

(36) Mamun AA, O'Callaghan M, Callaway L, Williams G, Najman J, Lawlor DA. Associations of gestational weight gain with offspring body mass Index and blood pressure at 21 years of age: evidence from a birth cohort study. Circulation 2009;119:1720-7.

(37) Wrotniak B, Shults J, Butts S, Stettler N. Gestational weight gain and risk of overweight in the offspring at age 7 y in a multicenter, multiethnic cohort study. American Journal of Clinical Nutrition 2008 Jun;87(6):1818-24.

(38) Stuebe AM, Forman M, Michels KB. Maternal-recalled gestational weight gain, pre-pregnancy body mass index, and obesity in the daughter. International Journal of Obesity 2009;33:743-52.

(39) Oken E, Taveras E, Kleinman K, Rich-Edwards J, Gillman M. Gestational weight gain and child adiposity at age 3 years. American Journal of Obstetrics and Gynecology 2007 Apr;196(4):322 e1-322 e8.

(40) Crozier SR, Inskip H, Godfrey KM, Cooper C, Harvey NC, Cole ZA, et al. Weight gain in pregnancy and childhood body composition: findings from the Southampton Women's Survey. American Journal of Clinical Nutrition 2010;91:1745-51.

(41) Shack-Nielsen L, Michaelsen KF, Gamborg M, Mortensen, EL, Sorensen TIA. Gestational weight gain in relation to offspring body mass index and obesity from infancy through adulthood. International Journal of Obesity 2010;34:67-74.

(42) Health Canada. Food and nutrition: body mass index (BMI) nomogram. Health Canada 2003 [cited 2010 Mar 30]; Available from: URL: http://www.hc-sc.gc.ca/fn-an/nutrition/weights-poids/guide-ld-adult/bmi_chart_java-graph_imc_java-eng.php

(43) IOM (Institute of Medicine). Weight gain during pregnancy: reexamining the guidelines. In: Rasmussen K, Yaktine AL, editors.Washington, D.C.: National Academies Press; 2009. p. page 214.

(44) McDonald SD, Han Z Mulla S, Beyene J. Overweight and obesity in mothers and risk of preterm birth and low birth weight infants: systematic review and meta-analysis. BMJ 2010;341(c3428):1-20.

(45) Fraser A, Tilling K, Macdonald-Wallis C, Hughes R, Sattar N, Nelson SM, et al. Associations of gestational weight gain with maternal body mass index, waist circumference, and blood pressure measured at 16 y after pregnancy: the Avon Longitudinal Study of Parents and Children (ALSPAC). American Journal of Clinical Nutrition 2011;93(6):1285-92.

(46) Olson C, Demment MM, Carling SJ, Strawderman MS. Association between mothers' and their children's weights at 4 years of age. Childhood Obesity 2010;6(4):201-7.

(47) IOM (Institute of Medicine). Early childhood obesity prevention policies. Washington DC: National Academies Press; 2011.

(48) Statistics Canada. Overweight and obese adults (self-reported), 2011. Statistics Canada 2012 [cited 2012 Jan 12]; Available from: URL: http://www.statcan.gc.ca/pub/82-625-x/2012001/article/11664-eng.htm

(49) Orpana H, Tremblay M, Finès P. Trends in weight change among Canadian adults: evidence from the 1996/1997 to 2004/2005 National Population Health Survey. Statistics Canada; 2006. Report No.: 82-618-MIE Vol. 2 No. 1.

(50) Statistics Canada. Health regions and peer groups. Statistics Canada 2011 [cited 2012 Dec 20]; Available from: URL: http://www.statcan.gc.ca/pub/82-221-x/2011002/hrpg-eng.htm

(51) Statistics Canada. Health profile June 2012. Statistics Canada 2012 [cited 2012 Dec 20]; Available from: URL: http://www12.statcan.gc.ca/health-sante/82-228/search-recherche/lst/page.cfm?Lang=E&GeoLevel=PEER&GeoCode=02

(52) Public Health Agency of Canada. What Mothers Say: The Canadian Maternity Experiences Survey MES. Ottawa: Public Health Agency of Canada; 2009.

(53) Statistics Canada. Table 35: Distribution of the household population aged 18-79, by body mass index norms based on measured inputs, by age and sex, Canada, 2007-2009. Canadian Health Measures Survey, Cycle 1 2010 [cited 2012 Jan 19]; Available from: URL: http://www.statcan.gc.ca/pub/82-623-x/2010001/t041-eng.htm

(54) Public Health Agency of Canada. Data tables - maternity experiences survey (MES). Public Health Agency of Canada 2009 [cited 2010 Aug 1];p61. Available from: URL: http://www.phac-aspc.gc.ca/rhs-ssg/pdf/tab-eng.pdf

(55) Crane JMG, White J, Murphy P, Burrage L, Hutchens D. The effect of gestational weight gain by body mass index on maternal and neonatal outcomes. Journal of Obstetrics and Gynaecology Canada 2009 Jan;(31):28-35.

(56) Public Health Agency of Canada. Canadian perinatal health report. Ottawa: Public Health Agency of Canada; 2008.

(57) Public Health Agency of Canada. Best Practice Interventions: Population Health Approach: The Organizing Framework. Public Health Agency of Canada 2010 [cited 2012 Oct 9]; Available from: URL: http://66.240.150.14/population_health/index-eng.html

(58) World Health Organization - Europe. Poverty and the social determinants of health. World Health Organization - Europe 2012

(59) Fuzhong L, Harmer P, Cardinal BJ, Bowsworth M, Johnson-Shelton D. Obesity and the built environment: Does the density of neighborhood fast-food outlets matter? American Journal of Health Promotion 2009;23(3):203-9.

(60) Jeffery RW, Baxter J, McGuire M, Linde J. Are fast food restaurants an environmental risk factor for obesity? International Journal of Behavioral Nutrition and Physical Activity 2006;3(2).

(61) Crawford DA, Timperio AF, Salmon JA, Baur L, Giles-Corti B, Roberts RJ, et al. Neighbourhood fast food outlets and obesity in children and adults. International Journal of Pediatric Obesity 2008;3:249-56.

(62) Ross NA, Tremblay S, Khan S, Crouse D, Tremblay MS, Berthelot JM. Body mass Index in urban Canada: neighborhood and metropolitan area effects. American Journal of Public Health 2007;97(3):500-8.

(63) Kuhle S, Veuglers P. Why does the social gradient in health not apply to overweight? Health Reports 2008 Dec;19(4).

(64) Lowell H, Miller DC. Weight gain during pregnancy, adherence to Health Canada's guidelines. Statistics Canada; 2010.

(65) Olsen C, Strawderman MS. Modifiable behavioral factors in a biosocial model predict inadequate and excessive gestational weight gain. Journal of the American Dietetic Association 2003;103(1):48-54.

(66) Phelan S, Phipps MG, Abrams B, Darroch F, Schaffner A, Wing RR. Practitioner advice and gestational weight gain. Journal of Women's Health 2011;20(4):585-91.

(67) Health Canada. Household food insecurity in select provinces and the territories in 2009-2010. Health Canada 2012 Available from: URL: http://www.hc-sc.gc.ca/fn-an/surveill/nutrition/commun/insecurit/prov_ter-eng.php

(68) Power EM. Determinants of healthy eating among low-income Canadians. Canadian Journal of Public Health 2005;96(3):s37-s42.

(69) Canadian Community Health Survey, 2007/2008 and 2009/2010 combined. Share data file. [computer program]. 2012.

(70) Inskip H, Crozier S, Godfrey K, Borland S, Cooper C, Robinson S. Women's compliance with nutrition and lifestyle recommendations before pregnancy: general population cohort study. British Medical Journal 2009 Feb;338(b481).

(71) Hure A, Young A, Smith R, Collins C. Diet and pregnancy in Australian women. Public Health Nutrition 2008;12(6):853-61.

(72) Blumfield ML, Hure AJ, MacDonald-Wicks LK, Patterson AJ, Smith R, Collins CE. Disparities exist between national food group recommendations and the dietary intakes of women. BMC Women's Health 2011;11(37).

(73) Crozier SR, Robinson SM, Godfrey KM, Cooper C, Inskip HM. Women's dietary patterns change little from before to during pregnancy. Journal of Nutrition 2009;139(10):1956-63.

(74) Rifas-Shiman SL, Rich-Edwards JW, Willett WC, Kleinman KP, Gillman MW. Changes in dietary intake from the first to the second trimester of pregnancy. Paediatric and Perinatal Epidemiology 2006;20(1):35-42.

(75) Wen LM, Flood VM, Simpson JM, Rissel C, Baur LA. Dietary behaviours during pregnancy: findings from first-time mothers is southwest Sydney, Australia. International Journal of Behavioral Nutrition and Physical Activity 2010;7(13):1-7.

(76) Stuebe AM, Oken E, Gillman MW. Associations of diet and physical activity during pregnancy with risk for excessive gestational weight gain. American Journal of Obstetrics & Gynecology 2009;201(58):e1-e8.

(77) Rifas-Shiman SL, Rich-Edwards JW, Kleinman KP, Oken E, Gillman MW. Dietary quality during pregnancy varies by maternal characteristics in project viva: a US cohort. Journal of the American Dietetic Association 2009;109(6):1004-111.

(78) Laraia B, Bodnar L, Siega-Riz A. Pregravid body mass index is negatively associated with diet quality during pregnancy. Public Health Nutrition 2007 Sep;10(9):920-6.

(79) Olafsdottir AS, Skuladottir GV, Thorsdottir I, Hauksson A, Steingrimsdottir L. Maternal diet in early and late pregnancy in relation to weight gain. International Journal of Obesity (Lond) 2006;30(3):492-9.

(80) Blair R, Hutcheson J, Lamon M, Reproductive Health Program. Gestational weight gain survey final report: An overview of healthy eating and physical activity behaviours of pregnant women in the Simcoe Muskoka District Health Unit area (unpublished manuscript). 2012.

(81) Uusitalo U, Arkkola T, Ovaskainen ML, Kronberg-Kippila C, Kenward MG, Veijola R, et al. Unhealthy dietary patterns are associated with weight gain during pregnancy among Finnish women. Public Health Nutrition 2009;12(12):2392-9.

(82) Cohen T, Plourde H, Koski K. Are Canadian women achieving a fit pregnancy? A pilot study. Canadian Journal of Public Health 2010 Jan;101(1):87-91.

(83) Urquhart CS, Mihalynuk TV. Disordered eating in women. Canadian Journal of Dietetic Practice and Research 2011;72(1):e116.

(84) Urquhart CS, Mihalynuk TV. Disordered eating in women. Canadian Journal of Dietetic Practice and Research 2011;72(1):e115-e125.

(85) de Lauzon-Guillain B, Basdevant MA, Romon M, Karlsson J, Borys JM, Charles MA, et al. Is restrained eating a risk factor for weight gain in the general population? American Journal of Clinical Nutrition 2006;83(1):132-8.

(86) Luppino FS dWLBPSTCP, Penninx BWJH, Zitman FG. Overweight, obesity and depression. Archives of General Psychiatry 2010;67(3):220-9.

(87) Bennett HA, Einarson A, Taddio A, Koren G, Einarson TR. Prevalence of depression during pregnancy: systematic review. Obstetrics & Gynecology 2004;103(4):698-709.

(88) Bowen A, Stewart N, Baetz M, Muhajarine N. Anenatal depression in socially high risk women in Canada. Journal of Epidemiology and Community Health 2009;63(5):414-6.

(89) Webb JB, Siega-Riz AM, Dole N. Psychosocial determinants of adequacy of gestational weight gain. Obesity 2009;17(2):300-9.

(90) Bodnar LM, Wisner KL, Moses-Kolko E, Sit DYK, Hanusa BH. Prepregnancy body mass index, gestational weight gain and the likelihood of major depression during pregnancy. Journal of Clinical Psychiatry 2009;70(9):1290-6.

(91) Gillman M. Developmental origins of obesity. New York: Oxford University Press; 2008.

(92) Ludwig DS, Currie J. The association between pregnancy weight gain and birthweight: a within-family comparison. Lancet 2010;376(9745):984-90.

(93) Lawlor DA, Lichtenstein P, Fraser A, Langstrom N. Does maternal weight gain in pregnancy have long term effects on offspring adiposity? A sibling study in a prospective cohort of 146,894 men from 136,050 families. American Journal of Clinical Nutrition 2011;94(1):142-8.

(94) Gardner B, Wardle J, Poston L, Croker H. Changing diet and physical activity to reduce gestational weight gain: a meta-analysis. Obesity Reviews 2011;12:e602-e620.

(95) O'Donnell V, Wallace S. First Nations, Métis and Inuit Women. Statistics Canada 2011 [cited 2012 Dec 20]; Available from: URL: http://www.statcan.gc.ca/pub/89-503-x/2010001/article/11442-eng.pdf

(96) Carriére G, Garner R, Sanmartin C, Longitudinal Health and Administrative Data Research Team. The health of First Nations living off-reserve, Inuit, and Métis adults in Canada:the impact of socio-economic status on inequalities in health. 2010.

(97) Giroux I, Lander S, Charlesworth S, Mottola M. Weight history of overweight pregnant women. Canadian Journal of Dietetic Practice and Research 2009 Sep 1;70(3):127-34.

(98) Katzmarzyk P. Obesity and physical activity among aboriginal Canadians. Obesity 2008 Jan;16(1):184-90.

(99) Grey-Donald K, Robinson E, Collier A, David K, Renaud L, Rodrigues S. Intervening to reduce weight gain in pregnancy and gestational diabetes mellitus in Cree communities: an evaluation. CMAJ 2000;163(10):1247-51.

(100) Statistics Canada. Canadian community health survey (CCHS). Statistics Canada 2009 [cited 2010 Mar 30]; Available from: URL: http://www.statcan.gc.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=3226&lang=en&db=imdb&adm=8&dis=2#1

(101) Vallianatos H BE, Raine K, Queenie S, Petawabano B, Dannenbaum D, Willows ND. Beliefs and practices of First Nation women about weight gain during pregnancy and lactation: Implications for women's health. Canadian Journal of Nursing Research 2006;38(1):102-19.

(102) Adelson N. The embodiment of inequity: health disparities in aboriginal Canada. Canadian Journal of Public Health 2005;96(March - April 2005):S45-S61.

(103) American Dietetic Association. Position of the American Dietetic Association and American Society for Nutrition: obesity, reproduction, and pregnancy outcomes. Journal of the American Dietetic Association 2009 May;109:918-27.

(104) Cogswell M, Scanlon K, Fein S, Schieve L. Medically advised, mother's personal target, and actual weight gain during pregnancy. Obstetrics & Gynecology 1999 Oct;94(4):616-22.

(105) Stotland N, Haas J, Brawarsky P, Jackson R, Fuentes-Afflick E, Escobar G. Body mass index, provider advice, and target gestational weight gain. Obstetrics & Gynecology 2005;105(3):633-8.

(106) McDonald SD, Pullenayegum E, Bracken K, Chen AM, McDonald H, Malott A, et al. Comparison of midwifery, family medicine, and obstetric patients' understanding of weight gain during pregnancy: A minority of women report correct counselling. Journal of Obstetrics and Gynaecology Canada 2012;34(2):129-35.

(107) Herring SJ, Platek DN, Elliott P, Riley LE, Stuebe AM, Oken E. Addressing obesity in pregnancy: What do obstetric providers recommend? Journal of Women's Health 2010;19(1):65-70.

(108) Glanz K. Review of nutritional attitudes and counseling practices of primary care physicians. American Journal of Clinical Nutrition 1997;65 (suppl):2016S-9S.

(109) Kolasa KM, Rickett K. Barriers to providing nutrition counseling cited by physicians: a survey of primary care practitioners. Nutrition in Clinical Practice 2010;25(5):502-9.

(110) Miller WR, Rollnick S. Ten things that motivational interviewing is not. Behavioural and Cognitive Psychotherapy 2009;37:129-40.

(111) Miller WR, Rose GS. Toward a theory of motivational interviewing. American Psychologist 2009;64(6):527-37.

(112) Armstrong MJ, Mottershead TA, Ronksley PE, Sigal RJ, Campbell TS, Hemmelgarm BR. Motivational interviewing to improve weight loss in overweight and/or obese patients: a systematic review and meta-analysis of randomized controlled trials. Obesity Reviews 2011;12:709-23.

(113) Bogaerts AFL, Devlieger R, Nuyts E, Witters I, Gyselaers W, Van den Bergn BRH. Effects of lifesyle intervention in obese pregnant women on gestational weight gain and mental health: A randomized controlled trial. International Journal of Obesity 2012;1-8.

(114) Health Canada. Eating well with Canada's food guide: A resource for educators and communicators. Health Canada 2007 [cited 2012 Jan 18]; Available from: URL: http://www.hc-sc.gc.ca/fn-an/food-guide-aliment/educ-comm/resource-ressource-eng.php

(115) Health Canada. Prenatal nutrition guidelines for health professionals-background on Canada's food guide. Health Canada; 2009 Nov.

(116) United States Department of Agriculture. Health and nutrition information for pregnant and breastfeeding women. United States Department of Agriculture 2012 [cited 2012 Sep 10]; Available from: URL: http://www.choosemyplate.gov/pregnancy-breastfeeding/pregnancy_weight_gain.aspx

(117) American Dietetic Association. Position of the American Dietetic Association and American Society for Nutrition: obesity, reproduction, and pregnancy outcomes. Journal of the American Dietetic Association 2009 May;109:924.

(118) American Dietetic Association. Position of the American Dietetic Association: nutrition and lifestyle for a healthy pregnancy outcome. Journal of the American Dietetic Association 2008;102(10):1479-90.

(119) Society of Obstetricians and Gynaecologists of Canada. Bigger Isn't Always Better: With over 50% of Canadian women overweight or obese, the time is now to focus on the Nutritional Needs of Women. Society of Obstetricians and Gynaecologists of Canada 2012 June 21 [cited 2012 Sep 10]; Available from: URL: http://www.sogc.org/documents/medNutritionthroughlifespan120622.pdf

(120) Kramer MS, Kakuma R. Energy and protein intake in pregnancy. Cochrane Database of Systematic Reviews [4]. 2003. John Wiley & Sons, Ltd.

(121) Davies GA, Wolfe L, Mottola M, MacKinnon C, Society of Obstetricians and Gynaecologists of Canada, SOGC Clinical Practice Obstetrics Committee. Joint SOGC/CSEP clinical practice guideline: Exercise in pregnancy and the Postpartum Period. Canadian Journal of Applied Physiology 2003;28(3):330-41.

(122) Wolfe L, Mottola M. PARmed-X for pregnancy. Canadian Society for Exercise Physiology 2002 [cited 2011 Dec 9]; Available from: URL: http://www.csep.ca/english/view.asp?x=698

(123) PAR-Q + Collaboration. ePARmed-X + Online. 2011. 12-20-2012.

(124) Charlesworth S, Foulds HJA, Burr JF, Bredin SSD. Evidence-based risk assessment and recommendations for physical activity clearance: pregnancy. Applied Physiology, Nutrition and Metabolism 2011;36(S1):S33-S48.

(125) ACOG Committee Obstetric Practice. ACOG Committee opinion. Number 267, January 2002: exercise during pregnancy and the postpartum period. Obstetrics & Gynecology 2002;99(1):171-3.

(126) Physical Activity Guidelines Advisory Committee. Physical Activity Guidelines Advisory Committee Report. Department of Health and Human Service Washington DC 2008 October 7 [cited 2012 Oct 9]; Available from: URL: http://www.health.gov/paguidelines/Report/Default.aspx

(127) Physical ActivityGuidelines Advisory Committee. Physical Activity Guidelines Advisory Committee Report, 2008. Department of Health and Human Service, Washington, DC, US 2008 October 7 [cited 2012 Oct 9];page G11-39. Available from: URL: http://www.health.gov/paguidelines/Report/Default.aspx

(128) Press E, Bennett S. Clinical practice guideline number 12. The management of women with a high or low body mass index. Association of Ontario Midwives 2010 [cited 2011 Dec 9]; Available from: URL: http://www.aom.on.ca/Health_Care_Professionals/Clinical_Practice_Guidelines/

(129) National Institute for Health and Clinical Excellence. Dietary interventions and physical activity interventions for weight management before, during and after pregnancy. National Institute for Health and Clinical Excellence 2010 [cited 2012 Jan 17]; Available from: URL: http://www.nice.org.uk/PH27

(130) Modder J, Fitzsimons KJ, RCOG Guidelines Committee. CMACE/RCOG Joint guideline: management of women with obesity in pregnancy. Centre for Maternal and Child Enquiries and Royal College of Obstetricians and Gynaecologists 2010 [cited 2012 Sep 10]; Available from: URL: http://www.rcog.org.uk/womens-health/clinical-guidance/management-women-obesity-pregnancy

(131) Modder J, Fitzsimons KJ, RCOG Guidelines Committee. CMACE/RCOG Joint guideline: management of women with obesity in pregnancy. Centre for Maternal and Child Enquiries and Royal College of Obstetricians and Gynaecologists 2010 [cited 2012 Sep 10];page 6. Available from: URL: http://www.rcog.org.uk/womens-health/clinical-guidance/management-women-obesity-pregnancy

(132) Modder J, Fitzsimons KJ, RCOG Guidelines Committee. CMACE/RCOG Joint guideline: management of women with obesity in pregnancy. Centre for Maternal and Child Enquiries and Royal College of Obstetricians and Gynaecologists 2010 [cited 2012 Sep 10];page 14. Available from: URL: http://www.rcog.org.uk/womens-health/clinical-guidance/management-women-obesity-pregnancy

(133) Modder J, Fitzsimons KJ, RCOG Guidelines Committee. CMACE/RCOG Joint guideline: management of women with obesity in pregnancy. Centre for Maternal and Child Enquiries and Royal College of Obstetricians and Gynaecologists 2010 [cited 2012 Sep 10];page 16. Available from: URL: http://www.rcog.org.uk/womens-health/clinical-guidance/management-women-obesity-pregnancy

(134) Campbell F, Johnson M, Messina J, Guillaume L, Goyder E. Behavioural interventions for weight management in pregnancy: A systematic review of quantitative and qualitative data. BMC Public Health 2011;11:491.

(135) Tanentsapt I, Heitmann BL, Adegboye ARA. Systematic review of clinical trials on dietary interventions to prevent excessive weight gain during pregnancy among normal weight, overweight and obese women. BMC Pregnancy and Childbirth 2011;11:81.

(136) Streuling I, Beyerlein A, von Kries Rudiger. Can gestational weight gain be modified by increasing physical activity and diet counseling? A meta-analysis of intervention trials. American Journal of Clinical Nutrition 2010;92(4):678-87.

(137) Dodd JM GCCC, Robinson JS. Antenatal interventions for overweight or obese pregnant women: a systematic review of randomised trials. BJOG 2010;117:1315-26.

(138) Quinlivan JA, Julania S, Lam L. Antenatal dietary interventions in obese pregnant women to restrict gestational weight gain to Institutee of Medicine Recommendations. Obstetrics & Gynecology 2011;118(6):1395-401.

(139) Skouteris H, Hartley-Clark L, McCabe M, Milgrom J, Kent B, Herring SJ, et al. Preventing excessive gestational weight gain: a systematic review of interventions. Obesity Reviews 2010;11(11):757-68.

(140) Ronnberg AK, Nilsson K. Interventions during pregnancy to reduce excessive gestational weight gain: a systematic review assessing current clinical evidence using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system. BJOG 2010;117(11):1327-34.

(141) Dozois E. Consumer and provider perspectives on healthy weight gain in pregnancy: Summary of focus group and interview findings. Word on the Street Consulting Ltd; 2006.

(142) Veitch T, Hanson A, Geake C, Decision Support Research Team. Three cheers for the early years: Healthy pregnancy weight project evaluation report. Calgary Health Region 2008 [cited 2012 Dec 20]; Available from: URL: http://www.calgaryhealthregion.ca/programs/3cheers/pdf/healthy_pregnancy_weight_evaluation.pdf

(143) Brownson RC, Baker EA, Leet TL, Gillespie KN, True WR. Evidence-Based Public Health. 2nd ed. New York: Oxford University Press, Inc; 2011.

(144) IOM (Institute of Medicine). Bridging the evidence gap in obesity prevention: A framework to inform decision making. Washington DC: The National Academies Press; 2010.

(145) Public Health Agency of Canada. What is the population health approach? Public Health Agency of Canada 2001 August 12 [cited 2012 Dec 20]; Available from: URL: http://www.phac-aspc.gc.ca/ph-sp/approach-approche/appr-eng.php#key_elements

(146) Public Health Agency of Canada. Reducing health disparities - roles of the health sector: recommended policy directions and activities. Public Health Agency of Canada 2005 [cited 2010 Apr 19]; Available from: URL: http://www.phac-aspc.gc.ca/ph-sp/disparities/dr_policy_1-eng.php

(147) Lussier MT, Richard C. The motivational interview. Canadian Family Physician 2007;53(12):2117-8.

(148) Wensing M, Bosch M, Grol. Selecting KT Interventions. In: Straus S, Tetroe J, Graham ID, editors. Knowledge Translation in Health Care.West Sussex: Wiley-Blackwell; 2009. p. 94-113.

(149) Health Canada. Eating well with Canada's food guide. 2007. Health Canada.

(150) Canadian Institute for Health Information. Giving birth in Canada: The costs. Canadian Institute for Health Information 2006 [cited 2012 Dec 20]; Available from: URL: https://secure.cihi.ca/estore/productSeries.htm?pc=PCC226

(151) Public Health Agency of Canada. 2011 Diabetes in Canada: Facts and figures from a public health perspective. Ottawa: Her Majesty the Queen in Right of Canada; 2011.

(152) Ontario Ministry of Health and Long Term Care. Ministry reports: Diabetes: strategies for prevention. Report of the Medical Officer of Health. Ontario Ministry of Health and Long Term Care 1999

(153) Ontario Ministry of Health and Long Term Care. Ontario Public Health Standards. Ontario Ministry of Health and Long Term Care 2008 [cited 2012 Jan 11];1-49. Available from: URL: http://www.health.gov.on.ca/english/providers/program/pubhealth/oph_standards/ophs/index.html

(154) IOM (Institute of Medicine). Weight gain during pregnancy: reexamining the guidelines. Washington, D.C.: National Academies Press; 2009.