

Obesity in Preconception and Pregnancy



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by/par health **nexus** santé

Executive Summary

1. Pregnancy is a critical period of growth, development and physiological change in the mother and child. Prenatal obesity (due to being obese prior to conception OR gaining excessive weight during pregnancy) poses significant health risks to both the mother and baby during pregnancy and beyond.
2. Prenatal obesity increases the maternal risk of gestational diabetes mellitus, preeclampsia, excessive gestational weight gain, labour complications and excess postpartum weight retention. Maternal obesity also increases the risk of fetal overgrowth (i.e., large for gestational age or macrosomia), fetal distress, child obesity and can promote an accelerated growth trajectory throughout the child's life course.
3. Pregnancy provides a window of opportunity for maternal interventions that are beneficial to maternal health and fetal development. Maternal physical activity and/or nutrition interventions have shown promise with respect to improving maternal glycemic control, adherence to gestational weight gain guidelines, limiting the risk of gestational diabetes mellitus, reducing labour complications and optimizing birth weight. In addition, strategies that aid in maternal sleep quality and duration have been shown to improve blood sugar control.
4. It remains unclear if maternal physical activity and nutrition counseling interventions reduce the incidence of childhood obesity.
5. There are many other potential factors influencing prenatal obesity that are beyond the scope of this report.
6. Research is required to determine effective strategies that reduce obesity in the preconception and prenatal periods, with a special emphasis on vulnerable populations and underlying factors such as poverty.



Résumé

1. La grossesse est une période critique de croissance, de développement et de changement physiologique chez la mère et chez l'enfant. L'obésité prénatale (être obèse avant la conception ou gagner un poids excessif pendant la grossesse) présente des risques importants pour la santé de la mère et du bébé pendant la grossesse et au-delà.
2. L'obésité prénatale augmente le risque maternel de diabète gestationnel, de prééclampsie, d'un gain de poids gestationnel excessif, de complications du travail et d'excès de rétention de poids après l'accouchement. L'obésité maternelle augmente également le risque de prolifération fœtale (par ex. lourd pour l'âge gestationnel ou macrosomie), la détresse fœtale, l'obésité infantile et peut favoriser une trajectoire de croissance accélérée tout au long du cycle de vie.
3. La grossesse présente un temps opportun pour les interventions maternelles qui sont favorables à la santé maternelle et au développement du fœtus. L'activité physique de la mère et / ou des interventions nutritionnelles ont montré des résultats prometteurs en ce qui concerne l'amélioration du contrôle glycémique maternel et le respect des lignes directrices de gain de poids durant la grossesse. Ceci limite le risque de diabète gestationnel, réduit les complications du travail et optimise un poids de naissance santé. Aussi, les stratégies qui favorisent la qualité et la durée du sommeil chez la mère démontrent une amélioration sur le contrôle de la glycémie.
4. Il reste difficile de savoir si les interventions maternelles visant l'activité physique et la nutrition réduisent l'incidence de l'obésité infantile.
5. Il y a beaucoup d'autres facteurs potentiels qui influencent l'obésité prénatale qui sont au-delà de la portée de ce rapport.
6. Des recherches s'imposent pour déterminer des stratégies efficaces qui permettront de réduire l'obésité au cours de la période de la préconception et de la période prénatale, avec un accent particulier sur les populations vulnérables et les facteurs sous-jacents comme la pauvreté.



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1.0 | Introduction



This report provides current information about the prevalence of, risk factors for, and implications of obesity in the preconception and perinatal periods in Ontario. Additional information is presented concerning approaches that have been effective in addressing obesity in the preconception and prenatal periods. Evidence-based practices are limited at this time and additional research is needed.

Note: This Best Start Resource Centre report focuses only on obesity in preconception and pregnancy. It does not address other factors that may influence child obesity, such as smoking during pregnancy. The information in this report is restricted to areas where there is evidence that a specific intervention can positively influence obesity in preconception and pregnancy. This is limiting, in that some of the deeper underlying potential causes of obesity, for example poverty, are difficult to influence, to research and to show evidence of clear positive direction for specific interventions.

In 2012 to 2013, the multi-sectorial Healthy Kids Panel received recommendations from parents, caregivers, as well as experts in the field and reviewed the scientific literature to determine how to best reduce the incidence of child obesity in Ontario.¹ Priorities and achievable strategies were identified that would have the greatest impact on child health. Recommendations from the panel focus on: starting all kids on the path to health by enhancing prenatal care for families and supporting breastfeeding; changing the food environment to increase the availability of healthy choices and building healthy communities that encourage healthy eating and active living. In support of evidence that suggests that significant change can be achieved by “laying the foundation for a lifetime of good health... before babies are conceived, and continues through the first months of life”, prenatal care for women was identified as a high priority by the Ontario Healthy Kids Panel Report.¹

1.1 Definition of Obesity

The most commonly used indicator of weight-related health risk is the Body Mass Index (BMI). BMI is calculated from the height and weight of an individual where the weight in kilograms is divided by height in meters squared (kg/m²). The table below, from the Canadian Guidelines for Body Weight Classification in Adults, provides categories of BMI and levels of health risk.

Table 1: Body Mass Index and health risk.

Classification	BMI Category (kg/m ²)	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
Class II	35.0-39.9	Very high
Class III	≥40.0	Extremely high

It is important to note that BMI does not apply to women who are pregnant or breastfeeding.

See this link for a pregnancy weight gain calculator:

www.hc-sc.gc.ca/fn-an/nutrition/prenatal/bmi/index-eng.php.

Overweight and obesity is one of the most significant public health issues in Canada and worldwide. In Ontario adult overweight and obesity is estimated at 58.6%, slightly below the national average of 59.1%.² Rates of obesity and related health consequences (such as diabetes, cardiovascular disease, osteoarthritis and some cancers) are at an all-time high and manifest at an earlier age.³

The adverse medical^{5,6} and psychosocial effects⁷ of obesity underscore the importance of early intervention and prevention. This is especially important given the significant economic burden that obesity related diseases have on the health care system, costing Ontario approximately \$1.6 billion annually, including \$647 million in direct costs and \$905 million in indirect costs. This contributes to the national figure of \$4.3 billion annually for obesity related diseases.⁸

As a result of the increasing rates and costs, scientists and clinicians are spending a great deal of time and effort trying to identify effective interventions and prevention programs to address this issue.

Obesity during the preconception and prenatal periods is a particularly important area of focus. Rates have increased in all age categories, with the most rapid increases in women of childbearing age (15-49 years of age), more than doubling in the last 25 years.⁹⁻¹¹ The health implications of obesity are considerable for both the mother and baby – during pregnancy and beyond – and must be recognized and acted upon by service providers. Initiatives are being designed to prevent obesity in the prenatal and early years populations, recognizing that obesity and related conditions track very closely from childhood through adolescence into adulthood.⁴

1.2 Causes of Obesity

Adult obesity results from long-term positive energy balance or simply storing more energy than your body requires for normal day-to-day functions. However, this oversimplifies the many causal factors responsible for obesity in modern society. Obesity may be caused by one or more of a combination of factors, including but not limited to, genetic predisposition, in utero determinants related to prenatal health, lack of physical activity, poor nutrition (namely excessive caloric consumption), socio-economic drivers, gender, lack of sleep, medication use and/or underlying medical problems that promote weight gain.

Given the progressive nature of weight gain and thus obesity, coupled with the notion that early life body weight tracks throughout one's lifetime, obesity prevention strategies have largely shifted to focus on preventing obesity during childhood. In an attempt to minimize the public health burden of adult and future child obesity an early years approach to prevention and management was developed for Ontario. The Healthy Kids Strategy¹ provides an overview of recent research and recommendations for Ontario in reducing child obesity.

Child obesity may be impacted by¹:

- Factors Affecting an Early Start in Life (such as genetics, adverse environments during pregnancy and infancy, sleep and mental health).
- Food Environment and Food Choices (for example parental time pressures, cost and accessibility of healthy food, knowledge of healthy food and marketing practices).
- Community Factors (such as time pressure, change in children's activities, cost of activities, parental perception of safety and social disparities).
- Factors influencing preconception and pregnancy include health prior to conception, health during pregnancy (for example cost and accessibility of healthy food, knowledge of healthy food) and social disparities.

The Healthy Kids Panel Report rational in preventing child obesity includes several factors related to preconception and prenatal health.¹ For example:

- Factors that lead to low birth weight (such as maternal smoking). While maternal smoking is associated with low birth weight, infants with low birth weights can experience a rapid catch up leading to later obesity.
- Overweight or obesity prior to pregnancy.
- Excessive weight gain during pregnancy.



Their recommendations specific to pregnancy include¹:

- Educate women of child-bearing age about the impact of their health and weight on their own well-being and on the health and well-being of their children.
- Enhance primary and obstetrical care to include a standard pre-pregnancy health check and wellness visit for women planning a pregnancy and their partners.
- Adopt a standardized prenatal education curriculum and ensure courses are accessible and affordable for all women.

The report includes recommendations related to poverty, mental health and obesity that are relevant to preconception and pregnancy¹:

- Speed implementation of the Poverty Reduction Strategy.
- Continue to implement the Mental Health and Addictions Strategy.
- Ensure families have timely access to specialized obesity programs when needed.

2.0 | Social Determinants of Health

The World Health Organization defines the social determinants of health as the “conditions in which people are born, grow, live, work and age, including the health system.”¹² The social determinants of health¹³ are largely responsible for health inequalities that exist between groups of individuals within a population.¹²

Despite the wealth of research on the social determinants of health, few research studies have examined how these determinants impact maternal obesity and newborn health. Whether counselling or designing public health programs for pregnant women who are overweight or obese, contextual issues, such as ethnicity and socio-economic status need to be considered and addressed. Recent studies that considered various social determinants of health have identified significant relationships between ethnicity,^{14, 15} poverty¹⁶ and poor maternal and neonatal health outcomes. While there is growing need to improve the health of the population at large, the need is greatest among minority groups and marginalized populations especially those with low socio-economic status.



The Social Determinants of Health¹³ include:

- Income and income distribution
- Unemployment and job security
- Early childhood development
- Housing
- Social safety network
- Aboriginal status
- Ethnicity
- Education
- Employment and working conditions
- Food security
- Social exclusion
- Health services
- Gender
- Disability

2.1 Vulnerable Populations

Obesity is an issue that disproportionately affects some groups in society. Several populations are at higher risk for obesity and health related consequences. These groups include various ethnic populations, those of low socio-economic status or educational level, and those living in remote or rural locations.^{17,18} An example of a vulnerable population in Canada is First Nations women of child-bearing age living on-reserve.¹⁹ Factors including poverty and food security, remote location, substandard housing conditions, histories of colonization and violence, etc., are associated with poor health outcomes, such as increased rates of becoming overweight or obese.¹⁸

Given Canada's increasing ethnic diversity, it is important to understand the social and environmental contexts in which populations can be vulnerable to becoming overweight or obese and how this may impact pregnancy outcomes. Although immigrants to North America are less likely than the non-immigrant population to be overweight,²⁰ within two or three generations, the prevalence of overweight often exceeds that of non-immigrants populations.^{20,21} While genetic predispositions may play a role, ethnic groups have different social pressures and norms around socially acceptable body weight ranges,^{22,23} which may partially explain some of the variations in obesity.²⁴ Cultural norms related to physical activity (sex-specific, age-specific, sport-specific, perception of intensity, etc.) and nutrition (dietary customs, acceptable foods and quantities) may also contribute to the differences. Awareness of cultural factors facilitates the development of culturally relevant obesity prevention and intervention strategies. The benefits, harms and costs of options to address obesity may vary across subpopulations. Implementation considerations may also vary across groups.

The social determinants of health are significant barriers to both preconception and prenatal health. This report highlights how health behaviours and outcomes may differ based on the social determinants of health. There are profound influences that go well beyond personal choice, but may be positively influenced by higher level changes such as helping women to meet their basic needs, policy development or environmental supports. While the indicators highlighted in this report are not comprehensive, they identify future areas of interest with respect to pro-active program delivery and prevention.

For additional information about the social determinants of health refer to:

- Primer to Action: Social Determinants of Health
www.en.healthnexus.ca/sites/en.healthnexus.ca/files/resources/primer_to_action.pdf
- Social Determinants of Health: The Canadian Facts
www.thecanadianfacts.org/
- Report on the state of Public health in Canada 2012
www.phac-aspc.gc.ca/cphorsphc-respcacsp/
- What Makes Canadians Healthy or Unhealthy?
www.phac-aspc.gc.ca/ph-sp/determinants/determinants-eng.php#unhealthy

3.0 | Obesity and Preconception



3.1 Preconception Obesity Rates

While there is little reliable (directly measured) provincial data regarding women of childbearing age, it is estimated that more than 40% of Ontario women of childbearing age are overweight or obese.¹¹

3.2 Implications of Obesity in Preconception

There is compelling evidence that overweight or obese individuals are at increased risk of a variety of health problems. Women who are obese during their childbearing years are at risk for conditions such as polycystic ovary syndrome,²⁵ menstrual irregularities, as well as poor cardiometabolic health (the clustering of various risk factors, namely insulin resistance, high triglycerides, high blood pressure and low HDL cholesterol putting an individual at high risk of developing type 2 diabetes) and cardiovascular disease. Women who are obese are also at higher risk for hypertension, respiratory issues (sleep apnea, asthma), thromboembolic disease, mental health issues such as depression and osteoarthritis.²⁶⁻²⁹

Obesity can lead to a range of reproductive health concerns including difficulty in conceiving, poor health during pregnancy, and poor perinatal and postpartum outcomes.

Women who are obese have more difficulty conceiving including, but not limited to, reduced fertility and less successful assisted reproduction.^{30,31} As BMI increases, pregnancy rates decrease.³² Women with a BMI > 30 have up to 68% decreased chance of having a live birth following their first assisted reproduction technology cycle compared with women with BMI < 30.³³

Obesity during the pregnancy planning stage has been implicated in metabolic and hormonal difficulties related to reproductive health. This happens when fat cells change their metabolism and secrete factors called adipokines (namely adiponectin and leptin) that interfere with normal hormonal processes. Additionally, obesity induces changes in various important regulatory hormones like insulin, androgens and sex hormone-binding globulin. These changes can result in anovulation, infertility and a higher risk of miscarriage. Management of anovulation with obesity commonly involves diet and exercise modification as well as standard approaches to ovulation induction.

Women who are obese have higher rates of complications during pregnancy including pregnancy-associated hypertension, gestational diabetes, large babies, caesarean section and perinatal mortality and morbidity.³⁴

Striving to achieve a normal body weight during the pregnancy planning stages may improve chances of conception and reduce maternal and fetal complications.

3.3 Importance of Achieving a Healthy Weight in the Childbearing Years

Ideally women should conceive at a healthy body weight (i.e., BMI: 18.5–24.9), taking full advantage of the adage prevention before conception^{36,37} in an attempt to lower their risk of obesity-related conditions.

Although preventative preconception weight loss is ideal for women who are overweight or obese, up to 50% of North American pregnancies are unplanned³⁸ and approximately 30-40% of Canadian women report having pregnancies that are unplanned.^{39,40} In addition, unintended pregnancies are more common among women who are young, unmarried, members of a minority group, have low income, and less than high school education.⁴¹ These sub-populations are disproportionately affected by obesity.^{42,43} A previous Best Start Resource Centre survey titled *Preconception Health: Awareness and Behaviours in Ontario* showed that more than half of the women surveyed did not make any health changes before conception (55%), and a quarter (26%) made no health changes in relation to their last pregnancy, either in the preconception or prenatal period.³⁹

Preconception weight loss may be difficult for many women given that the social determinants of health impose many barriers in achieving a healthy weight. Additionally, there is little compliance to health messaging at the population level and many nutrition and exercise intervention programs (the cornerstone of obesity treatment) show poor adherence, modest long-term success, and a high likelihood of weight regain because of significant barriers both on the part of affected individuals and the service provider.⁴⁴ Expert opinion supports continued efforts to at least maintain weight (i.e. slow or prevent further gain) during the preconception period to lessen the risks during pregnancy (see Section 4.2).

Obesity is more prevalent in the most socio-economically deprived population. There is an inverse relationship between level of education and BMI in women.¹⁸ In addition, lower socio-economic status is associated with larger body size in women in developed countries.⁴⁵ An inverse trend between income and obesity for females has also been observed among Aboriginal peoples.⁴⁶ This may be related to women's physical activity and eating patterns as Ontario women with some post-secondary education or a university degree were more likely to be active than women with lower levels of education⁴⁷ and those with the lowest education levels were least likely to eat at minimum of five servings of fruits and vegetables each day.⁴⁷ Poverty can influence ability to purchase healthy food, take part in certain recreational activities, as well as well-being.

Poor mental health is both a risk factor and consequence of chronic disease including obesity.⁴⁸⁻⁵⁰ As a risk factor, poor mental health can affect an individual's ability to undertake health-promoting behaviours⁵¹ and to seek help. It can also impact the prenatal health care providers' ability to diagnose and treat their condition and can influence prognosis.^{50,52} Similarly, individuals struggling with obesity are more likely to experience poor mental health.

3.4 Preconception BMI and Gestational Weight Gain

Preconception BMI is a key indicator for service providers as pre-pregnancy BMI defines the recommended individual gestational weight gain. The Institute of Medicine recently modified their guidelines in regards to healthy weight gain during pregnancy due to the increasing prevalence of obesity among women of childbearing age, increases in gestational weight gain and the associated health implications of both of these factors. Health Canada has adopted these recommendations. These new guidelines recommend a much smaller weight gain range in pregnancy for those categorized as overweight (7-11.5 kg) and obese (5-9 kg).⁵³

Table 2: Gestational weight gain recommendations

BMI Weight (kg) Height (m ²)	Recommended Weight Gain	Rates of Weight Gain per week in 2nd and 3rd trimester*	
Underweight < 18.5 kg/m ²	28-40 lbs (12.5-18 kg)	1 pound	0.51 kilograms
Normal Weight: 18.5 -24.9 kg/m ²	25-35 lbs (11.5-16 kg)	1 pound	0.42 kilograms
Overweight: 25.0-29.9 kg/m ²	15-25 lbs (7-11.5 kg)	0.6 pounds	0.28 kilograms
Obese ≥ 30.0 kg/m ²	11-20 lbs (5-9 kg)	0.5 pounds	0.22 kilograms

*Calculations assume a 1.1 – 4.4 lbs (.45 – 2 kg) weight gain in the first trimester. Note: The Society of Obstetricians and Gynaecologists of Canada recommend that women who are obese gain no more than 7kg during pregnancy. Their report titled The SOGC Clinical Practice Guideline on Obesity and Pregnancy⁵⁴ can be found here: www.sogc.org/guidelines/obesity-in-pregnancy/. For a pregnancy weight gain calculator go to: www.hc-sc.gc.ca/fn-an/nutrition/prenatal/bmi/index-eng.php.

For women who are overweight or obese prior to conception, exceeding gestational weight gain guidelines dramatically increases the likelihood of delivering a large for gestation age baby⁵⁵ with higher fat mass.⁵⁶ Additionally women who exceed gestational weight gain guidelines are at risk for postpartum weight retention,^{57,58} which can translate to higher rates of:

- Postpartum maternal obesity.⁵⁹
- Increased body weight before subsequent pregnancies.⁵⁷
- Cardiometabolic risk factors.⁶⁰

Barriers for Canadian women in meeting the gestational weight gain guidelines include low income or education,⁴⁰ member of a First Nations group, lack of knowledge of the guidelines or dietary requirements for pregnancy and low availability of healthy foods.⁶¹ It is important for service providers to understand these barriers and obstacles in order to help women have healthier pregnancies.

3.5 What Can Be Done?

Since weight loss is inadvisable during pregnancy, attempts to reach a healthy body weight should be made prior to pregnancy. The preconception period provides an ideal time for health care providers to intervene in order to improve pregnancy and pre-pregnancy related outcomes. The health care provider can identify the risks associated with overweight and obesity for preconception and prenatal health and then support women with methods to reduce these risks, such as referrals to appropriate services.

Obesity is considered a modifiable risk factor. Women can be reached in the preconception period through a variety of approaches including preconception classes, displays, media and health care provider appointments. Strategies for weight control before conception include:

a. Calculation of BMI for appropriate categorization

b. Gauging readiness for change

The Transtheoretical Model⁶² for health behaviour change can be used to gauge a woman's readiness for change, guiding messaging about obesity prevention:

- **Pre-contemplation:** The woman is not interested in change. The service provider can educate the woman on her weight status and the reasons it would be beneficial to make changes and wait until she is prepared to consider acting on advice.
- **Contemplation:** The woman is aware of the problem and is thinking of making changes. The service provider can discuss the obstacles or barriers to change that a woman is facing and help her to work through these problems and gain support.
- **Preparation:** The woman is deciding how to change and starting the process of making small changes. The service provider can provide information to the woman on small changes that could assist her in losing weight slowly and encourage continuation.
- **Action:** The woman has already made some changes in her life. At this stage the service provider is an important source of support and can guide further change that she may not have been prepared for previously.
- **Maintenance:** The woman has met her preconception body weight goal. At this point the service provider should continue to assist her in maintaining her change and in moving on to new goals and healthful behaviours.

c. Assessment of diet

- *What does the woman eat during a typical day?*
- *Is she following the recommendations from the Eating Well with Canada's Food Guide?*
- *Does she have dietary restrictions?*
- *How often is she eating convenience food or restaurant food?*

Responses to these questions and other questions in Section 5.3.2 can be used to assist women who are obese in reducing their caloric intake (if identified as a concern) in a safe and healthful manner by making healthier choices and using available and reliable nutrition resources. Refer to a registered dietitian for dietary counselling, if appropriate.

Along with physical activity, diet is the most well-studied behavioral risk factor influencing overweight and obesity risk. Overall, the balance of the data underscores the importance of healthy eating patterns and access to healthy food as key factors associated with obesity at the population level. Similar to the general population, women who are obese and contemplating pregnancy should follow Eating Well with Canada's Food Guide. Dietary habits and healthy nutrition are associated with fertility.⁶³⁻⁶⁸ Ovulatory dysfunction related to excess body fat may be resolved in the months following improved nutrition. This may be linked to restoring adiponectin, leptin and/or insulin levels.⁶⁶

All women thinking about becoming pregnant should be directed to Health Canada's website to assist them with healthy eating during pregnancy. Information concerning important dietary recommendations for women, information for health care providers, and a series of links to additional resources for pregnant women and health care providers can be found here: www.hc-sc.gc.ca/fn-an/nutrition/prenatal/index-eng.php

Service providers should inform women in the preconception period about folic acid:

Folic Acid: Folate is a B vitamin that is essential to the normal development of the spine, brain and skull of the fetus, especially during the first four weeks of pregnancy. This is a time when many women are not yet aware that they are pregnant. Health Canada encourages women of childbearing age to take a daily multivitamin supplement containing folic acid (0.4 mg) in addition to eating folate-rich foods (e.g. dark green leafy vegetables (i.e. spinach), citrus fruits, nuts, legumes, whole grains). Canada has added folic acid to white flour, enriched cornmeal and enriched pasta since 1998. Fortification of whole wheat flour is voluntary in Canada. While few Canadians have folate deficiency, approximately 22% of Canadian women of childbearing age are still not achieving a folate concentration considered optimal for neural tube defect risk reduction.⁶⁹ Women who are obese may be at increased risk of having a baby with a neural tube defect and may require a high dose folic acid supplement (4-5 mg per day). Consult the Health Canada guide available from: www.hc-sc.gc.ca/fn-an/nutrition/prenatal/fol-qa-qr-eng.php#a2. Despite this, women of child bearing age who are overweight or obese are less likely than other women of child bearing age to take a folic acid supplement.⁷⁰

d. Assessment of physical activity level

- *Is the woman meeting Canada's Physical Activity Guidelines of 150 minutes/week of moderate to vigorous physical activity?* www.csep.ca/english/view.asp?x = 804

There is an inverse relation between the prevalence of obesity and leisure-time, physical activity or energy expended on activities of daily living, occupational or work-related activity, active commuting and incidental movement.⁷¹⁻⁷³ During preconception, women who are obese (along with the general adult population) should follow Canada's Physical Activity Guidelines of 150 minutes/week of moderate to vigorous physical activity (jogging, brisk walking, gardening, cycling, stair climbing and swimming etc.), in bouts of at least 10 minutes, to reduce their risk of chronic disease. For those starting a physical activity routine for the first time it is suggested that they start slowly and work their way up to the current recommendation.

e. Assessment of sedentary habits

- *Are they spending too much time in sedentary activities (i.e. sitting, lying, watching TV, computer, internet etc.)?*

Being active and eating a healthy diet reduces your risk of chronic diseases.⁷⁴ The more you sit, the greater your risk of developing diabetes, heart disease, cancer, and dying prematurely.⁷⁵ The Canadian Physical Activity Guidelines and Canadian Sedentary Behaviour Guidelines are available at: www.csep.ca/english/view.asp?x=804

f. Assessment of sleep hygiene

- *Are they sleeping too little?*
- *What are the barriers?*

Increasing evidence supports the role of insufficient sleep in contributing to obesity.⁷⁶ Lack of sleep may compromise the effectiveness of common weight-loss recommendations.⁷⁷ A healthier amount of sleep time is associated with less gain in fat mass. Addressing sleep for weight management has recently been endorsed by the Canadian Obesity Network (CON) through the 5A's of Obesity Management, see: www.obesitynetwork.ca/5As.

g. Identification of barriers and potential solutions to behavioural change

- *Where do they live?*
- *Can they access facilities for physical activity?*
- *Can they be active in their neighborhood (i.e. sidewalks, green space, bike paths)?*
- *Do they have equipment at home?*
- *Do they have access to healthy food? Why or why not?*
- *Do they know the difference between healthy and unhealthy food?*
- *Can they afford healthy food?*

This information can assist the service provider in suggesting solutions that may work for the client, taking into account their personal circumstances. See Section 9.0 for further resources.

TAKE HOME MESSAGES ABOUT OBESITY AND PRECONCEPTION

- *Approximately 40% of Ontario women are overweight or obese during their childbearing years.*
- *Women who are obese may experience reproductive issues (i.e. lower fertility, lower success with artificial reproductive technologies).*
- *Weight loss during the preconception period is a significant challenge for most women.*
- *Healthy eating and regular physical activity, even in the absence of weight loss, have tremendous health benefits.*
- *Preconception may be the most opportune time for primary obesity prevention including slowing or stopping weight gain.*

4.0 | Maternal Obesity and Gestational Weight Gain

Obesity during pregnancy can be due to obesity prior to conception (maternal obesity) or to excessive weight gain during pregnancy (gestational weight gain).

4.1 Maternal Obesity Rates

Obesity in pregnancy is on the rise¹⁰ and according to the 2006-2007 Canadian Maternity Experiences Survey, approximately one-third of Canadian women aged 15 and older report beginning their pregnancy either overweight or obese.⁴⁰ Obesity is particularly prevalent in First Nations women, and as a result, they are at greater risk of experiencing negative maternal reproductive health implications.⁷⁸ More research is needed to better understand the factors that influence overweight and obesity, such as ethnicity, culture, other social determinants of health, etc.

Table 3 illustrates mean BMI rates and the prevalence of women who enter pregnancy at normal vs. overweight or obese from the Better Outcomes Registry Network (BORN) Ontario. The overweight/obese prevalence of approximately 45% shown here is not necessarily representative of the province of Ontario as a whole but corresponds to the 4 hospitals for which Better Outcomes Registry and Network has adequate pre-pregnancy BMI data.

Table 3 – Prenatal BMI categorization of women in Ontario

Variable	Normal	Overweight	Obese Class I	Obese Class II	Obese Class III
Number (%)	3698 (55.4)	1648 (24.7)	786 (11.8)	288 (4.3)	254 (3.8)
BMI (mean ± standard deviation)	21.9±1.75	27.2±1.39	32.1±1.42	37.1±1.35	45.9±5.72

* Northern Ontario hospitals are excluded from the above data

4.2 Implications of Maternal Obesity

If a woman struggling with obesity is successful at conceiving she is at an increased risk for several pregnancy-related complications.³⁶ The risk of any form of obstetrical complication is about three times more likely in mothers who are obese as compared to mothers who are not obese.⁷⁹ As BMI goes up, so does the risk of negative prenatal outcomes for the mother and/or the baby.⁸⁰⁻⁸²

4.2.1 Maternal Outcomes: Pregnancy

As illustrated in Figure 1, the most notable complications in early pregnancy include increased risk of spontaneous abortion and recurrent miscarriages.⁸³⁻⁸⁶ As a pregnancy progresses women who are obese are at increased risk of gestational diabetes,⁸⁷ hypertensive disorders, preeclampsia, blood clots, infections, and preterm delivery.^{43,81,88,89} Women who are obese are more likely to experience these complications with a greater severity when compared to women of normal weight.¹⁰

Risks associated with overweight/obese pregnancy

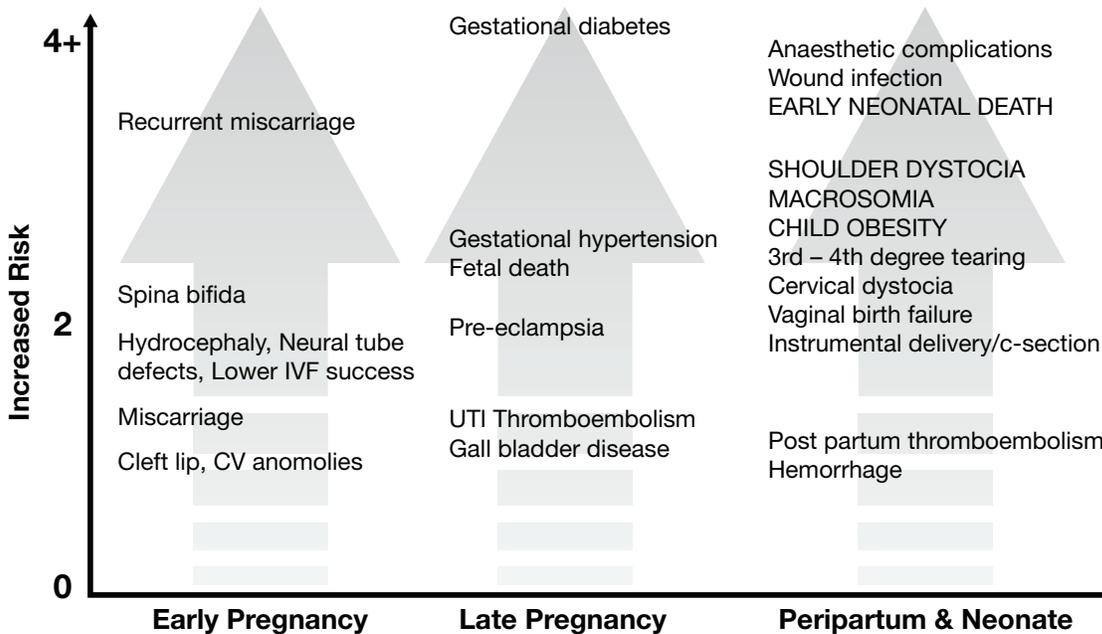


Figure 1: Risks associated with pregnancies complicated by overweight or obesity. The x-axis shows the time course and the y-axis illustrates the degree of elevated risk for each outcome based on published literature (IVF = in vitro fertilization, CV = cardiovascular, UTI = urinary tract infection). (Adapted from Adamo, Ferraro, Brett³⁶)

Mental and Emotional Health

There is significant evidence that individuals with higher BMIs experience more emotional distress such as increased stigmatization or depressive and anxiety disorders.^{90,91} One study found similar emotional and psychological distress in non-pregnant women with high BMIs such as stereotyping or discrimination.⁹²⁻⁹⁴ Obese and overweight women often experience negative interactions with their health care provider which can result in psychological distress.⁹⁵ This distress stems from the lack of guidance they receive from their health care providers, particularly when discussing their weight.⁹⁵⁻⁹⁷ Psychological and emotional distress is also due to feelings of guilt, worry, embarrassment and anxiety during their healthcare visits.^{95,97}

Service providers need to be sensitive in their approach and mindful of the psychological impacts in discussing weight management with pregnant women who are overweight or obese.

Insulin Resistance and Gestational Diabetes

Obesity is the most common risk factor for insulin resistance (i.e., when the body has a lowered response to insulin). Insulin sensitivity (i.e., the ability to uptake/use sugar in muscle and fat) supports nutrients to cross the placenta to reach the fetus for optimal growth.⁹⁸ Insulin sensitivity is reduced by 50-60% during pregnancy. Pregnant women who are overweight or obese face more challenges responding to insulin and clearing sugar from their blood. Gestational diabetes mellitus prevalence rates are much higher in women who enter pregnancy overweight or obese.⁹⁹ In comparison to women with a normal BMI, the risk of developing gestational diabetes mellitus rises exponentially with increasing BMI. For example, the odds of developing gestational diabetes mellitus are 1.97 for overweight, 3.01 for obese and 5.55 for women who are morbidly obese.⁸⁷

While increased fat mass is clearly a contributor, the location of the fat mass is also important. Accumulation of intra-abdominal fat (i.e., fat surrounding the organs) is particularly harmful. In one study, those with increased amounts of intra-abdominal fat compared to those who had increased amounts of subcutaneous adipose fat in the first trimester (12 weeks) of pregnancy had a 17 times greater risk of having insulin sensitivity in later pregnancy (24-28 weeks).¹⁰⁰

Women who develop gestational diabetes mellitus during one pregnancy are at increased risk for developing gestational diabetes mellitus in subsequent pregnancies¹⁰¹ and the majority (50-60%) develop type 2 diabetes in the years following delivery.¹⁰²

Gestational diabetes is a growing concern in Canada's First Nations women. A study of a First Nations population in Ontario's Sioux Lookout Zone found that the prevalence of gestational diabetes in pregnancy was 8.4% (the highest rate reported so far in a Canadian population). The study also found that prevalence rates increased with age, peaking at 46.9% in women over 35 years old.¹⁰³ Similarly, a study among the James Cree women in northern Quebec showed a gestational diabetes mellitus rate 2 times higher than among women in the general North American population and the second highest reported in an Aboriginal peoples worldwide.^{104,105} Data from the Sioux Lookout Zone found that 70% of First Nations women diagnosed with gestational diabetes mellitus went on to develop diabetes within three years.¹⁰⁶ This highlights the importance of making efforts to promote better glycemic control during pregnancy for the health of both the mother and baby. It also suggests that the broader social determinants of health should be considered when developing health promotion strategies to prevent gestational diabetes in First Nations and other vulnerable populations.

Hypertensive Disorders and Pre-eclampsia

The risk of pregnancy-induced hypertension and pre-eclampsia is also greater in women who enter pregnancy obese. The risk of gestational hypertension for first time mothers who are obese and severely obese is estimated to be 2.5 to 3.2 times greater respectively when compared to women of normal pregnancy weight.¹⁰⁷ Similarly, the risk for pre-eclampsia is 1.6 times greater for women who are obese and 3.3 times greater for women who are severely obese.¹⁰⁸ The prevalence of pre-eclampsia doubles with each 5 BMI points above normal weight.¹¹⁰

Women who are obese or severely obese are at risk for pre-eclampsia during a future pregnancy when compared to mothers with normal weights.¹⁰⁹ Weight loss or gain between pregnancies can also decrease or increase the risk respectively.¹⁰⁹

Hypertensive disorders and pre-eclampsia are associated with reduced insulin sensitivity, dysfunctional blood vessels, blood proteins that increase inflammation and the presentation of free radicals/oxidative stress.^{81,111} Women with a history of pre-eclampsia continue to exhibit higher levels of fasting insulin, blood fat and increased levels of blood clotting factors postpartum.¹¹²

Dyslipidemia

Elevated blood fats (dyslipidemia) are not uncommon in pregnancy. Insulin plays a key role in glucose metabolism, and is also instrumental in fat metabolism. As a pregnancy progresses there is a significant increase in blood fat concentrations and these increases are greater in pregnancies complicated by obesity and/or gestational diabetes mellitus.¹¹⁴ This pattern resembles a metabolic syndrome (i.e., a clustering of cardiometabolic risk factors).

Normally, insulin is able to control fat breakdown during pregnancy. As a result of increased concentrations of fat in the blood, there are higher levels of free fatty acid to support maternal needs in late pregnancy when energy requirements are greatest. For pregnant women who are obese, elevated free fatty acid levels can occur because insulin is less able to decrease fat breakdown as pregnancy progresses. This leads to obesity-related disturbances in fat cell function resulting in excess circulating free fatty acid in the blood (i.e., dyslipidemia), increased secretion of pro-inflammatory proteins and increased storage of fat. This then leads to the accumulation of fat in skeletal muscle and liver, further promoting insulin resistance.⁸¹

Fetal Monitoring and Clinical Assessment

Because of the potential for pregnancy-related complications, pregnant women who are obese are monitored frequently. This monitoring can be challenging for both the mother and her service provider. For instance the ability to visualize the baby during ultrasound can be difficult and there is a higher likelihood of difficulties in fetal surveillance as well as screening for anomalies in heavier women.¹¹⁶ Abdominal palpation for fetal growth assessment may be difficult to perform on women with obesity due to



excess fat tissue in the abdominal area.⁵⁴ Methods for measuring and monitoring fetal growth such as ultrasound, arterial Doppler and cardiotocography are difficult to read with women who are obese. Consequently, these vital tests do not always provide conclusive results. For example, poor or inaccurate ultrasound images increase physician intervention which can lead to unnecessary caesarean sections when fetal overgrowth (i.e., macrosomia) is mistakenly diagnosed.⁵⁴ In women with the highest BMIs (above the 97.5 percentile), only 63% of fetal structures are well visualized. It can be difficult to see the fetal heart, spine, kidneys, diaphragm and umbilical cord on an ultrasound in women who are overweight or obese.¹¹⁷

The Society of Obstetricians and Gynaecologists of Canada recommends that ultrasound assessment be delayed until 20 to 22 weeks in women who are overweight and obese.⁵⁴ It is also suggested that women who are overweight and obese undergo the use of a non-invasive abdominal fetal electrocardiogram to monitor fetal heart rate.¹¹⁸

4.2.2 Maternal Outcomes: Labour and Delivery

Women who are obese (BMI > 30) have significantly more pregnancy-associated disease that results in a greater number of adverse outcomes for both the mother and baby during labour and delivery.^{119,120} Around the time of delivery women who are obese are at greater risk of labour induction, anaesthetic or surgical complication, caesarean-section or instrumental delivery,¹²¹⁻¹²³ haemorrhage,¹²⁴ as well as postpartum thromboembolism (i.e., blood clot- which may be related to limited mobility).¹²⁵

Women who are stage II obese (BMI > 35) are at an elevated risk of anesthesia-related complications. They are more likely to suffer delayed recovery from general anesthesia and postoperative hypoxemia (oxygen concentration within the arterial blood that is abnormally low).^{119,126,127} In addition, the risk of caesarean delivery more than doubles for women who were obese and triples for women who were severely obese, compared with pregnant women who were a normal weight.¹²²



Women struggling with obesity during pregnancy may have longer labours. Depending on the frequency of the contraction, the range of time difference noted for duration of the first phase of labour in women who are obese seems to be between 37 minutes to 1.55 hours (length of latent phase).¹²⁸⁻¹³⁰ During the latent phase of labour contractions occur between 5–10 minutes apart with each contraction lasting between 45–60 seconds suggesting that the number of contractions experienced by a labouring woman is somewhere between 6–12 contractions per hour. However, once a woman enters the active phase of labour there is no discernible difference in duration of labour between women who are obese, very obese and not obese.¹²⁹

Many studies have identified obesity in women as a risk factor for postpartum haemorrhage, especially when undergoing induction. This may be due in part to the effect of obesity on muscle contractibility.^{128,131} Synthetic oxytocin does not work as predictably in women who are obese,^{132,133} increasing the risk of prolonged maternal-fetal exposure.

Women with obesity may also have poor outcomes when induced in part due to the reduced options for positioning and mobility during labour and delivery. Some nursing staff may not be eager to have larger labouring women freely mobile and may encourage the women to remain in bed in part to reduce their own risk for injury.^{134,135}

The use of intermittent auscultation may be more challenging with women who are obese making it harder to monitor fetal wellbeing during labour and delivery. Electronic fetal monitoring may be recommended for woman who are obese.^{54,136} Electronic fetal monitoring equipment comes with

standard sized elastic belts which must be pinned together for dealing with a larger abdominal circumference, a situation which may be frustrating and humiliating for both the woman and her caregiver. If external monitoring is not effective then internal monitoring will be necessary. Internal monitoring requires access to the fetal scalp which means that the amniotic membranes must first be ruptured. Artificial rupture of membranes is strongly associated with the increased use of synthetic oxytocin and the risk for a cascade of interventions which can affect labour and delivery options.⁵⁴

In terms of delivery, the traditional position (supine, legs elevated, knees bent and pulled or pushed back towards ears with contraction) is not the most effective¹³⁷ especially for women with large amounts of abdominal fat. Women who are obese may benefit from a more upright and or hands and knees position. For women who cannot remain comfortably on hands and knees the facility may need to bring in equipment such as Hoyer Lifts or birthing pools to facilitate delivery.

4.2.3 Maternal Outcomes: Postpartum and Long Term Maternal Health

The metabolic challenges experienced by women whose pregnancies are complicated by obesity are heightened and are strongly associated with an increased risk of diabetes and cardiovascular diseases in later life.¹¹⁵ Women who are obese are also highly susceptible to postpartum weight retention.^{57,58,139,140} This directly translates to higher rates of postpartum maternal obesity¹⁴¹ and greater increases in body weight before subsequent pregnancies.⁵⁷ This contributes to a dramatic increase in the severity of the intergenerational cycle of obesity.

Excess gestational weight gain is associated with an increased risk of exceeding gestational weight gain recommendations for subsequent pregnancies and increased and persistent postpartum weight retention. Women who exceed their gestational weight gain recommendations have greater difficulty returning to their original pre-pregnancy weight.¹⁴² However, gestational weight gain and postpartum weight retention is an issue for all women, not just those with obesity, as an increase in just 3 BMI points between two pregnancies increases the risk of pre-eclampsia, pregnancy hypertension, caesarian-section delivery, still birth and delivering a large for gestational age baby, even if a woman has a normal BMI for both pregnancies.¹⁴³

Gestational weight gain is a modifiable risk factor and health care providers are encouraged to recommend appropriate gestational weight gain rates and ranges for all women regardless of their pre-pregnancy BMI, to improve the health for both the mother and baby. Information about weight gain can be provided through prenatal classes, written materials and prenatal appointments.

Breastfeeding

The health benefits of breastfeeding are widely acknowledged. Breastfeeding is recommended for the health of the mother and the baby.

A systematic review indicates that women who are overweight or obese are less likely to initiate breastfeeding or tend to breastfeed for a shorter period of time.¹⁴⁴ There are a number of potential factors including biological, psychological, behavioral and/or cultural. Exclusive breastfeeding for six months reduces maternal gastrointestinal infection, helps the mother lose weight and delays the return of menstruation.¹⁴⁵ However, evidence for the protective effect of breastfeeding against overweight in childhood is mixed.^{146,147} In one report, children who were breastfed — however briefly — were 15 per cent less likely to become overweight in childhood compared to those children who were never breastfed.¹⁴⁸

Encouragement to breastfeed can happen through prenatal classes, written materials, prenatal appointments etc.

4.2.4 Fetal, Neonatal and Child Outcomes of Maternal Obesity

In addition to risks to the mother, maternal obesity is also associated with a variety of health risks for the fetus and infant. Mothers who are obese are at higher risk for perinatal complications including stillbirth, neonatal death, low Apgar scores, fetal distress, macrosomia (fetal overgrowth), presence of meconium, shoulder dystocia, neural tube defects such as spina bifida and congenital anomalies (cardiovascular anomalies, as well as cranial-facial anomalies including cleft palate and lip).^{88,125,149,150,151}

The severity of most pregnancy-related complications increases as the level of obesity increases. Women who are obese have roughly twice the risk of stillbirth compared to mothers with normal weights. As maternal weight increases, so does the risk of a neural tube defect.¹⁴⁹

4.2.5 Postnatal and Downstream Child health

Children born to mothers who are overweight or obese are significantly more likely to be large for gestational age (birth weight $\geq 90^{\text{th}}$ percentile), and to be considered obese as infants, preschoolers, adolescents and adults (see reviews by Adamo et al.).^{36,111} This may fuel the intergenerational cycle of obesity (see Figure 2).

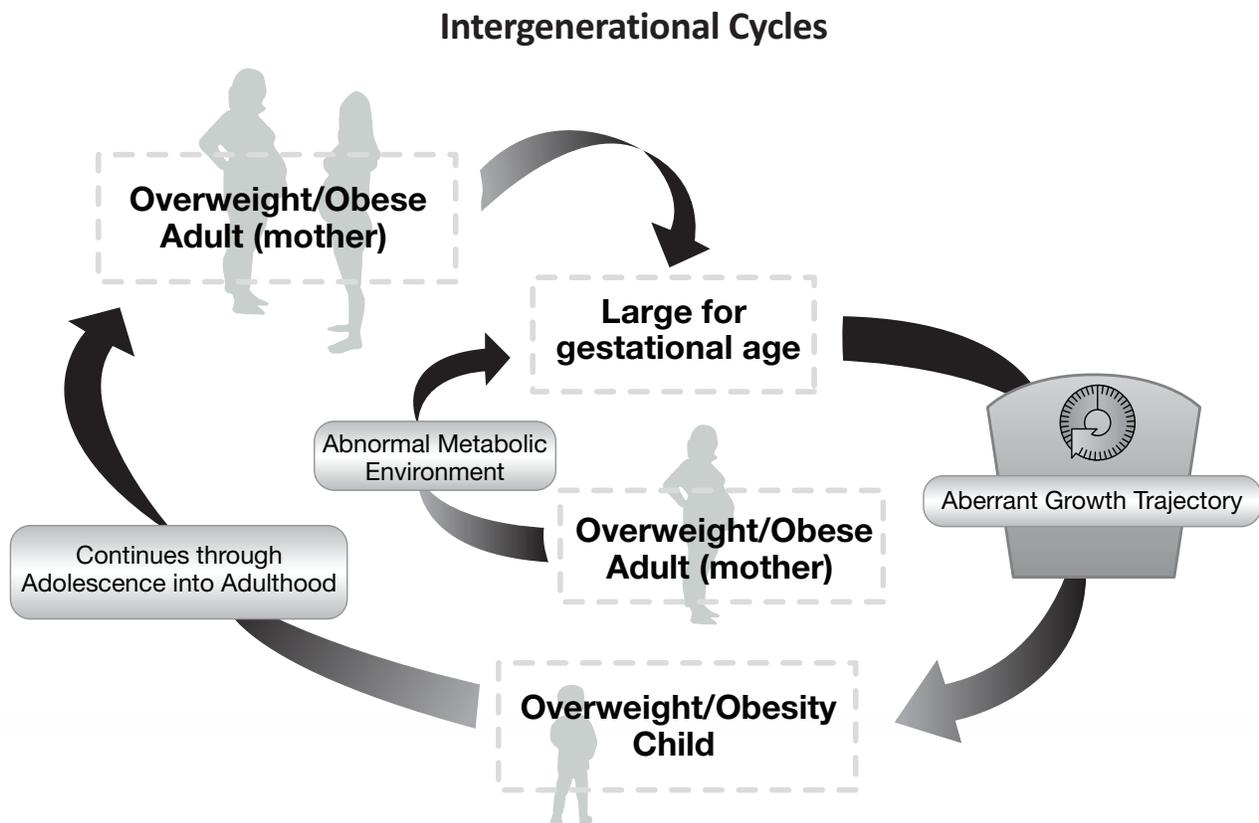


Figure 2: Intergenerational cycle of obesity. (Adapted from Adamo, Ferraro, Brett³⁶)

Birth weight is frequently used as a surrogate marker of the intrauterine environment.¹⁵³ There is an association between high birth weight (> 4,000 g) and the risk of downstream obesity. The relationship between high birth weights persists from preschool to school age to adolescence and into adulthood.¹⁵⁴

The amount of fat and muscle in a newborn (i.e., neonatal body composition) is suggested to be a more reliable marker than birth weight with respect to in utero metabolic disturbance and is strongly linked to impaired maternal glucose tolerance. Poor control of maternal blood sugar leads to dysfunctional fetal growth and babies born with increased body fat.¹⁵²

Obesity and gestational diabetes mellitus may alter the quality of fetal growth and increase susceptibility to excessive weight gain later in life leading to the early onset of childhood obesity.³⁶ For women who are overweight or obese prior to conception, an increase in gestational weight gain is related to an increase in fetal body fat.⁵⁶ Women who are obese generally have more fat stores under the skin and are more likely to accumulate fat around the internal organs during pregnancy.¹⁵⁵

Babies born to mothers who are obese may develop insulin resistance in utero.¹⁵⁶ This finding provides evidence that developing neonates are unable to process the excessive sugar load. In fact, maternal obesity prior to pregnancy is the strongest risk factor for obesity and metabolic dysfunction (early presentation of diabetes) in children.¹⁵⁷ Infants who are exposed to gestational diabetes mellitus in utero are at increased risk for obesity and future development of type 2 diabetes and metabolic syndrome.^{158,159} Children of mothers who are obese that were born large for gestational age have twice the risk of developing insulin resistance along with childhood obesity at age 11 years.¹⁶⁰

In summary, children of mothers with diabetes and/or obesity are at increased risk of metabolic disorders later in life with increased offspring size being a key indicator in this relationship. Maternal obesity is a strong risk factor for impaired downstream physiological health in offspring.¹⁶⁰ Although diabetic control during pregnancy remains vital¹⁶¹ it is important to maintain a healthy weight in all women of childbearing age.

4.3 Obesity and Gestational Weight Gain

As with maternal obesity, excess weight gain during pregnancy places both mother and child at increased risk of serious complications during pregnancy and after delivery.¹⁶⁵

Gestational weight gain recommendations are directly related to pre-pregnancy BMI. The Institute of Medicine and Health Canada suggests that the maximum weight gain for women who are obese is 9 kg. The Society of Obstetricians and Gynaecologists of Canada recommends the optimal gain for these women is 7 kg. While controlling weight gain to 7 kg or less, (including weight loss and no weight gain), has been associated with reduced rates of macrosomia, pre-eclampsia, c-section and other adverse outcomes, the safety of weight loss and maintenance during pregnancy is yet to be determined.

Average weight gain in pregnancy has increased over the last 4 decades from 10 to 15 kg. The average gestational weight gain has increased in all pre-pregnancy BMI categories.¹⁶² Overweight women are 3 times more likely to exceed the weight gain recommendations when compared to mothers with normal weights.¹⁶³ In a recent study of pregnant women in Eastern Ontario, 60%



of women exceeded the Institute of Medicine guidelines and 75% of women who were overweight or obese exceeded these guidelines.¹⁶⁴

Given that women struggling with obesity tend to exceed gestational weight gain recommendations more often than mothers with normal weights, it is important to manage gestational weight gain in women who are obese. When maternal obesity is combined with excessive gestational weight gain, heavier babies and increased risk for adverse pregnancy outcomes are more common.¹⁶⁴ Excessive gestational weight gain is associated with greater incidence of pre-eclampsia and significantly increased risk of developing gestational diabetes mellitus.¹⁶⁸⁻¹⁷¹ Additionally, excessive gestational weight gain is associated with less favourable weight trajectories for subsequent pregnancies. Women who gain in excess of what is recommended have difficulty losing weight in the postpartum period and thus enter their next pregnancy at an elevated BMI, raising the risk for both mother and baby. Overall, gestational weight gain is a modifiable risk factor that health care providers can monitor to minimize health consequences.¹⁴²

With respect to gestational weight gain and its influence on child health, women who gain equal to, or more than the recommended weight during pregnancy, increase their risk of having a child who is overweight by their preschool years.¹⁷² The odds of offspring being overweight at age 7 years have been shown to increase by 3% for every 1 kg over recommended gestational weight gain guidelines.¹⁷³ Given that both obesity and gestational weight gain are positively associated with infant birth weight,^{119,166,173} it is not surprising that the incidence of term babies born large for gestational age has increased dramatically in many countries over the last few decades.

There is also a strong relationship between gestational weight gain and future weight status in childhood and through adulthood, regardless of pre-pregnancy weight.¹⁷⁴ Mean infant birth weight is highest in women with excessive gestational weight gain, and each 1 kg increment in birth weight increases the odds of their child being overweight in adolescence by 30-50%.¹⁷⁵

Women who maintain a healthy pre-pregnancy weight generally deposit the majority of this fat centrally in the subcutaneous compartment of the trunk and upper thigh,^{155,176} however in late pregnancy there is more accumulation of visceral fat or intra-abdominal fat.¹⁷⁷ While all women increase their intra-abdominal fat stores during pregnancy, women who are obese who have more subcutaneous fat stores, tend to accumulate more intra-abdominal fat during pregnancy than lean women.¹⁵⁵ Intra-abdominal fat is more closely linked to unhealthy outcomes in pregnancy (e.g., gestational diabetes mellitus, dyslipidemia, hypertension, and pre-eclampsia)¹⁷⁸ and postpartum. Collectively, this suggests that gestational weight gain has an impact on the weight status of the mother during pregnancy, her increased risk of chronic disease, her ability to lose weight for her following pregnancy, and the neonatal size at birth as well as the child's body size later in life.

The contribution of intrauterine/environmental factors is greater in women who are overweight or obese compared to women who are normal weight.¹⁷⁹ As a result, weight issues during the earliest stages of human development, particularly in the overweight or obese population, can have lifelong impact on obesity and associated chronic disease.

A discussion about gestational weight gain would not be complete without addressing the disparity associated with socio-economic status. Women with low family incomes are more likely to exceed gestational weight gain recommendations compared to women with higher incomes.¹⁸⁰ Single mothers are particularly vulnerable to poverty.¹⁸¹ Women from ethnic minority groups in North America have been shown to gain weight excessively in pregnancy.^{78,182,183} First Nations populations are often at increased risk for reasons including, but not limited to, inadequate housing, limited economic opportunities, high food costs and limited food choices.¹⁸⁴ Many of the conditions experienced by First Nations women may predispose them to high gestational weight gain. Further research in this area is warranted.

TAKE HOME MESSAGES ABOUT MATERNAL OBESITY AND GESTATIONAL WEIGHT GAIN

- *It is important to appropriately screen all pregnant women to identify modifiable risk factors.*
- *Make recommendations that aid in gestational weight gain management, using the Institute of Medicine guidelines and improving glucose control with healthy diet and physical activity.*
- *Obstetrical complications are about 3 times greater in mothers who are obese.*
- *Insulin sensitivity decreases in all pregnant women by approximately 50% but more so in women who are overweight or obese.*
- *Those with greater visceral fat depots (i.e., fat around organs) are at greater risk of gestational diabetes mellitus.*
- *Those who develop gestational diabetes mellitus during one pregnancy are at increased risk for gestational diabetes mellitus in subsequent pregnancies and type 2 diabetes later in life.*
- *The risk of gestational hypertension or pre-eclampsia increases with increasing BMI.*
- *Weight loss or gain between pregnancies can decrease or increase the risk of chronic disease respectively.*
- *Women whose pregnancies are complicated with hypertension or pre-eclampsia have higher risk of cardiovascular disease in later life.*
- *Meeting gestational weight gain guidelines decreases the risk of labour/delivery challenges and postpartum risk of chronic disease.*

5.0 | Prenatal Behaviour Changes



5.1 What Can Service Providers Do?

Pregnancy represents a specific opportunity to influence maternal health in order to improve the health outcomes of the mother and child.¹⁸⁵ The concepts of healthy eating, physical activity and making evidence-based gestational weight gain goals (i.e., informing women of their personal gestational weight gain recommendations) are important for a broad range of health care providers. In addition, broader health promotion strategies can also support maternal health at this time, addressing issues that may be beyond a woman's personal control or choice.

When it comes to prenatal health, the most effective target may be gestational weight gain. Restrictive dieting resulting in negative energy balance is not recommended for pregnant women, however, women can follow *Eating Well with Canada's Food Guide* and the Canadian Society for Exercise Physiology/Society of Obstetricians Gynaecologists of Canada exercise guidelines for pregnancy (discussed further in section 5.3) to help maintain a gestational weight gain within upper limits for their BMI category.

5.2 Who Should Take Action?

Everyone needs to come together to address this complex problem

As individuals with excess weight are at increased risk of many chronic diseases, health care providers, including but not limited to general practitioners, midwives, nurses, dietitians, certified exercise physiologists and other medical specialists, have the opportunity to interact with women and assist them in achieving a healthy body weight or slow the rate of weight gain before pregnancy. Health care providers should be aware of the benefits of healthy eating during pregnancy as well as physical activity and reducing sedentary time. In light of the increasing rates of obesity, service providers should work together to assist women as they attempt to overcome the challenges presented to them in our modern obesogenic environment.

Providers need to be prepared

There is considerable debate about the preparedness and the competency of service providers to appropriately address or deliver counseling and supports to patients struggling with obesity. In Ontario there is a patient-provider discrepancy in information delivered by obstetric or maternal service providers and what women report having discussed.¹⁸⁶ About 40-80% of information provided by health care providers is not absorbed and up to 50% is remembered incorrectly by the patient.¹⁸⁷ Some service providers do not feel it is their responsibility to talk to their patients about weight.¹⁸⁸ This calls for consensus and a need to standardize the provision of this information (who, when and what) to the patient, ensuring that the information channel is freely open and that the patient is receiving the most evidence-based recommendations.

TAKE HOME MESSAGES ABOUT PRENATAL BEHAVIOUR CHANGES

- *All service providers have a role to play in facilitating preconception weight loss goals or coaching women to meet gestational weight gain recommendations.*
- *Discrepancies have been noted between providers and clients with regard to messages.*
- *Service providers may be aware of the weight gain guidelines but may not feel confident in addressing obesity with their clients.*
- *Slowing the rate of gestational weight gain is important when women are approaching their upper limit early in pregnancy.*

5.3 Modifiable Targets

5.3.1 Physical Activity

Promotion of physical activity has demonstrated some promise. Women can benefit from exercise both before and during pregnancy.¹⁸⁹ Routine physical activity during pregnancy in women with no contraindications to exercise (Physical Activity Readiness Medical Examination for pregnancy www.csep.ca/cmfiles/publications/parq/parmed-xpreg.pdf) or a low-risk pregnancy may reduce the risks associated with an increased body weight.¹³⁸

Regular engagement in physical activity during pregnancy:

- Does not increase risk of adverse pregnancy or neonatal outcomes in well-nourished populations,¹⁹⁰⁻¹⁹⁴ but is an important component of a healthy pregnancy (see the review by Ferraro, Gaudet and Adamo³⁷).
- Is associated with decreased incidence of gestational diabetes mellitus^{195,196} and has been shown to reduce risk of gestational diabetes mellitus in approximately 50% of women with high BMI.¹⁹⁷
- May reduce the risk of preterm delivery¹⁹⁸ and protect against pre-eclampsia.¹⁹⁵
- Is associated with a decreased antenatal and postpartum depression.^{199,200}
- Can reduce gestational weight gain.^{37,201}

General physical activity recommendations for a healthy pregnancy have been published^{193,202} including those for women who are overweight/obese.²⁰³ A review of the potential benefits of an active pregnancy and simple exercise prescriptions is available.^{37,203}

TAKE HOME MESSAGES ABOUT PHYSICAL ACTIVITY

- *Counsel all women to be screened by their healthcare provider (PARmed-X for pregnancy) before engaging in an exercise program.*
- *Be aware of and refer to local community resources that may assist with increased physical activity.*
- *Recommend that pregnant women without contraindications participate in physical activity:*
 - *Frequency: 4 days per week*
 - *Intensity: moderate-to-vigorous:*
 - *A target heart rate of 110-131 beats per minute is recommended women who are overweight or obese aged 20-29 years.*
 - *A target heart rate of 108-127 beats per minute for is recommended women who are overweight or obese aged 30-39 years).*²⁰³
 - *The talk test may also confirm that women are not over exerting.*
 - *For previously sedentary women 3 days per week of low to moderate intensity physical activity is recommended with a gradual increase towards 30 minutes.*¹⁹³
 - *Duration: greater than 30 minutes per session.*
 - *Type: low impact aerobic activities (swimming, walking, cycling) and resistance and/or strength training). Exercise in the supine position should be avoided after 16 weeks pregnancy.*
- *Encourage women to avoid prolonged periods of sitting and to get up and walk around every 20 minutes.*

5.3.2 Nutrition

Little is known about the quality of Canadian women's diets as they prepare for pregnancy or during pregnancy. None of the pregnant women in one study met the recommendations for healthy eating for all food groups.²⁰⁶

With regard to overweight and obesity during pregnancy studies have shown:

- Women with higher pre-pregnancy BMIs tend to have poor quality diets during pregnancy compared to women whose pre-pregnancy BMIs are within the normal weight category.^{207,208}
- Women who were overweight consumed significantly more calories as their pregnancy progressed compared to women with normal weights, more fat and carbohydrates and less dietary fibre.^{207,208}
- There is 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 risk of gaining excessive weight.²⁰⁹
- Fast food consumption is positively associated with maternal weight gain rate in a dose dependent fashion.²¹⁰



One of the strongest predictors of excessive gestational weight gain is higher self-reported caloric intake. Women whose gestational weight gain exceeds the Institute of Medicine recommendations consumed, on average, 2,186 calories per day or about 300 calories more than optimal.²¹¹

The caloric intake is important and the quality of nutrition is equally relevant. The growing fetus obtains all of its nutrients from the mother through the placenta. Dietary intake has to meet the needs of mother and baby for the pregnancy to thrive.²¹² While there is an increased requirement for certain vitamins (i.e., A, C, Folate) and minerals (iron, magnesium and zinc), the adage of eating for two is no longer accepted www.hc-sc.gc.ca/fn-an/nutrition/prenatal/index-eng.php. Changes in metabolism occur during pregnancy, resulting in more efficient use and absorption of nutrients^{213,214} and thus the need for increased caloric intake is minimal, i.e. ~ 340 kcal 2nd trimester and ~ 450 in the 3rd. It must be noted that these recommendations are based on the energy needs of a normal weight woman and the actual energy requirements for pregnant women who are overweight and obese are unknown.²¹⁵

Dietary energy density (i.e., the kcal ingested per amount of food; where lettuce has a low energy density and a chocolate bar is high) is a modifiable factor that may assist pregnant women in managing their weight.²¹⁶ Compared to women consuming foods with a mean energy density of 0.71 kcal per gram, those in the highest quartile (i.e., 1.21 kcal per gram) gained more weight during pregnancy. Total energy (kcal) intake and dairy product intake have been associated with excess gestational weight gain. A vegetarian diet in the first trimester was also found to protect against excessive gestational weight gain.²¹⁷ Additionally, this study found no association between overall vegetable and fruit consumption and excess gestational weight gain suggesting that fruit and vegetables are not the prime culprits driving excess gains.

Women receiving individualized diet plans specific to their pre-pregnancy weight, activity level and gestational weight gain goals, had fewer perinatal complications and had infants with lower birth weights, a lower percentage of large for gestational age and less macrosomia,²¹⁸ demonstrating that proper nutrient intake during pregnancy has the potential to significantly affect the health of both mother and child.

Assessment of dietary patterns according to *Eating Well with Canada's Food Guide* can be a practical way to assess the overall nutrition to optimize outcomes. Where resources permit, evidence suggests that nutritional assessment and counseling can best be performed using a multidisciplinary team approach. This team may be led by a registered dietitian with specialized training in pregnancy, and include an obstetrical care provider and other health allied care professionals involved in patient care. By asking the client questions in an appropriate and culturally sensitive manner, the medical history and self-report dietary intake may help uncover habits, eating disorders, negative thoughts towards food and weight gain as well as nutrition-related disease (e.g., Crohn's, irritable bowel syndrome, etc.). Understanding this information and working with the client will aid the provider in making evidence-based recommendations that are personal and aimed to improve overall maternal-fetal health and well-being. In addition to health care provider appointments, information about healthy eating can also be provided through prenatal classes, written materials etc.



Dietary assessment through the following questions can be used to assist women who are obese in reducing their caloric intake (if identified as a concern) in a safe and healthy manner by making healthier choices and using available nutrition resources.

- *What is a typical day (i.e., what is your habitual food intake in a single day)?*
- *How many meals and snacks?*
- *Are they meeting Eating Well with Canada's Food Guide recommendations?*
- *Are they consuming a variety of foods and balanced meals?*
- *Do they have food allergies, religious restrictions or specific food or activity restrictions (i.e. vegan)?*
- *What food sources do they have access to (i.e., grocery store, fruits and vegetable store, restaurants, fast food, food bank, food supplements from prenatal support program etc.)?*
- *What are their cooking skills?*
- *Do they rely on pre-packaged foods?*
- *What is their knowledge on caloric intake, breaking the eating for two myth?*
- *What is their general nutrition knowledge and ability to make healthy food choices?*

For further information refer to:

- *My Food Guide Servings Tracker:*
www.hc-sc.gc.ca/fn-an/food-guide-aliment/track-suivi/index-eng.php
- *Eat right Ontario:* www.eatrightontario.ca/en/
- *Eating Well with Canada's Food Guide:*
www.hc-sc.gc.ca/fn-an/food-guide-aliment/index-eng.php
- *Eating Well with Canada's Food Guide – First Nations, Inuit and Metis:*
www.hc-sc.gc.ca/fn-an/food-guide-aliment/fnim-pnim/index-eng.php
- *Dietitians of Canada:* www.dietitians.ca/
- *EaTracker:* www.eatracker.ca/

During pregnancy, it is important that pregnant women follow *Eating Well with Canada's Food Guide* to meet their overall nutrient needs for both their health and the baby's. A balanced maternal diet is beneficial for before and during pregnancy. It should be high in vegetables and fruits (i.e., fibre), contain moderate protein from plant and/or animal sources and avoid energy-dense, nutrient poor food choices such as sugar sweetened beverages and foods high in saturated fats. By eating one more food guide serving, pregnant women will meet their nutrients needs for pregnancy. For more information about how following *Eating Well with Canada's Food Guide* pattern of eating supports a healthy pregnancy, see: www.hc-sc.gc.ca/fn-an/nutrition/prenatal/index-eng.php

The nutrient of greatest concern as related to obesity in pregnancy is folate. It can be difficult for pregnant women to consume enough dietary folate during pregnancy. In order to support the folate needs during pregnancy, Health Canada recommends women consumed a diet rich in dietary folate and continue to take a multivitamin containing 0.4 mg folic acid per day (as was recommended in the preconception period). Pregnant women who are obese may be at increased risk of having a baby with a neural tube defect and should consult their health care provider to determine if higher dose folic acid supplements are needed for the first



10 to 12 weeks of pregnancy. For more information on high dose folic acid supplementation, see *Health Canada's High dose folic acid supplementation – questions and answers for health professionals* at www.hc-sc.gc.ca/fn-an/nutrition/prenatal/fol-qa-qr-eng.php. For more information on good food sources of folate, see: www.dietitians.ca/Nutrition-Resources-A-Z/Factsheets/Vitamins/Food-Sources-of-Folate.aspx.

There are certain foods that should be avoided or consumed in limited quantities during pregnancy. For example fast foods and/or processed foods can be high in sodium, fat or sugar and have been associated with chronic diseases such as cardiovascular disease, obesity or diabetes.²¹²⁻²¹⁴

Make sure that foods containing artificial sweeteners are not being consumed at the expense of more nutrient-dense, energy-yielding foods needed for pregnancy:

www.hc-sc.gc.ca/hl-vs/iyh-vsv/food-aliment/sugar_sub_sucres-eng.php.

5.4 Barriers

In Canada, studies examining the implications of overweight and obesity among vulnerable and/or marginalized prenatal populations (immigrant women, First Nations, women who struggle with drug misuse, women with mental health conditions, etc.) who may experience very different social contexts and have limited access to service providers, healthy food options, social support networks, or safe areas to engage in physical activity. Even without such barriers, many women and their service providers are unaware of what constitutes healthy eating or safe and effective physical activity in pregnancy and have difficulty overcoming common barriers to participation.^{219,220} In addition many service providers may fail to recognize the benefits of being physically active during pregnancy and may be unaware of available screening tools such as the *Physical Activity Readiness Medical Exam for Pregnancy* (PARmedX)¹⁹³ and some make unfounded recommendations.^{221,222} Service providers may also be unaware of barriers to healthy choices, and the support services that may make a difference (for example prenatal nutrition supplementation services). It is helpful to be aware of a range of community services available to support women in making health changes prior to and during pregnancy, however access may be limited to additional care services (dietitian, physiotherapy, occupational health) if women live far from the facility and have no means of transport.

TAKE HOME MESSAGES ABOUT NUTRITION

- *Although gaining weight is a natural part of pregnancy it is important to advise women to gain within the recommendations. How much weight a woman should gain depends on her pre-pregnancy BMI. For women with obesity, the upper limit of gain according to the Institute of Medicine is 9 kg but the Society of Obstetricians and Gynaecologists of Canada recommends an optimal gain of 7 kg.*
- *Assist women who are obese in developing an eating plan that follows **Eating Well with Canada's Food Guide** and is relative to their pre-pregnancy BMI and gestational weight gain target (see www.hc-sc.gc.ca/fn-an/nutrition/prenatal/index-eng.php).*
- *Recognize that the additional 340 kcal and 450 kcal requirements for pregnant women are based on needs of a normal weight woman.*
- *Counsel pregnant women to take a multivitamin containing 0.4 mg of folic acid every day. Women who are obese may benefit from additional folic acid.*

6.0 | What has Worked? Evidence from Systematic Review and Interventions

There have been twelve relevant systematic or meta-analytic reviews²²³⁻²³⁴ and one comprehensive review²³⁵ addressing the issue of weight-management interventions during pregnancy or the postpartum period.

For women in intervention groups, weight-related outcomes tended to be more favourable and showed an improving trend indicating that interventions can help pregnant and postpartum women manage their weight. However the conclusions put forth by the various reviews are inconsistent.

The common thread that can be pulled from these reviews is that knowledge gaps remain regarding the benefits and potential harms associated with nutrition and physical activity interventions for pregnant women who are overweight and obese. Collectively there is a consensus, recently echoed in the revised Institute of Medicine Weight Gain During Pregnancy guidelines,⁵³ that further evaluation through randomized trials is required to demonstrate their efficacy with the hope that effective implementation will help offset the many poor health outcomes associated with maternal obesity and childhood obesity.^{224,236,237}

What can be done to help manage weight gain during pregnancy?

- Nutrition and physical activity interventions during pregnancy improve maternal and pregnancy outcomes.
- Addressing barriers to health during pregnancy is key – for example women may not be eating well because they cannot afford or are unaware of what constitutes healthy food, or may not know how to prepare healthy food.

The following table is a summary of pregnancy intervention programs that have shown improvements in Gestational Weight Gain & Postpartum Weight Retention.

Author	Population	Intervention	Main Outcome	Findings: Maternal Outcome	Findings: Neonatal Outcome
Randomized control trials					
Bechtel-Blackwell 2002 ²³⁸	African-American women USA Age 13–18 years	Nutrition Patient education Group sessions Repeated nutritional assessment	Reduction in gestational weight gain and postpartum weight retention at 6 weeks	1st trimester; less gestational weight gain 2nd trimester; no difference 3rd trimester; higher gestational weight gain Higher postpartum weight retention in control group at 6 weeks Intervention had less postpartum weight retention	

Author	Population	Intervention	Main Outcome	Findings: Maternal Outcome	Findings: Neonatal Outcome
Randomized control trials					
Prevedel 2003 ²³⁹	Low-risk First time mothers Brazil	Hydrotherapy throughout gestation	Maternal body composition and cardiovascular capacity Perinatal weight and prematurity	Intervention group maintained their fat index and VO2 max Control group increased their fat and saw a reduction in VO2 max Intervention group had improved fat metabolism	No difference in prematurity or weight loss in newborns
Wolff 2008 ²⁴⁰	Caucasian, non smoking Denmark BMI > 30 Age > 18 years	Nutrition Individual dietary consultations on 10 separate occasions during pregnancy Healthful diet instruction and restriction of energy intake	Reduction in pregnancy induced increases in insulin, leptin and glucose	Significantly less total gestational weight gain in the intervention group, lower energy intake, improved insulin & leptin (appetite control) Intervention less postpartum weight retention Less gestational weight gain & less postpartum weight retention in intervention group	
Asbee 2009 ²⁴¹	USA BMI < 40.5 Age 18–49 years	Nutrition & Exercise One consultation with dietitian in early pregnancy Information about Institute of Medicine Recommendations and weight grid provided Moderate exercise recommended 3-5 times per week If not following guidelines – diet & exercise regime reviewed and modified	Reduced proportion of women who exceeded gestational weight gain recommendations	Intervention reduced gestational weight gain No significant differ- ence in adherence to Institute of Medicine gestational weight gain recommendations No difference in preeclampsia, gestational diabetes mellitus Intervention had less gestational weight gain	Trend for lower c-section rate in intervention Higher c-section rate in control due to failure to progress

Author	Population	Intervention	Main Outcome	Findings: Maternal Outcome	Findings: Neonatal Outcome
Randomized control trials					
Jeffries 2009 ²⁴²	Australia	Women were given optimal gestational weight gain range and asked to self-monitor weight at various time points over course of pregnancy	Reduction in excessive gestational weight gain	Reduced gestational weight gain in women who were overweight No difference in adherence to 1990 gestational weight gain guidelines Less gestational weight gain in intervention	No difference in gestational age, birth weight, complications or APGAR score
Thornton 2009 ²⁴³	BMI > 30 USA	Nutrition Balanced dietary program with energy restriction and food diary monitoring	Reduction in negative perinatal outcomes	Reduced gestational weight gain Reduced gestational hypertension Less 6-week postpartum weight retention Less gestational weight gain & postpartum weight retention in intervention	No difference in birth weight, macrosomia, c-section, APGAR score
Landon 200 ²⁴⁴	Mild gestational diabetes mellitus USA	Nutrition Formal nutrition counseling and diet therapy, as per the American Diabetes Association's recommendations and interventions for diabetes Self-monitoring of blood glucose, and insulin therapy (if necessary)	Composite of stillbirth or perinatal death and neonatal complications, including hyperbilirubinemia, hypoglycemia, hyperinsulinemia, and birth trauma	Fewer cesarean deliveries in the treatment group Lower frequency of pre-eclampsia and gestational hypertension in the treatment group BMI at delivery and gestational weight gain was lower in the treatment group Better weight outcomes in intervention	No significant difference between the groups in the frequency of composite primary perinatal outcome Mean birth weight, neonatal fat mass and frequency of large for gestational age and macrosomia was significantly reduced in the treatment group
Korpi-Hyovalti 2011 ²⁴⁵	Women at Risk of gestational diabetes mellitus	Nutrition & Exercise Diet Exercise: moderate intensity physical activity was encouraged during pregnancy and 6 appointments with a physiotherapist to encourage physical activity	Improved maternal glucose tolerance, decreased incidence of gestational diabetes mellitus and perinatal complications	No differences in change in glucose tolerance from baseline to weeks 26-28 of gestation Trend towards less gestational weight gain in the intervention Trend towards better weight outcomes in intervention	Mean birth weight was higher in the intervention group, but not difference in macrosomia No differences in neonatal outcomes

Author	Population	Intervention	Main Outcome	Findings: Maternal Outcome	Findings: Neonatal Outcome
Randomized control trials					
Hui 2011 ²⁴⁶	Nondiabetic, urban-living Canada <26 weeks gestation	<p>Nutrition & Exercise</p> <p>Provided with community-based group exercise sessions, instructed home exercise (total of 3-5 times per week) and 2 dietary counseling sessions (upon enrolment and 2 months in)</p>	Reduce prevalence of excessive gestational weight gain, levels of physical activity and dietary intake	<p>After 2 months the intervention group reported lower daily intake of calories, fat, saturated fat, cholesterol and higher physical activity compared with control</p> <p>Lifestyle intervention reduced excessive gestational weight gain</p> <p>Intervention was successful in reducing excessive gestational weight gain</p>	
Phelan 2011 ²⁴⁷	Normal weight or overweight/obese USA	<p>Nutrition & Exercise</p> <p>One face-to-face visit, weekly mailed education materials promoting appropriate gestational weight gain, healthy eating and exercise</p> <p>After each clinic visit individual gestational weight gain graphs were provided and 3, 10-15 min telephone calls from dietitian</p> <p>Additional calls were placed to those not on track with gestational weight gain guidelines</p>	Reduce prevalence of excessive gestational weight gain and postpartum weight retention	<p>Reduced number of normal weight women exceeded gestational weight gain guidelines</p> <p>Increased number of normal weight and women who were overweight/obese who return to the pre-pregnancy weight</p> <p>Intervention successful in reducing gestational weight gain and return to pre-pregnancy weight</p>	

Author	Population	Intervention	Main Outcome	Findings: Maternal Outcome	Findings: Neonatal Outcome
Randomized control trials					
Quinlivan 2011 ²⁴⁸	Melbourne, Australia BMI > 25	Continuity of care by a single maternity care provider Assessing weight gain at each antenatal visit Brief intervention (5 min) by a food tech before each visit Assess by clinical psychologist, if difficulties identified, an individualized solution-focused treatment plan was implemented	Reduced prevalence of combined diagnoses of decreased gestational glucose tolerance and gestational diabetes mellitus	Intervention was associated with a significant reduction in incidence of gestational diabetes mellitus Intervention associated with reduced gestational weight gain Intervention successful in reducing gestational weight gain and lowered risk of gestational diabetes mellitus	No difference in birth weight
Nascimento 2011 ²⁴⁹	82 pregnant women ≥18 yrs BMI ≥ 26 Gest age: 14-24 weeks	Exercise Weekly exercise class under supervision and received home exercise counseling performed 5 times per week	Reduction of gestational weight gain and proportion exceeding the gestational weight gain guidelines	No difference in absolute gestational weight gain or numbers exceeding guidelines (47 vs. 57%) No difference in Quality of Life The overweight women in the intervention gained less weight Intervention successful in reducing gestational weight gain	
Haakstad 2011 ^{250,251}	Sedentary, nulliparous Norway n (I) = 52 n (C) = 53	The exercise program consisted of supervised aerobic dance and strength training for 60 minutes, twice per week for a minimum of 12 weeks, with an additional 30 minutes of self-imposed physical activity on the non-supervised week-days All aerobic activities were performed at moderate intensity measured by ratings of perceived exertion at 12-14 (somewhat hard) on the 6-20 Borg's rating scale	Birth weight, gestational age at delivery and Apgar-score	More women in the intervention met gestational weight gain guidelines Intervention participants who attended 24 exercise sessions differed from controls with regard to weight gain during pregnancy and postpartum weight retention More intervention women met gestational weight gain guidelines	Intervention was not associated with reduction in birth weight, preterm birth rate or neonatal well-being

Author	Population	Intervention	Main Outcome	Findings: Maternal Outcome	Findings: Neonatal Outcome
Randomized control trials					
Olson 2004 ²⁵²	BMI 19.8–29.0 USA Age > 18 years	Nutrition & Exercise Education of healthcare providers Personalized gestational weight gain grid Participant education about physical activity by mail Dietary health checkbook and self-monitoring tips and newsletters	Prevention of excessive gestational weight gain	No overall less gestational weight gain Improved gestational weight gain and adherence to guidelines in low-income subgroup Less postpartum weight retention in low income overweight subgroup Important intervention that was successful in marginalized groups	No difference in infant birth weight
Claesson 2008 ²⁵³	BMI > 30 Sweden	Nutrition & Exercise Cognitive Behavioural Therapy patient education and motivational interview Frequent individual sessions Weekly aqua aerobic exercise and information about nutrition during pregnancy	Reduce gestational weight gain to < 7kg	Less gestational weight gain in the intervention group Better adherence to gestational weight gain guidelines No difference in pregnancy outcomes Less gestational weight gain in intervention group	No difference in mode of delivery
Shirazian 2010 ²⁵⁴	BMI > 30 USA	Nutrition & Exercise Written material, seminars, and counseling sessions encouraging walking (self monitor via pedometer), and healthful eating (food diary, calorie counting)	Reduce gestational weight gain	Significantly less gestational weight gain in intervention group Less gestational weight gain in the intervention group	No difference in birth weight, gestational age at delivery, preeclampsia, gestational hypertension, gestational diabetes mellitus, c-section, fetal complications and labour complications

Author	Population	Intervention	Main Outcome	Findings: Maternal Outcome	Findings: Neonatal Outcome
Randomized control trials					
Mottola 2010 ²⁵⁵	BMI > 25 Canada	Nutrition & Exercise Individualized nutrition plan and walking program 3-4 times per week	Prevented excessive gestational weight gain, birth weight and postpartum weight retention	80% of intervention women meet gestational weight gain recommendations (whether different from control is not reported) 53% of NELIP women were within 2 kg of pre-pregnancy weight at 2 months postpartum (whether different from control is not reported) Intervention did better with regard to meeting gestational weight gain	No difference in birth weight
Lindholm 2010 ²⁵⁶	BMI > 30	Nutrition & Exercise Meeting with midwife bi-weekly Two support group sessions One dietary consultation Food diaries & physical activity diaries Aqua fitness class 1 time per week and encouraged to exercise for 30 minutes on the other days	To limit gestational weight gain to < 6 kg	56% met the goal of < 6 kg Intervention showed signs of improvement	All appropriate for gestational age babies
Artal 2007 ²⁵⁷	Women who are obese with gestational diabetes mellitus USA	Nutrition & Exercise All patients were provided a eucaloric or hypocaloric consistent carbohydrate meal plan and instructed in self-monitoring blood glucose Exercise and diet group prescribed an exercise routine equal to 60% symptom-limited VO2max (1 time per week supervised in the lab and 6 days per week independently)	Improved glycemic control, pregnancy outcome and total gestational weight gain	Gestational weight gain was lower in the exercise and diet group Intervention successful at limiting gestational weight gain	No difference in gestation age No difference in complications or caesarean-section delivery Fewer macrosomic infants in mothers who restricted intake and exercised

7.0 | Conclusions

Currently, there are no clear and simple solutions for obesity.

Knowing that treatment is often unsuccessful once obesity has developed, early prevention efforts are urgently needed. There is no doubt that the seeds of the current obesity crisis facing the adult population were planted in childhood or even earlier.

There are a number of periods in the life course during which there may be specific opportunities to influence behaviour such as critical periods of metabolic adaptation/plasticity (e.g., early life, pregnancy, and menopause). These times are linked to spontaneous change in behaviour, or periods of significant shifts in attitudes and physiology. Pregnancy is one of these periods when women are motivated to adopt healthy behaviours believing their child may benefit, as evidenced by reduced alcohol consumption and smoking.^{185,258} Past efforts to advise women on healthy weights for pregnancy (before, during, and after) have focused less on maternal obesity and more on the concerns about low birth weight delivery outcomes.

Over the long-term, children born large for gestational age and born to mothers who were obese are at increased risk of developing obesity and metabolic syndrome.^{119,160} Although preconception weight loss would be ideal in women who are overweight and obese to prevent this scenario, this

recommendation is unavailable for many women given that 30-49% of pregnancies are unplanned, with 65-75% of these unintended pregnancies being mistimed and 25-35% being unwanted.³⁸

Knowing that high pre-pregnancy BMI is a primary determinant of gestational weight gain,¹⁰⁷ and having an obese parent is one of the most significant predictors of childhood obesity,^{259,260} the World Health Organization,²⁶¹ Obesity Canada,⁴⁴ the U.S. Institute of Medicine²⁶² and the U.K. government^{263,264} have all identified childhood obesity prevention as a priority and have acknowledged maternal obesity and pregnancy as primary targets for prevention of downstream childhood obesity. The prenatal period is a crucial time of growth, development and physiological change in mother and child. This provides a window of opportunity for intervention via maternal nutrition and physical activity that can benefit the mother and baby. A healthy, active pregnancy may contribute to minimizing the intergenerational cycle of obesity.



8.0 | Summary of Key Informant Themes

With regard to the key informant interviews there was a consistent message that maternal obesity is a problem without an easy solution and that in general a multi-faceted, interdisciplinary approach is likely necessary to help these women. However, comprehensive approaches that focus on prenatal or antenatal care are not currently in place.

Overall, it was identified that:

- There is a lack of resources and allied care providers to deal with such a prevalent health issue, resulting in many underserved patients.
- The use of a dietitian and social worker shows promise when a patient is able to access these services.
- Society of Obstetricians and Gynaecologists of Canada clinical practice guidelines as well as additional training on obesity management through the Canadian Obesity Network have been viewed as helpful to understand obesity and help implement healthy behaviours.



9.0 | Grey Literature Sources

This is not an exhaustive list.

Alberta Centre for Active Living

Resources on healthy living including one entitled *Exercise and Pregnancy – Guide for Health Professionals*
www.centre4activeliving.ca/resources/index.html

Association of Ontario Midwives

2009 Breastfeeding Strategy, www.aom.on.ca/Communications/Position_Statements/No_1.aspx

Atlantic-Prairie Women’s Health Centre

Overweight and Obesity in Pregnancy: A Review of Evidence www.pwhce.ca/pdf/overweightObesityPregnancy.pdf

Best Start Resource Centre

Nov. 16, 2012 Maternal, Neonatal, Child Health Promotion (MNCHP) Bulletin Special Topic Bulletin: Overweight and Obesity in Pregnancy

www.beststart.org/services/bulletins/Special_bulletins/Overweight_and_obesity_in_pregnancy_Nov_16.pdf

Healthy Eating for a Healthy Baby (Revised 2012). Prenatal nutrition information booklet based on Eating Well with Canada’s Food Guide. The booklet is available in English, French, Arabic, Filipino, Hindi, Punjabi, Spanish, Chinese, Tamil and Urdu. www.beststart.org/resources/nutrition/index.html

British Columbia Provincial Health Authority: Perinatal Health Program

Identification of Maternal and Perinatal Implications and Primary Maternity Care Providers’ Opportunities for Interventions to Improve Health Outcomes

www.healthypregnancybc.ca/sites/healthyweight/files/maternal_weight_FINAL_mar5_09.pdf

Canadian Academy of Sports Medicine

Exercise and Pregnancy Position Statement

www.sirc.ca/newsletters/may08/documents/PregnancyPositionPaper.pdf

Canadian Obesity Network (CON)

The Canadian Obesity Network is Canada’s largest professional obesity association for: Health professionals, Researchers, Policy makers, Obesity stakeholders. www.obesitynetwork.ca/join

CON 5 A’s of obesity management

The 5As of Obesity Management is a set of practical tools to guide primary care practitioners in obesity counseling and management www.obesitynetwork.ca/5As

Child Health Network – GTA

Nidday Perinatal Fifth Annual Report 2008

<http://bornontario.ca/en/data/data-dictionary/legacy-datasets/>

City of Hamilton

Active Pregnancy, Preconception Checklist

www.hamilton.ca/NR/rdonlyres/7416ECEC-9E47-4F67-B478-6685694A5642/0/PreconceptionChecklist.pdf

Clinical Practices for Nurses in Primary Care

Ch 12 Obstetrics & Ch 13 Women’s Health and Gynaecology

www.hc-sc.gc.ca/fnihah-spnia/services/nurs-infir/clin/adult/index-eng.php

College Physicians and Surgeons

Culturally Safe Curriculum

www.ipac-amic.org/wp-content/uploads/2011/10/21118_RCPSC_CoreCurriculum_Binder.pdf

Ontario’s Healthy Kids Panel

No Time to Wait: The Healthy Kids Strategy (2013)

The expert panel was tasked to provide advice on strategies to address Government of Ontario’s goal to reduce childhood obesity by 20% over five years.

www.health.gov.on.ca/en/common/ministry/publications/reports/healthy_kids/healthy_kids.pdf

Public Health Ontario

Addressing Obesity in Children and Youth (2013)

Outlining: trends in risk factors and strategies to measure and monitor obesity rates and risk factors; the effectiveness and cost-effectiveness of interventions to prevent and treat overweight and obesity; healthy weight promotion and obesity prevention programs and initiatives implemented by Ontario public health units and other jurisdictions.

www.publichealthontario.ca/en/BrowseByTopic/HealthPromotion/Pages/Addressing-Obesity-in-Children-and-Youth.aspx

ECHO

Smoking Cessation for Pregnant Women www.ontla.on.ca/library/repository/mon/25006/310458.pdf

Encyclopedia on Early Childhood Development – Obesity Synthesis 2012

Summary about the effects of excess weight in child growth and development and an overview of the various determinants of obesity and its complications.

www.child-encyclopedia.com/en-ca/child-obesity/how-important-is-it.html

Public Health Agency of Canada

10 Great Reasons to Breastfeed your Baby

www.phac-aspc.gc.ca/hp-ps/dca-dea/stages-etapes/childhood-enfance_0-2/nutrition/reasons-raisons-eng.php

A Sensible Guide to a Healthy Pregnancy

www.phac-aspc.gc.ca/hp-gs/guide-eng.php

Health Canada

Eating Safely During your Pregnancy

www.health.gov.on.ca/en/public/programs/publichealth/foodsafety/docs/fs_eat_pregnancy_20120321.pdf

Prenatal Nutrition Guidelines for Health Professionals

www.hc-sc.gc.ca/fn-an/pubs/nutrition/guide-prenatal-eng.php

Food safety for pregnant women

www.healthycanadians.gc.ca/eating-nutrition/safety-salubrite/pregnant-enceintes-eng.php

Statistics Canada

Weight Gain during Pregnancy – Adherence to Health Canada’s Guidelines

www.statcan.gc.ca/pub/82-003-x/2010002/article/11145-eng.pdf

Institute of Medicine (IOM) Report 2009 – Weight Gain During Pregnancy: Re-examining the Guidelines

This report was based on a systematic review

www.iom.edu/Reports/2009/Weight-Gain-During-Pregnancy-Reexamining-the-Guidelines.aspx

See Chapter 4 for information concerning the determinants of gestational weight gain. This chapter provides an overview of the determinants of health and developmental programming.

[www.iom.edu/~media/Files/Report Files/2009/Weight-Gain-During-Pregnancy-Reexamining-the-Guidelines/Report Brief - %20Weight Gain During Pregnancy.pdf](http://www.iom.edu/~media/Files/Report%20Files/2009/Weight-Gain-During-Pregnancy-Reexamining-the-Guidelines/Report%20Brief-%20Weight%20Gain%20During%20Pregnancy.pdf)

Kingston – KFL&A Public Health

Always Active – Activity guide during pregnancy and beyond

www.kflapublichealth.ca/Files/Resources/always_active.pdf

Ministry of Health Promotion

Healthy Eating, Physical Activity, Healthy Weights

www.mhp.gov.on.ca/en/healthy-communities/public-health/guidance-docs/HealthyEating-PhysicalActivity-HealthyWeights.pdf

Middlesex-London Health Unit

Healthy Eating Before and During Pregnancy

Move for Two – Healthy pregnancy DVD

www.healthunit.com/physical-activity-pregnancy

Midwifery Group

Managing Women with High or Low BMI

www.ontariomidwives.ca/images/uploads/guidelines/No12CPG_BMI_FINAL.pdf

Nutrition in Pregnancy

www.midwiferygroup.ca/downloads/first/Nutrition%20in%20Pregnancy.pdf

MOHLTC

Northern Fruit and Vegetable Pilot Program Evaluation

www.mhp.gov.on.ca/en/healthy-eating/NFVP-English-Final_EN.pdf

Public Health Agency of Canada

Curbing Childhood Obesity: A Federal, Provincial and Territorial Framework for Action to Promote Healthy Weights

www.phac-aspc.gc.ca/hp-ps/hl-mvs/framework-cadre/2011/overview-resume-eng.php

Saskatchewan Prevention Institute

Maternal Obesity, Excessive Pregnancy Weight Gain

[www.preventioninstitute.sk.ca/uploads/Maternal Obesity Excessive Gestational Weight Gain.pdf](http://www.preventioninstitute.sk.ca/uploads/Maternal%20Obesity%20Excessive%20Gestational%20Weight%20Gain.pdf)

Simcoe Muskoka District Health Unit

Tools that focus on health before and during pregnancy: a gestational weight gain survey report (2012), a webinar, clinical practice tools, other clinical practice guidelines related to gestational weight gain, physical activity during pregnancy clinical practice guidelines and information and resource for pregnant women.

www.simcoemuskokahealth.org/jfy/healthprofessionals/primaryhealthcare/MaternalChildHealth/PracticeGuidelines/GestationalWeightGain.aspx

Society of Obstetricians and Gynaecologists of Canada

Exercise in Pregnancy and the postpartum period

www.sogc.org/guidelines/exercise-in-pregnancy-and-the-postpartum-period/

Obesity in Pregnancy

www.sogc.org/guidelines/obesity-in-pregnancy/

Sunnybrook Health Sciences Centre

A Practical Guide to Preparing for your Baby

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The Wellesley Institute

Strategies to reduce childhood obesity in Ontario and its associated health problems by taking a health equity and social determinants of health approach. This document was prepared for the Ontario Healthy Kids Panel which is advising the provincial government on how to meet its goal of reducing childhood obesity by 20% over the next five years.

www.wellesleyinstitute.com/wp-content/uploads/2012/10/Reducing-Childhood-Obesity-in-Ontario.pdf

The Canada Prenatal Nutrition Program (CPNP)

CPNP provides support to pregnant women, and new mothers and their infants who are facing challenging life circumstances including low socio-economic status, poverty, teen pregnancy/parenthood, social or geographic isolation or recent arrival to Canada.

www.phac-aspc.gc.ca/hp-ps/dca-dea/prog-ini/cpnp-pcnp/

Atlantic Centre of Excellence for Women's Health and Prairie Women's Health Centre of Excellence

www.acewh.dal.ca/pdf/WeightExpectations_exec-sum-Nov12.pdf

Weight Expectations: Experiences and Needs of Overweight and Obese Pregnant Women and their Healthcare Providers (2012)

This resource includes information on psychological aspects, from the clients' perspective, of excessive weight gain in pregnancy. www.pwhce.ca/pdf/weightExpectations2012.pdf

National Institute for Health and Clinical Excellence (NICE)

NICE Public Health Guidance # 27 –Dietary interventions and physical activity interventions for weight management before, during and after pregnancy (2010)

www.planapregnancy.co.uk/PP2010/static/NICEweightloss.pdf

Regional Municipality of Durham – Health Department

Online Prenatal Class #1 – Healthy Lifestyles in Pregnancy

www.durham.ca/extcontent.asp?nr=/departments/health/OnlineLearning/Prenatal/Intro/Intro.htm

10.0 | References

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