

# CLINICAL PRACTICE **12** GUIDELINE



The management of women  
with a low or high  
**BODY MASS INDEX**

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Association of  
Ontario **Midwives**  
*Delivering what matters.*

# CLINICAL PRACTICE GUIDELINE NO.12

## The Management of Women with a High or Low Body Mass Index

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The views expressed in this guideline are strictly those of the Association of Ontario Midwives. No official endorsement by the Ministry of Health and Long-Term Care is intended or should be inferred.

The AOM is committed, through our statement on Gender Inclusivity and Human Rights, to reflect and include trans, genderqueer and intersex communities in all aspects of our work. In this document, there are references to sources that use gendered language to refer to populations of pregnant and birthing people. In order to accurately represent these sources, we may have maintained gendered language. We support research and knowledge translation that engages and reflects the entire childbearing population.

# The management of women with a high or low BODY MASS INDEX

## Statement of purpose

The goal is to provide an evidence-based clinical practice guideline (CPG) that is consistent with the midwifery philosophy of care. Midwives are encouraged to use this CPG as a tool in clinical decision-making.

## Objectives

The objective of this CPG is to provide a critical review of the research literature on the management of uncomplicated pregnancy in women who have a pre-pregnancy body mass index (BMI) less than 18.5 or greater than or equal to 30.

Topics of interest:

- Risk Factors
- Prevention of Poor Outcomes
- Associated Complications (Pregnancy, Intrapartum, Postpartum Maternal, Neonatal/Infant)

## Outcomes of interest

### Critical:

- Neonatal mortality
- Early onset GBS disease (sepsis/bacteremia, pneumonia, meningitis)
- Long-term sequelae of EOGBSD

### Important:

- Potential harms associated with assessment/monitoring (pain/injury, separation of neonate and parent)

## Methods

A search of the Medline database and Cochrane library from 1994-2009 was conducted using the key words: pregnancy, body mass index (BMI), weight gain, birth weight, postpartum weight, maternal health, preterm delivery, obesity, overweight. Vaginal birth after caesarean section (VBAC) was excluded and will be

This guideline reflects information consistent with the best evidence available as of the date issued and is subject to change. The information in this guideline is not intended to dictate a course of action, but inform clinical decision making. Local standards may cause practices to diverge from the suggestions within this guideline. If practice groups develop practice group protocols that depart from a guideline, it is advisable to document the rationale for the departure.

Midwives recognize that client expectations, preferences and interests are an essential component in clinical decision making. Clients may choose a course of action that may differ from the recommendations in this guideline, within the context of informed choice. When clients choose a course of action that diverges from a clinical practice guideline and/or practice group protocol this should be well documented in their charts.

addressed in the AOM's VBAC CPG (forthcoming). Additional search terms were used to provide more detail on individual topics as they related to pre-pregnancy BMI. Older studies were accessed in cases of commonly cited statistics, or significant impact on clinical practice.

### Review:

This CPG was reviewed using a modified version of the AGREE instrument (1), the Values-based Approach to CPG Development (2), as well as consensus of the CPG Subcommittee, the Insurance and Risk Management Program and the Board of Directors.

### Abbreviations

BMI	Body Mass Index (kg/m <sup>2</sup> )
GDM	Gestational Diabetes Mellitus
GWG	Gestational Weight Gain
IOM	Institute of Medicine
IUGR	Intrauterine Growth Restriction
LBW	Low Birth Weight
LGA	Large for Gestational Age
NTD	Neural Tube Defect
SGA	Small for Gestational Age
T2DM	Type 2 Diabetes Mellitus
WHO	World Health Organization

### Key to evidence statements and grading of recommendations, from the Canadian Task Force on Preventive Health Care

Evaluation of evidence criteria		Classification of recommendations criteria	
I	Evidence obtained from at least one properly randomized controlled trial	A	There is good evidence to recommend the clinical preventive action
II-1	Evidence from well-designed controlled trials without randomization	B	There is fair evidence to recommend the clinical preventive action
II-2	Evidence from well-designed cohort (prospective or retrospective) or case-control studies, preferably from more than one centre or research group	C	The existing evidence is conflicting and does not allow to make a recommendation for or against use of the clinical preventive action; however, other factors may influence decision-making
II-3	Evidence obtained from comparisons between times or places with or without the intervention. Dramatic results in uncontrolled experiments (such as the results of treatment with penicillin in the 1940s) could also be included in this category	C	The existing evidence is conflicting and does not allow to make a recommendation for or against use of the clinical preventive action; however, other factors may influence decision-making
III	Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees	D	There is fair evidence to recommend against the clinical preventive action
		E	There is good evidence to recommend against the clinical preventive action
		L	There is insufficient evidence (in quantity or quality) to make a recommendation; however, other factors may influence decision-making

Reference: (142)

## INTRODUCTION

This CPG reviews the body of research related to the antenatal, intrapartum and postpartum clinical management of women with a BMI of less than 18.5 or greater than/equal to 30 kg/m<sup>2</sup>. Available evidence on this topic is predominantly observational: primarily retrospective or prospective cohorts, chart reviews or large database analyses. Randomized controlled trials (RCTs) available were limited to nutritional or exercise-based interventions. While many of the studies reviewed lacked a high level of rigour and suffered from methodological limitations, they often demonstrated a strong association between high or low BMI and risk of pregnancy-related complications.

Most importantly, while this CPG deals with discrete categorizations, BMI is a continuous variable. Not all obese or underweight women are at equal risk for developing complications. Midwives are encouraged to use this guideline in the context of clinical judgment and midwifery values.

### Defining Body Mass Index

BMI, a measure of an individual's weight in relation to her height, is the best pre-pregnancy weight measure available.<sup>(3,4)</sup> BMI is calculated as follows:

$$\text{BMI} = \frac{\text{weight (kg)}}{\text{height (metres)}^2} \quad \text{BMI} = \frac{\text{weight (pounds)}}{\text{height (inches)}^2} \times 703$$

While BMI classification is both a common and accepted measurement, other methods used to classify underweight and obesity include waist circumference, waist-to-hip ratio or specific body weights (e.g. more than 90 kg for obesity).<sup>(5)</sup> Although a consistent definition for BMI categorization is lacking, many studies reviewed used either the 1990 Institute of Medicine (IOM) classification or the World Health Organization (WHO) classification. In their updated 2009 report on weight gain during pregnancy, the IOM adopted the WHO categorization for BMI, a popular and widely accepted categorization of BMI (Table 1).

Observational data suggests that women who gain weight within the ranges outlined in Table 2 have better pregnancy outcomes than those who do not.<sup>(3)</sup>

While BMI may be a convenient estimate of adiposity, it cannot measure it directly. BMI is unable to account for the distribution of body fat or body composition. Fat distribution is an important factor as excess body fat in the abdominal area is associated with increased health risks compared to fat distribution elsewhere. BMI classification may also result in the misclassification of specific individuals, such as those who are naturally very lean or muscular, or those belonging to a certain ethnic or racial group. Limitations of BMI categorization are summarized in Table 3.

**TABLE 1: OBESITY AND UNDERWEIGHT CLASSES AS DEFINED BY THE WORLD HEALTH ORGANIZATION (6)**

Obesity Classes	BMI	Underweight Classes	BMI
Obesity Class I	30 to 34.9	Severe thinness	< 16
Obesity Class II	35 to 39.9	Moderate thinness	16 to 16.99
Obesity Class III	≥ 40	Mild thinness	17 to 18.49

**TABLE 2: NEW RECOMMENDATIONS FOR TOTAL AND RATE OF WEIGHT GAIN DURING PREGNANCY, BY PRE-PREGNANCY BMI (3)**

Pre-pregnancy BMI	BMI (WHO)	Total Weight Gain Range (lbs)	Rate of Weight Gain* 2nd and 3rd Trimester (Mean Range in lbs/wk)
Underweight	< 18.5	28 to 40	1 (1-1.3)
Normal	18.5 to 24.9	25 to 35	1 (0.8-1)
Overweight	25.0 to 29.9	15 to 25	0.6 (0.5-0.7)
Obese (all classes)	≥30.0	11 to 20	0.5 (0.4-0.6)

\* Calculations assume a 1.1 to 4.4 lb weight gain in the first trimester (Siega-Ritz, 1994 quoted in (3))

**TABLE 3: LIMITATIONS OF BMI CATEGORIZATION**

- Not a direct measure of adiposity
- Unable to account for distribution of body fat or body composition
- May misclassify certain individuals (lean, muscular, certain ethnic/racial groups)

Although the IOM developed new weight recommendations, they were unable to develop more specific recommendations for gestational weight gain (GWG) among women with obesity classes II and III due to insufficient evidence. (3) Midwives should keep in mind the limitations of BMI categorization and weight gain recommendations when recording BMI and establishing an individualized management plan with their clients.

Obesity and underweight-related complications can be reduced or prevented through weight and lifestyle changes. Midwives can play a role in helping to curb BMI-related health complications both during and after pregnancy through clinical management, education, resource referral and nutritional counselling. Midwives are well situated to identify and contribute to behaviour change efforts and inform women about the lifelong implications of pre-pregnancy weight for them and their offspring. By helping women to develop dietary and exercise habits that promote health habits and linking women to other community health services where appropriate, midwives can help women normalize their weight on a long-term basis.

## RISK FACTORS

A woman's BMI is influenced by a wide variety of factors that differ between populations and among individuals. Table 4 outlines the risks that have been identified in the research literature. Many of the risk factors associated with high and low BMI are also associated with both biological and social determinants of health, such as income, education and food security. Midwives can support clients by familiarizing themselves with appropriate provincial and local community programs and agencies that deal directly with issues of poverty and marginalization.

### Eating Disorders

Eating disorders such as anorexia nervosa or bulimia disproportionately affect women of childbearing age compared with the general population. They can have major impacts on the overall well-being of women and their children and are associated with increased risks of mortality. (22) A 2002 survey showed that 1.5% of Canadian women 15 to 24 years had an eating disorder (23), and that approximately 3% of women will be affected by an eating disorder in their lifetime. (24) Studies have linked both high and low BMI women with eating disorders to complications in pregnancy such as high or low gestational weight gain, hyperemesis, low birth weight (LBW), caesarean section, postpartum depression and small for gestational age (SGA). (25-27) Detection of eating disorders could identify other factors such as excess gestational weight gain, binge eating and smoking, that affect birth outcomes. (26) A review of the literature focused on, and limited to, identifying and monitoring eating disorders and the most effective treatment interventions from a midwifery perspective is available (see Eating Disorders and Women's Health: An Update (21)), however, an in-depth discussion of the evidence and critical appraisal is beyond the scope of this guideline.

**TABLE 4: RISK FACTORS ASSOCIATED WITH OBESITY AND UNDERWEIGHT**

Risk factors associated with high BMI	Risk factors associated with low BMI
Ethnicity: Hispanic, African American, Aboriginal (7)	Ethnicity: Asian (8)
Low level of physical activity & poor diet (9)	Coffee drinker (10)
Less than high school education (7,9)	Less than high school education (11)
Low-income household (9,12-14)	Low-income household (15-17)
Household food insecurity (14)	Household food insecurity (17)
Increasing age (13,18)	Young age (8,10,11,15,19)
Smoker (20)	Smoker (10,15,16)
Psychological issues: e.g. anxiety, depression (17)	Psychological issues: e.g. anxiety, depression (15,17)
History of eating disorder (21)	Eating disorder or history of eating disorder (10,21)
Multiparity (13,18,20)	

### RECOMMENDATION

1. Offer referral to the most appropriate and available mental health services for women who have or are suspected of having an eating disorder. [III-C]

## PREVENTION OF POOR OUTCOMES

The information presented below is a summary of prevention or intervention strategies that reduce the risk in pregnancy due to an elevated or decreased BMI. Ultimately, midwives should discuss an individualized care plan with clients, tailored to their specific needs while accounting for individual, social and societal realities that may affect their clients' ability to achieve their goals.

Ideally, to improve both maternal and child health outcomes, women should be within a normal BMI range when they conceive and should also gain appropriately. (3) Given that midwives meet women after the point of conception, the ability to change BMI for the current pregnancy is limited. However, midwives can provide information related to the pregnancy in question as well as on long-term weight gain or loss.

### Charting Weight Gain on Antenatal Records

The IOM recommends documenting preconception BMI as well as subsequent weight gain throughout pregnancy and sharing these results with clients so that they are aware of their progress toward their weight gain goal. (3) In some cases, midwives or clients may choose not to routinely measure or document weight gain. An informed choice discussion on the benefits and risks of charting weight gain for women with BMI < 18.5 and  $\geq 30$  may be offered. The risks and benefits of charting of GWG for women in the normal BMI category are outside the scope of this guideline.

In a study where physicians were trained to chart and monitor GWG adequacy based on the IOM weight gain recommendations, results showed that low-income women receiving the intervention were less likely to gain excessive gestational weight. Women in this trial received 5 patient education newsletters by mail with action-oriented messages of how to gain adequate weight. (12) In a longitudinal birth cohort study, women who inaccurately estimated their pre-pregnancy body weight were more likely to gain excessive gestational weight, with the greatest likelihood of excessive gain among overweight/obese women who under assessed their true pre-pregnancy weight (OR 7.6, 95% CI 3.4-17.0).(28)

## RECOMMENDATION

2. Calculate and document pre-pregnancy BMI on the first antenatal record. [II-2B] If pre-pregnancy weight is unknown, document BMI at the intake visit [III-B]

### Nutrition and Physical Activity in Pregnancy

Pregnant women should be offered services for counselling and physical activity to help them achieve their GWG goals: the desired outcome being a reduction in obstetric risk and postpartum weight retention. These kinds of behavioural interventions may also improve long-term health, normalize infant birth weight and help reduce childhood obesity. (3) While studies have shown that women who gain within the IOM guidelines have better pregnancy outcomes than those who gain outside of the guidelines, there is still a lack of good evidence to guide clinical practice on how to empower women to meet their weight gain goals during pregnancy, specifically which interventions are the most effective. (3) Unfortunately, it is not clear what the format and intensity of any intervention offered to women during pregnancy to limit weight gain should be. (3,29-31)

Since midwives initiate contact with women only after pregnancy, the ability to affect pre-pregnancy BMI is limited. Midwives are able to provide advice and recommendation on GWG during pregnancy. The associations between diet, physical activity and the risk of excessive GWG are complex, and of increasing interest to researchers as rates of obesity rise. A prospective cohort study of 1388 women attempted to identify modifiable risk factors for excessive GWG through food frequency questionnaires and physical activity scales. When comparing adequate or inadequate GWG to excessive GWG based on the IOM recommendations, predictors of excessive GWG were total energy intake (OR 1.11 95%CI 1.00-1.23  $p = .02$ ), fried foods (OR 3.68 95%CI 0.96-14.13  $p = .007$ ) and dairy intake (OR 1.08 95%CI 1.00-1.17  $p = .08$ ). Predictors of adequate gain were first trimester vegetarian diet (OR 0.45 95%CI 0.27-0.76  $p = .01$ ), walking (30 min/day) (OR 0.92 95%CI 0.83-1.01  $p = .03$ ) and vigorous activity (30 min/day) (OR 0.76 95%CI 0.60-0.96  $p = .005$ ). (32) These results suggest that modifying caloric intake, limiting or avoiding fried foods and remaining active during pregnancy may reduce the risk of excessive GWG.

Reviews of current evidence suggest that in the absence of medical contraindications women who exercise

regularly should be encouraged to maintain their pre-pregnancy activity level.(33) Independent of maternal BMI, physical inactivity prior to pregnancy has been suggested as a contributing factor to fetal macrosomia. (34) Exercise in pregnancy is associated with an improvement of cardiovascular function and a reduction of excess weight gain.(29,33)

A joint CPG on exercise in pregnancy and the postpartum period developed by the Society of Obstetricians and Gynaecologists of Canada and the Canadian Society for Exercise Physiology recommends that sedentary women begin with 15 minutes of continuous exercise 3 times per week, increasing gradually to 30 minute sessions 4 times a week. Low-risk, previously active women can continue their exercise routines. (35) Research clearly outlines the risks of a sedentary lifestyle during pregnancy with the following adverse outcomes: loss of muscular and cardiovascular fitness, excessive GWG, higher risk of gestational diabetes or pregnancy-induced hypertension (PIH), development of varicose veins and deep vein thrombosis, a higher incidence of complaints for conditions such as dyspnea or low back pain, and poor psychological adjustment to the physical changes of pregnancy. (35) Table 5 summarizes the findings of the research with respect to exercise during pregnancy.

### Multi-faceted Interventions

A systematic review suggests that family support, knowledge of healthy foods, the ability to prepare separate meals when needed and ability to eat meals at home enabled healthy eating habits in pregnant women. Cravings, demands on time and nausea have been observed as barriers to healthy eating. (17) Most research describes interventions designed for weight loss in a non-

pregnant population, but the best practices identified are transferable to encourage more general healthy behaviour changes. Reviews of studies have shown greater changes in health outcomes when a multifaceted intervention is adopted, compared to just receiving dietary advice, exercising, or adopting behavioural strategies alone. Moreover, the number of contacts for the intervention can significantly increase the success of the intervention. (29) Midwives can assist women to identify barriers to healthy eating so that effective nutrition, exercise and/or behavioural intervention can be implemented. Midwives, as primary health care providers, have the opportunity to engage women in discussions about their current dietary choices, past efforts to achieve a healthy BMI, and their desire to change eating and exercise behaviours. They can also help women identify the social factors that may limit their ability to follow through with behaviour changes and the supports that are available locally to overcome these barriers.

### RECOMMENDATIONS

3. All women should be counselled about the importance of good nutrition and exercise in pregnancy. Canada's Food Guide is an example of a nutrition guideline that includes dietary advice for pregnant and breastfeeding women. [II-2-B]
4. For women with a BMI < 18.5 or ≥ 30 midwives should identify and offer referral to the most appropriate health care provider available in their community to discuss nutrition and provide dietary advice. [II-2-B]
5. Discuss the risks of excessive GWG in pregnancy for women with BMI ≥ 30. [II-2-B]

**TABLE 5: BENEFITS OF EXERCISE DURING PREGNANCY / RISKS OF BEING SEDENTARY (32,35)**

Benefits of exercise:	Risks of not exercising:
Less excessive GWG	Loss of fitness
Cardiovascular health	Weight gain
	Increased risk of: gestational diabetes, hypertensive disorders of pregnancy, varicose veins, deep vein thrombosis



# HIGH MATERNAL BMI

## Background

The worldwide prevalence of obesity has risen dramatically in the past few decades. According to the WHO, obesity “is now so common that it is replacing traditional public health concerns, including undernutrition and infectious disease, as one of the most significant contributors to ill health.” (36) In general, obesity is a public health concern and is contributing to the development of hypertensive disorders, heart disease, type 2 diabetes, thromboembolism, osteoarthritis, respiratory problems and certain cancers. (37)

As the prevalence of obesity increases so too does the prevalence of obesity among women of childbearing age. The prevalence of obesity in US women aged 12 to 44 years has more than doubled since 1976. (3) This includes a dramatic increase in severe obesity among women of reproductive age. According to the IOM, between 1979-2004, rates of class I and II obesity doubled and class III

obesity tripled in the US (3) In 2003, self-reported data from the Canadian Community Health Survey (CCHS) observed an obesity rate of 15.2% in Canada. In 2004, when the CCHS started to directly measure respondents’ height and weight, 23.1% of Canadians aged 18 or older, an estimated 5.5 million adults, were obese (BMI ≥ 30). (4) This survey also found that the percentage of 25- to 35-year-olds who were obese more than doubled, rising from 8.5% in 1978/9 to 20.5% in 2004. In Canada, Aboriginals living off-reserve had an obesity rate of 37.6%, about 1.6 times higher than the national average. (4) As obesity prevalence increases, so will the number of obese clients to whom midwives provide care.

## Associated Complications

High BMI is associated with possible complications throughout pregnancy, as listed in Table 6. Research is emerging in this area as many studies examining the effects of obesity are in progress and new information is regularly becoming available.

**TABLE 6: MATERNAL AND NEONATAL COMPLICATIONS ASSOCIATED WITH BMI ≥ 30**

<b>Pregnancy-related complications</b>	Amenorrhea/infertility (38-41) Miscarriage (38,39,41,42) Hypertensive conditions and pre-eclampsia (3,11,18,20,43-50) Gestational diabetes (3,11,13,29,43,45-47,51,51-53) Infection (41,43,54-56) Elective preterm delivery (18,43,59-65) Poor ultrasound resolution (47,63,65-67)
<b>Intrapartum-related complications</b>	Longer labour and increased induction rates (38,56,68) Caesarean section(3,11,13,20,51,52,64,69-73) Anesthetic complications (18,74,75)
<b>Postpartum complications</b>	Postpartum hemorrhage (43,45,55). Difficulty with lactation (3,41,76-80) Weight retention (3,12,59,81)
<b>Neonatal complications</b>	Large for gestational age (LGA) and macrosomia (and resulting birth trauma: shoulder dystocia; brachial plexus injury) (16,20,46,47,51,58,64) Neural tube defects and other congenital anomalies (82-87) NICU admission (41,43,56) Stillbirth or neonatal death (11,20,43,44,88,89)
<b>Long-term complications in offspring</b>	Obesity and metabolic disorders in childhood (3,71,74)

## Amenorrhea/Infertility and Miscarriage

Body weight has an impact on the ability to conceive. (38) Obesity is known to be a risk factor for infertility and reproductive dysfunction mainly due to anovulation, irregular menstrual cycles and oligomenorrhea. (39) Mild weight loss has been shown to restore ovulation and address many reproductive dysfunctions. (38) Obesity may lead to subfertility (ie requiring medical assistance to achieve pregnancy). (40,47) A retrospective study of class III obese women (BMI > 35) found a subfertility incidence of 12% compared to 2% in the control group (95% CI 3.1-16.9, p = .005). (47)

Reports on miscarriage, fertility and obesity also suggest that obese women receiving fertility treatment have higher rates of miscarriage. (39,41) However, studies examining the association between miscarriage and natural conception among obese women are contradictory. (38,42) Although a case-control study found that both early miscarriage and recurrent early miscarriages were significantly higher among obese women, (OR 1.2 and 3.5, 95% CI 1.01-1.46 and 1.03-12.01, respectively, p = .04 for both) more research is needed regarding this association. (41,42)

## Hypertensive Disorders and Pre-eclampsia

Numerous observational studies have found an increased prevalence of hypertensive conditions related to high BMI. (3,11,18,20,43-50) Pre-existing hypertension is more prevalent among obese pregnant women at the time of conception and the risk for pregnancy-induced hypertension is greater among women entering pregnancy overweight or obese. (3,43) Compared to a reference group of normal BMI, pre-eclampsia is twice as prevalent among overweight and about 3 times as prevalent among obese women. (3,64) A meta-analysis of 13 cohort studies comprising nearly 1.4 million women found that even after controlling for confounders the risk of pre-eclampsia typically doubled with each 5- to 7-kg/m<sup>2</sup> increase in pre-pregnancy BMI. (50) Not only is obesity an independent predictor of pre-eclampsia, but the severity of pre-eclampsia increases as BMI increases. (49,50)

## RECOMMENDATION

1. Obtain and document a baseline blood pressure, using the appropriate cuff size for women with BMI ≥ 30. [II-2-B]

## Gestational Diabetes

In general, obese women are at increased risk of developing type 2 diabetes mellitus (T2DM). Obese women are also more prone to having pre-existing T2DM at the time of conception. (3,11,13,29,43,45-47,51,51-53)

The incidence of gestational diabetes mellitus (GDM) is significantly higher among women who begin their pregnancy overweight or obese. In a retrospective case-control study of 1532 women, the incidence of impaired glucose tolerance/gestational diabetes was 13% among women with a BMI ≥ 35 as compared to 1% in the control group (BMI between 20 and 25). (47) In a retrospective cohort study, close to 30% of gestational diabetes cases analyzed between 1995-1999 were attributed to obesity (> 200 lbs). (52) The link between gestational diabetes and high BMI was also demonstrated in a British retrospective cohort study. Overweight and obese women were significantly more at risk of developing GDM (OR 1.68 and 3.6 respectively, 99% CI 1.53 -1.84). (43)

A prospective multicenter database study that included 16 102 women found obese women had an adjusted OR of 2.6 (95% CI 2.1-3.4) and morbidly obese patients had an adjusted OR of 4.0 (95% CI 3.1-5.2) for developing gestational diabetes compared with the control group. (64) When examining outcomes for obese women with GDM and their babies, evidence must be considered carefully as it is unclear whether increased poor outcomes are due to GDM or obesity itself.

While the association between high BMI and diabetes is clearly demonstrated, there is weak evidence to support an association between excess GWG and development of abnormal glucose metabolism. (3) A case-control study of 345 cases and 800 controls who were screened for GDM at 24 to 28 weeks' gestation found that risk of GDM increased with increasing rates of GWG. When adjusted for BMI, age, race, parity and blood pressure, weight gain more than 0.41 kg/wk or more was associated with increased risks of GDM (OR 1.74, 95%CI 1.16-2.60). This was primarily attributed to GWG in the first trimester. (90)

According to the most recent Cochrane Review of 8 studies (1418 women), the best method of testing for and treating GDM is not clear. GDM is associated with macrosomia, and the treatment of GDM has shown an increase in

induction of labour. Therefore, the actual benefit of and choice of treatment for women with GDM is not supported by substantial evidence. More research is needed on long-term outcomes of obese women with GDM. There is insufficient evidence to determine whether increased rates of GDM in obese women are a major contributor to poor fetal outcomes. More research is needed to assess long-term mother and baby outcomes. (91)

## RECOMMENDATION

2. For women with BMI  $\geq 30$ , midwives should discuss the increased risk of gestational diabetes mellitus (GDM) along with the risks and benefits of GDM screening. [II-2-A]

## Infection

In general, observational studies suggest that women who are overweight or obese are at increased risk of developing infection. (41,43,54-56) A cohort study of 5131 women found that obese women who entered a higher BMI category during pregnancy had significantly higher rates of chorioamnionitis ( $p = .003$ ) when compared with women who remained in the same category. (54) In a recent meta-analysis, the rate of infection (including wound, abdominal wound, uterine wound, combined wound, urinary tract, perineum, chest and breast) was significantly higher in obese women, with an almost 3.5-fold increase compared with women of a normal BMI (95% CI 2.74-4.06). (56)

## Thromboembolism

Some observational studies have found that obesity predisposes women to an increased risk of thrombosis. A 15-year, population-based Canadian cohort study of 142 404 singleton pregnancies found that as maternal weight increased, so too did the risk of thromboembolism. In this study, pregnant women weighing 90 to 120 kg had an OR of 2.17 (95% CI 1.30-3.63) of developing thromboembolism while women weighing more than 120 kg had an OR of 4.13 (95% CI 1.26-13.54) when compared with women weighing 55 to 75 kg. However, risk of caesarean section was also increased among moderately obese (OR 1.60, 95% CI 1.53-1.67) and severely obese women (OR 2.46, 95% CI 2.15-2.81), which may confound the risk of thromboembolism. Obese women undergoing caesarean section should be encouraged by their specialist to ambulate early post-surgery to reduce the risk of thromboembolism. (18)

Similarly in a retrospective study of 1243 women, 2.5% of obese women had thromboembolic disease compared with 0.6% of women with an ideal BMI. (58) However, in a meta-analysis, thromboembolic events were not significantly related to any specific BMI groups. (56)

## RECOMMENDATION

3. Obesity is a moderate risk factor for thromboembolism. Women with BMI  $\geq 30$  undergoing caesarean section should be encouraged to discuss options for thromboprophylaxis with their consulting obstetrician. [II-2-B]

## Ultrasound Resolution

Obesity affects the ability to detect fetal malformations through ultrasound. Maternal adiposity may result in poor resolution of the ultrasound beam. (47) A review of 11 019 pregnancies found that the rate of suboptimal visualization of fetal cardiac structures increased 49.8% and craniofacial structures increased 31% in obese women compared with normal weight women. (65) Similar results were found in a review of 1622 pregnancies and a review of 10 112 standard and 1098 targeted ultrasounds. (66,67) Suboptimal visualization was most pronounced for fetal heart, umbilical cord and spine. (67) The detection rate for abnormalities decreases in both types of ultrasounds as BMI increases. Of 10 112 standard examinations, detection rates among normal BMI, overweight, and class I, II, and III obese patients were 66%, 49%, 48%, 42% and 25%, respectively. Among 1098 targeted ultrasonography examinations, detection rates were 97%, 91%, 75%, 88% and 75% ( $p=.03$ ). (66)

## Abdominal Palpation

The use of ultrasound may occur more frequently in women who have high BMI, as clinical assessment may not be reliable. A 12-fold increase in difficulty in determining fetal lie by abdominal palpation in obese women was found when compared with non-obese women. (56) Midwives may find abdominal palpation and symphysis-fundal measurements more difficult to interpret in women with high BMI as growth charts may not be accurate for this group. (63)

## RECOMMENDATIONS

4. For second trimester ultrasounds reporting sub-optimal visualization, discuss limitations of ultrasound with client and consider offering repeat ultrasound if needed. [III-B]

5. For women in whom abdominal palpation is challenging and/or symphysis-fundal measurements unreliable, discuss risks and benefits of third trimester ultrasound and offer as necessary to address these information gaps. [II-2-B]

### Length of Labour and Induction of Labour

A study of 612 nulliparous women found those with a BMI > 29 had a slower median duration of labour from 4 to 10 cm, after controlling for other variables. (68) Women with an ideal BMI had a median duration of labour of 6.2 hours compared to 7.5 hours for overweight ( $p < .01$ ) and 7.9 hours for obese women ( $p < .001$ ). When comparisons were limited to vaginal deliveries only, the differences in length of labour between ideal BMI and overweight women were not significant, but remained so for obese women ( $p < .01$ ). (68) A large retrospective population-based study found that obese women were more likely to present with failure to progress in the first stage of labour compared to women with an ideal BMI. There was no difference in the duration of the second stage. (38) In contrast, a Canadian study found that women with a BMI > 25 have a shorter duration of labour than those with a BMI < 25. (45)

Obesity is strongly associated with induction of labour. (20,38,41,43) In a secondary analysis of the Misoprostol Vaginal Insert Trial, a double-blind RCT, researchers estimated the effect of maternal BMI on progress and outcomes of prostaglandin labour induction of 1273 women. The duration, characteristics and outcomes of labour were analyzed after stratification by BMI categories. Four hundred eighteen women in the study were either normal or overweight (BMI < 30), 644 were obese (BMI 30-39.9) and 211 were extremely obese (BMI  $\geq$  40 or higher).. Risk of caesarean section increased with BMI: women with a BMI 30 to 39.9 had an OR of 1.57 (95% CI 1.18-2.1,  $p = .002$ ), and women with a BMI  $\geq$  40 or higher had an OR of 2.12 (95% CI 1.47-3.06,  $p < .001$ ). Median time to delivery was significantly longer in women with BMI  $\geq$  40 (27 hours) and BMI 30 to 39.9 (24.9 hours) groups compared with the BMI < 30 (22.7 hours) group ( $p < .001$ ). (92) Additionally, the risk of failed induction appears to be higher among obese women but more research is needed. (54,56,68) The length of labour for women with BMI  $\geq$  30 may be slightly longer than for women with an ideal BMI.

### Caesarean Section

While an increased BMI does not seem to increase the risk of an operative vaginal delivery (3,11,13,20,51,52,64,69-

73), the IOM cites 10 observational studies that noted an increased risk of caesarean delivery among women entering pregnancy overweight or obese compared to women entering pregnancy at a lower BMI. (3) This association between high BMI and the need for caesarean section is independent of other variables such as maternal height and age, primiparity, macrosomia and maternal diabetes. Relative risk rates that do not take into account confounding variables have been reported to vary from 1.2 to 3.6. (38,70,93) A meta-analysis of 33 studies, found that the unadjusted odds ratios of a caesarean delivery for overweight, obese and severely obese women were 1.46 (95% CI 1.34-1.60), 2.05 (95% CI 1.86-2.27) and 2.89 (95% CI 2.28-3.79), respectively, compared with women with a normal BMI. (13)

A higher rate of caesarean delivery for women with an elevated BMI has important health implications. (64) Operative complications for obese and morbidly obese patients include excessive operative blood loss greater than 1000 mL, increased operative time and increased incidence of postoperative wound infection. (64,74)

### Anesthesia

Midwives should discuss options for pain management in labour as well as the risks and benefits of these options as they relate to women with high BMI. In the event that pain relief is requested or necessary for women with high BMI, information sharing related to complications prior to labour is ideal. It should be noted that though dural puncture may be higher among obese women, BMI is a poor predictor of distance to the epidural space, and standard epidural needles can generally be used. (75)

There are reports in the literature of increased difficulties with placing epidural or spinal catheters and/or with intubation among obese women. (18,74,75) The incidence of failed intubation in women who are obesity class III has been reported to be as high as 33%. Moreover, the incidence of accidental dural puncture may be as high as 4% in morbidly obese parturients, compared to 0.5 to 2.5% in non-obese women. (75)

### RECOMMENDATION

6. Midwives should consider offering an antepartum anesthesiology consultation for women planning an epidural or for those who wish to have a more detailed discussion regarding potential anesthesia complications related to BMI  $\geq$  30. [III-C]

## Bariatric surgery and pregnancy

Bariatric surgery is performed on people who are very obese. Weight loss is usually achieved with a medical device (gastric banding) or gastric bypass. The majority of bariatric surgery patients are women of childbearing age. (100) In 2007, 1313 surgeries were performed in Canada with 6783 patients on waiting lists. (101) The most popular surgeries are laparoscopic adjustable gastric band (LAGB) and Roux-en-Y gastric bypass (RYGB), which reduce the size of the stomach. Surgeries that bypass all or part of the small intestine result in food restriction and malabsorption and increase the risk of nutritional deficiencies. (102,103) Evidence on pregnancy outcomes after bariatric surgery is growing but limited, and includes case reports, case-control and cohort studies.

For pregnant women who have had gastric bypass, folate, iron and B12 malabsorption and deficiencies may occur. (104) Close monitoring of these women may be particularly important with respect to their nutritional status. (103)

GDM testing may require alternate methods, as use of the standard glucose solutions can cause rapid gastric emptying. Sugar consumption may cause cramping, diarrhea, hypotension, nausea or tachycardia. Midwives may consider measuring fasting serum glucose periodically, or to refer to a physician for a 3-day, continuous glucose sensor. These methods do not supersede traditional oral glucose screening, but might be better tolerated by women who have had bariatric surgery. (104) Women whose weight have stabilized and maintain nutritional balance throughout their pregnancies experience less morbidity and mortality than they would have experienced with obesity. Small studies have shown that compared to obesity, women who have bariatric surgery have lower risks of pre-eclampsia, LGA babies, gestational diabetes, macrosomia and hypertension disorders. (102,105) In a retrospective study of 808 women who had surgery before and after delivery, the surgery was independently associated with a reduced risk of diabetes, hypertensive disorders and fetal macrosomia. (106)

Women with bariatric surgery may be at increased risk of abdominal hernias, gallstones, changes in metabolism, including metabolism of medications, organ displacement as the uterus enlarges, and possible increased risk of intrauterine growth restriction (IUGR). (103) Women should be encouraged to breastfeed postpartum. It is important to note, however, that there are limited case reports of nutritional deficiency in the infants of women who have gastric bypass, even if the mother is asymptomatic. (107) More research is needed comparing pregnancy complications by the type of surgery. (108)

## MATERNAL POSTPARTUM CONSIDERATIONS: HIGH BMI

### Postpartum Hemorrhage

As BMI increases, so does the risk of postpartum hemorrhage (PPH). (43,45,55) An analysis of 287 213 pregnancies found that the risk of PPH rose with increasing BMI, and was about 30% more frequent for overweight women (OR 1.16, 99% CI) and about 70% more frequent for obese women (OR 1.39, 99% CI) compared with the reference group. (43)

### Lactation

Women with a BMI  $\geq 30$  are less likely to initiate breastfeeding and have been shown to have a shorter duration of breastfeeding (both exclusive and any breastfeeding) regardless of GWG. (3,41,76-80) A systematic review found that even after adjusting for confounders, the majority of published studies indicate

that obese women breastfeed for shorter durations than women with an ideal BMI. (80) The precise reason for the association between poor breastfeeding and obesity is not well understood. Suggestions include a decreased prolactin response to suckling (which would in turn reduce milk production) or a delay in lactogenesis. (41)

Midwives can play a vital role in encouraging breastfeeding by discussing the benefits of breastfeeding. Midwives should also try to explore and address the concerns of women who plan or decide not to breastfeed.

## RECOMMENDATION

7. Midwives are well suited to help women with BMI  $\geq 30$  who may experience difficulties with breastfeeding to establish good positioning, latch and milk supply. When appropriate, midwives should refer women to a lactation consultant or other specialist who can aid with the breastfeeding process. [III-B]

## Weight Retention

There is a strong association between GWG and postpartum weight retention. Compared with women with an ideal BMI, overweight and obese women are more likely to gain excessive gestational weight and keep it on after delivery. (3,12,59,81) Data gathered from 60 892 women with term pregnancies found that women who gained 16 to 19 kg had 2.3-fold higher odds and those who gained  $\geq 20$  kg had 6.2-fold higher odds of retaining  $\geq 5$  kg at 6 months postpartum than women who gained only 10 to 15 kg. (81) Postpartum weight retention may result in a woman moving into a higher BMI category than she was in before pregnancy. In turn, this higher BMI category is associated with a greater risk of pregnancy complications and adverse birth outcomes in a subsequent pregnancy. (3,94-96)

Adolescents with high BMI may also be more likely to retain more weight at one year postpartum when they exceed the IOM guidelines for GWG. A small study of 102 pregnant adolescents (age 15-21) observed that pre-pregnancy BMI and GWG were the strongest predictors of postpartum weight retention at one year. Regression models showed that each unit increase in BMI was associated with an increase of 1.23 lbs of weight retention at one year, and every pound increase in pregnancy weight gain was associated with an increase of 0.37 lbs of weight retention postpartum one year. (97)

## Postpartum Depression and Mental Health

The IOM cites 2 small studies, not controlling for pre-pregnancy BMI, that provide weak evidence regarding the connection between postpartum weight retention up to one year post delivery and self-esteem/depression. (3) However, other studies have demonstrated strong associations between BMI and depression or other psychiatric disorders. (98,99)

## INFANT NEONATAL / PERINATAL COMPLICATIONS: HIGH MATERNAL BMI

### Large for Gestational Age and Macrosomia

LGA fetuses ( $> 90$ th percentile) and fetal macrosomia ( $> 4000$  g or  $> 4500$  g) are more common in obese and morbidly obese women. (16,20,46,47,51,58,64) Macrosomia is associated with an increased risk of shoulder dystocia, birth injury and perinatal death as well as an increased risk of delivery via caesarean section.

(63) It is important to note that after adjusting for fetal macrosomia, maternal obesity is not an independent risk factor for shoulder dystocia. (18,38,99)

A review of 14 studies examining the relationship between maternal weight gain and LGA infants found that 11 studies demonstrated an association between high GWG and LGA infants. It is unclear how much of this effect can be attributed to BMI alone. (79)

In general, studies examining the impact of obesity prior to pregnancy and macrosomia have found a strong association between the two. (63,64) In a large prospective multicentre database study of 16 102 women, obese and morbidly obese women had ORs of 1.7 (95% CI 1.4-2.0,  $p < .0001$ ) and 1.9 (95% CI 1.5-2.3,  $p < .01$ ) for a fetal birth weight greater than 4000 g and ORs of 2.0 (95% CI 1.4-3.0,  $p < .0006$ ) and 2.4 (95% CI 1.5-3.8,  $p < .01$ ) for a fetal birth weight greater than 4500 g when compared to a control group of women with an ideal BMI. (64) Similarly, a large prospective cohort study found that the prevalence of LGA was almost 4 times as high among women with BMI  $> 40$  than among women of ideal BMI (OR 3.82, 95% CI 3.5-4.16). (20) For a fetal birth weight greater than 4500 g, a linear relationship has been described between increasing maternal BMI and macrosomia. (63)

## Congenital Anomalies

Congenital anomalies are one of the leading causes of stillbirth and infant mortality and can lead to preterm birth and childhood morbidity. Maternal obesity is associated with increased risk of congenital malformations, in particular neural tube defects (NTDs). (82-86) A systematic review and meta-analysis of 12 studies gave unadjusted and pooled ORs for NTDs of 1.22, 1.70 and 3.11 among overweight, obese and severely obese pregnant women, respectively, compared with pregnant women of ideal weight. (109) In women who were obese at the start of pregnancy, a 2009 meta-analysis demonstrated a significantly increased risk of NTDs (including spina bifida), cardiovascular anomaly, septal anomaly, cleft palate and cleft lip and palate, anorectal atresia, hydrocephaly and limb reduction anomaly. The risk of gastroschisis among obese mothers was significantly reduced. (87)

## Neural Tube Defects and Folic Acid Intake

Since the introduction of mandatory folic acid fortification of flour in 1997, there has been a dramatic 46% decrease

in NTDs in Canada. (110) However, there is evidence that women with BMI > 30 remain at increased risk of NTDs even after fortification. A slightly increased risk among overweight women is less consistent. The reasons for this remain unclear, but researchers have suggested several possibilities: poor absorption, lower fruit and vegetable consumption, overall increased energy intake, higher metabolic demands or a high-glycemic index diet all may be more prevalent among higher BMI women, decreasing folate absorption and therefore increasing the risk of NTDs. (41,85,111-113)

A case-control study of 604 fetuses or infants with NTDs and 1658 fetuses or infants with other major malformations showed an increased relative risk of NTDs ranging from 1.9 (95% CI 1.2-2.9) for women weighing 80 to 89 kg to 4.0 (95% CI 1.6-9.9) for women weighing 110 kg or more, compared with a reference group of women weighing between 50 and 59 kg. Even when controlling for folate intake, there was still a 3-fold higher risk of NTDs in women in the heaviest groups. In women weighing less than 70 kg, the risk of NTD was reduced by 40% with folate intake of 0.4 mg or more, but did not decrease at all in heavier women. Results suggest that inadequate folate intake is not the reason for increased risk of NTDs among the babies of obese women. (112)

A 2005 retrospective, population-based study in Ontario looking at changes in NTD risk for obese women after flour fortification found a total of 292 open NTD among 420 362 women. The adjusted OR for NTD was 1.2 (95% CI 1.1-1.3) per 10 kg rise in self-reported maternal weight at 15 to 20 weeks' gestation. When the highest and lowest deciles of maternal weight were compared, the adjusted OR was 3.3 (95% CI 1.7-6.2). Overall, the effect of maternal weight on NTD risk increased (adjusted OR 2.8, 95% CI 1.2- 6.6) after flour fortification. This study was limited, as the researchers did not know which women were taking folic acid supplements before or during pregnancy. (111)

Whether overweight and obese women require greater amounts of folic acid before conception or in early gestation remains speculative. (111,114,115) It may be more helpful to recognize obesity itself as a risk factor for NTD.

### **Summary statement: NTD and folic acid supplementation**

Women with BMI > 35 are at increased risk of having a fetus with NTD. Research concerning folic

acid supplementation for women with BMI > 35 is conflicting. Research has not shown that increased intake of folic acid in overweight and obese women results in a similar drop in NTDs as compared to ideal BMI women. Folic acid is considered safe in pregnancy for both mother and fetus. It is a water soluble vitamin and excess is excreted through urine.

The Compendium of Pharmaceuticals and Specialties states that after doses of about 2.5 to 5.0 mg, about half of a dose is excreted in urine. Folic acid supplementation may rarely cause allergic reactions including erythema, pruritus and/or urticaria. Doses of folic acid up to 5.0 mg have not been known to have adverse effects on pregnant women or their fetus. (116)

### **NICU Admission**

Research examining whether or not there is a relationship between increased NICU admission rates and maternal obesity is conflicting. The bulk of these studies do not control for confounders such as maternal diabetes. Thus, while 2 prospective studies failed to show an association between maternal obesity and NICU admission, other studies have found that babies of obese women are at increased risk of NICU admission. (41) In a large retrospective cohort analysis, babies of obese women were at higher risk of NICU admission. (43) Another study reported a statistically significant relationship between obesity and incubator requirement (OR 1.64), respiratory distress (OR 1.71) and need for resuscitation (OR 1.75). (56)

### **Increased risk of stillbirth**

Many studies examining the relationship between stillbirth and/or neonatal death and obesity have found a significant correlation. (11,20,43,44,88,89) The risk of stillbirth is almost twice as high among obese women. A 2007 meta-analysis examining the relationship between stillbirth and maternal obesity found that elevated BMI was associated with increased risk of stillbirth for both overweight and obese women (OR 1.47 and 2.07 respectively). (13) In a systematic review of evidence from 1995-2005, pre-pregnancy obesity was one of the top 3 most prevalent risk factors for unexplained stillbirth, along with socioeconomic factors and advanced maternal age. (117)

### **Long-term fetal consequences**

The impact of maternal obesity has long-term implications for the fetus. LGA and macrosomic infants are at increased risk of developing metabolic

syndromes (obesity, hypertension, insulin resistance and dyslipidaemia). (74) As an adult, children born to women who are obese or glucose impaired have a higher risk of insulin resistance and obesity. (3,71,74)

### RECOMMENDATION

8. For women with BMI  $\geq 30$ , discuss the benefits of achieving a normal BMI prior to the next conception. [II-2-B]

## MIDWIFERY-SPECIFIC CONSIDERATIONS

### Establishing IV access

Visualization and palpation of a suitable vein for IV cannulation may be more challenging in women with BMI  $\geq 30$ . This is due to thicker subcutaneous adipose tissue, which can result in smaller and more superficial veins that will often have more valves and bifurcations. (118) In the event of an emergency, midwives may find establishing an IV line in the high BMI woman difficult and may consider placing an IV during labour, particularly in the event of a planned home birth.

### Choice of birthplace

Women with BMI  $\geq 30$  with uncomplicated pregnancies should be supported regarding their choice of birthplace following a discussion of risks and benefits of place of birth.

### Summary statement – intrapartum complications associated with BMI $\geq 30$

Observational studies have found an increased prevalence of hypertensive conditions related to high BMI.

BMI  $\geq 30$  is associated with increased difficulty in determining fetal lie by abdominal palpation.

LGA fetuses and fetal macrosomia are more common in women with BMI  $\geq 30$ . Macrosomia is associated with an increased risk of shoulder dystocia, birth injury and perinatal death as well as an increased risk of delivery via caesarean section. It is important to note that after adjusting for fetal macrosomia, maternal obesity is not an independent risk factor for shoulder dystocia.

Maternal obesity is associated with increased risk of congenital malformations, in particular neural tube defects (NTDs).

## RECOMMENDATIONS

9. All women with BMI  $\geq 30$  should have an informed choice discussion of increased risks during labour. The following should be included as part of the informed choice discussion:
  - » Increased risk of fetal macrosomia [II-2-B]
  - » Increased risk of postpartum hemorrhage [II-2-B]
  - » Increased difficulty of auscultating the fetal heart [II-2-B] and the potential need for internal fetal heart rate monitoring [III-C]
  - » Increased risk of having a missed abnormality on ultrasound (NTD) [II-2-B]
  - » Increased risk of stillbirth [II-2-B]

Midwives should support the choice of birthplace for women with BMI  $\geq 30$  once increased risks have been discussed.

10. Midwives should ensure that they feel competent to successfully perform venipuncture and gain IV access in women with BMI  $\geq 30$  at home and may consider establishing IV access during labour in women choosing home birth. [III-C]

## LOW MATERNAL BMI

### Introduction

The prevalence of being underweight (BMI  $< 18.5$ ) in Canada was approximately 2% in 1996/97. (9) In 2005, Statistics Canada estimated that the prevalence of having BMI  $< 18.5$  had reached 2.5%. While many studies examine the health impacts of being overweight or obese, fewer studies have examined the health consequences of those who are underweight, with the exception of studies examining the health of individuals with eating disorders such as anorexia nervosa and bulimia. In general, depending on the BMI categorization used to define underweight, and the contributing factors that lead to being underweight (e.g. disease, malnutrition, lean body type etc.), expert opinion on the actual health consequences of having a low BMI vary. (15) In Canada, the health of underweight individuals has not been found to differ substantially from the reference group (BMI 18.5-24.9). (9) However, when malnutrition is the cause of low BMI, as is often the case in developing countries, or sometimes seen in women who are new to Canada from developing countries, maternal morbidity and mortality may result from micronutrient deficiency, infections and anaemia. (119,120)



**TABLE 7: MATERNAL AND FETAL COMPLICATIONS ASSOCIATED WITH LOW BMI****Pregnancy and Intrapartum Complications**

Amenorrhea and infertility (40,122)

Miscarriage (10,123)

Iron deficiency anaemia (12,124,125)

IUGR (45,126-128)

SGA (&lt;10%) (45)

LBW (&lt;2500g) (19,126,129,130)

Preterm birth (7,60,62,125,126,131,132)

Placental abruption (125,133)

**Neonatal and Long Term Complications**

Metabolic disorders including: insulin resistance and type 2 diabetes; hypertension; obesity; and cardiovascular disease (16,134)

**ASSOCIATED COMPLICATIONS**

Low BMI is associated with decreased rates of pre-eclampsia, gestational hypertension, induction of labour, caesarean delivery and fetal macrosomia compared to other BMI categories. (19,121) However, women with low BMIs at the point of conception have been shown to be at increased risk for the complications listed in Table 7. Different studies have used different reference points to define what constitutes being underweight. In the studies reviewed, underweight was variably defined as either a specific weight or a BMI less than 21 to 18.5.

**LOW BMI PREGNANCY****Amenorrhea and Infertility**

BMI < 18.5 may contribute to menstrual irregularities and infertility problems. (40,122) Menstrual periods often stop after a 10% to 15% decrease in normal body weight. (135) A US and Canadian-based case-control study found a modest increase in ovulatory infertility in women with a BMI < 17 (RR 1.6, 95% CI 0.7-3.9). (40) Irregular menses may make calculating an estimated due date by menstrual history alone more difficult, compared to women who have regular cycles.

**Miscarriage**

The literature relating to low BMI and risk of spontaneous abortion is unclear. In a UK population-based case-

control study, a BMI of < 18.5 was significantly linked to an increased risk of miscarriage (OR 1.72, 95% CI 1.17–2.53). (123) A prospective cohort study (2005) also found that underweight women (BMI < 18.5) were at increased risk of miscarriage compared to women with a BMI of 18 to 24.9. However this study failed to reach statistical significance.(10) Other studies have failed to show an association between low BMI and miscarriage in a relatively well-nourished population. (136,137)

**Gestational Weight Gain**

It is unclear whether women with BMI < 18.5 are at increased risk of poor outcomes if they gain outside of the IOM guidelines for GWG. Because the underweight population in North America is small, it is difficult to adequately power studies to estimate risk. A study of 5377 women from Newfoundland, 160 of who had a BMI < 18.5, found no significant differences in outcomes of low BMI women who gained more or less than the IOM recommendations for GWG. (138) Some statistical models suggest that even wider GWG ranges than are recommended by the IOM can be tolerated to avoid poor outcomes. Categorizing women by BMI only may not be enough to accurately predict risk. (139) No clear evidence was found to guide midwives on the risks of excessive or inadequate GWG for low BMI women.

## Iron Deficiency Anaemia

BMI < 18.5 has also been associated with iron deficiency anaemia (12,124,140) likely due to poor diet. In a retrospective cohort study of 437 403 births, anaemia was found to be more prevalent among women who were underweight compared to the reference group ( $p < .01$ ). One study showed that blood work taken between 28 and 32 weeks' gestation showing anaemia (defined in this study as hematocrit < 0.33) is significantly predictive of a preterm birth (unadjusted RR 1.83, 95% CI). (12) While the relationship between low BMI and iron deficiency anaemia has been clearly established, the relationship between anaemia and preterm labour has not been consistently demonstrated across studies. (124)

## Intrauterine Growth Restriction

A retrospective cohort study of 15 196 pregnancies from a perinatal database in Cleveland, Ohio reported that women with a pregravid BMI < 19.8 had an increased risk of IUGR (RR 1.67, 95% CI, 1.2 – 2.39) and delivering a LBW infant (RR 1.8, 95% CI 1.1-2.9). (126) In a hospital-based cohort study of 65 280 women from Montreal, those with a BMI < 19.8 had an OR of 1.69 (95% CI 1.55-1.85) for mild IUGR and 1.92 (95% CI 1.62-2.26) for severe IUGR. Low BMI women constituted 24.7% of the study population. Low BMI was also associated with a higher risk of preterm birth with IUGR (OR 1.51 95% CI 1.19-1.93) using logistic regression analysis. (127) A subsequent review article on the effects of socioeconomic status on IUGR identified low BMI as a risk factor that was lower in relative risk than hypertension in pregnancy or smoking, but more prevalent among all women. (128)

## Small for Gestational Age

SGA is generally defined as infants born with a birth weight < 10th percentile for their gestational age. The categorization of SGA as < 10th percentile likely captures a mix of individuals who are appropriately or inappropriately small. (3) In a study of 18 633 women from Montreal, women with BMI < 20 had a significantly higher risk of SGA (OR 1.54, 95%CI 1.37-1.72). (45)

## Low Birth Weight

Similarly, an analysis of a large Austrian database found that pre-pregnancy BMI < 18.5, irrespective of GWG, was significantly associated with having low birth weight infants (< 2500 g). (129) In a retrospective cohort in

South Carolina, women with a BMI < 19.8 had an increased risk, independent of weight gain, for delivering a moderately low birth weight infant (1,500 to 2,499 g) (OR 2.5, 95% CI). (130) While the relationship between low BMI and fetal weight has been established, this relationship is less clear with regards to GWG.

## Recommendations

- Midwives should perform a thorough menstrual history with all clients. For women who report menstrual irregularities discuss the risks and benefits of a dating ultrasound preferably prior to 14 weeks' gestation. [I-A]
- Women with BMI < 18.5 are at higher risk of IUGR, SGA and LBW. If poor fetal growth is suspected, offer third trimester ultrasound or serial growth studies as necessary to rule out IUGR. [II-2-B]

## INTRAPARTUM: LOW BMI

### Preterm Birth

Various observational studies have found a significant association between low BMI and preterm birth. (7,60,62,125,126,131,132) Women with low BMI have nearly double the risk of delivering preterm (< 37 weeks' gestation) compared to the reference group. (7) A prospective study of 7589 pregnant women in Los Angeles found a significant trend for preterm births with decreasing BMI. Underweight women had nearly double the likelihood of delivering preterm (adjusted OR 1.98, 95% CI 1.33-2.98). Inadequate GWG in the third trimester defined as < 0.34 kg/wk for underweight women also increased the risk of preterm birth (adjusted OR 1.91, 95% CI = 1.40, 2.61). (7)

In a study of 437 403 women with low or normal BMI, women with BMI < 18.5 were more likely to experience a preterm delivery, and risk increased with underweight severity ( $p < .01$ ). Women with BMI  $\leq$  15.9 with very low and very high GWG were at the greatest risk for spontaneous preterm birth, but underweight women with moderate GWG (0.23-0.68 kg/wk) had a lower risk for spontaneous preterm birth. (125)

## POSTPARTUM: LOW BMI

### Breastfeeding

Some evidence suggests that there is no significant difference between women with BMI < 19.8 and those with a normal BMI with respect to initiating or

sustaining breastfeeding. In an Italian study of 1272 women, after adjusting for education, primiparity, vaginal delivery and birth weight, no difference was found between the study range for underweight (BMI < 19.8) and normal weight women (BMI 19.8 to 26) for initiation or duration of breastfeeding (mean difference, 0.4; 95% CI -0.1- 0.9 months) or exclusive breastfeeding (0.1, 95% CI -0.1-0.3 months). However, fewer than 50% of women in the pooled sample continued breastfeeding 6 months after delivery, and only 34% practiced exclusive breastfeeding 4 months after delivery. (141) Unless malnutrition is severe, maternal undernutrition has little impact on the volume or composition of breast milk.

### Long-term outcomes

Long-term outcomes for infants who are born to mothers with a low BMI include metabolic disorders in adulthood, insulin resistance and type 2 diabetes, hypertension, obesity and cardiovascular disease. (134) According to Dietz et al, only term infants below the third percentile, as opposed to all SGA babies, have higher mortality and morbidity rates from conditions such as seizures, respiratory distress, hypoglycemia and hyperbilirubinemia. Infants below the third percentile are at increased risk for neurodevelopmental disorders that affect cognitive development and behavior, as well as increased risk for metabolic syndrome. (16)

## CONCLUSION

This clinical guideline highlights some of the increased risks that women with both elevated and decreased BMI may face. It is important to note that not all women in a particular BMI category are at equal risk. The possible consequences of labelling individuals 'high risk' before any complications actually occur need also to be taken into account. Clearly BMI, on its own, without complication, is not cause to automatically categorize women of high or low BMI as high risk. Overall, midwives can continue to inform women of potential

complications and increased risks, support women to modify nutrition and exercise behaviours where appropriate and consult when necessary.

When careful assessment of term underweight women rules out SGA, IUGR and LBW infants, there is no increased risk compared to women with an ideal BMI. Likewise, among women who are obese but who do not exhibit any of the comorbidities discussed and in whom the index of suspicion for an LGA or macrosomic infant is low, complications such as ultrasound visualization, infection, PPH, stillbirth, delayed lactation and NICU admission may not prove to be problematic. As a unique individual, each client deserves to be given an individualized care plan, which may or may not include issues related to BMI. An appropriate approach is to offer a realistic discussion of risk associated high and low BMI, their significance should they develop, and an assessment of the midwife's ability to respond to them.

## RISK MANAGEMENT

Practice groups may wish to create a written protocol specific to the practice group that documents which of the recommendations within the Clinical Practice Guideline they are adopting and how they are putting into practice those recommendations, including what would be included in an informed choice discussion with each client. Midwives are advised to document clearly that an informed choice discussion has taken place. If the practice group has a written protocol about what should be discussed with each client, that discussion should be followed. Any deviation from that discussion should also be documented in the woman's chart. If there is no protocol about what information is provided then documentation in the woman's chart should provide details of that discussion. If, based on the client's health or risk status, the midwife makes recommendations for surveillance or intervention that the client declines, the midwife should document that her recommendation was declined.

## SUMMARY OF RECOMMENDATIONS

### BMI and GWG

1. Offer referral to the most appropriate and available mental health services for women who have or are suspected of having an eating disorder. [III-C]
2. Calculate and document pre-pregnancy BMI on the first antenatal record. [II-2B] If pre-pregnancy weight is unknown, document BMI at the intake visit [III-B]
3. All women should be counselled about the importance of good nutrition and exercise in pregnancy. Canada's Food Guide is an example of a nutrition guideline that includes dietary advice for pregnant and breastfeeding women. [II-2-B]
4. For women with a BMI < 18.5 or  $\geq 30$  midwives should identify and offer referral to the most appropriate health care provider available in their community to discuss nutrition and provide dietary advice. [II-2-B]
5. Midwives should discuss the risks of excessive GWG in pregnancy for women with BMI  $\geq 30$ . [II-2-B]

### HIGH BMI

1. Obtain and document a baseline blood pressure, using the appropriate cuff size for women with BMI  $\geq 30$ . [II-2-B]
2. For women with BMI  $\geq 30$ , midwives should discuss the increased risk of gestational diabetes mellitus (GDM) along with the risks and benefits of GDM screening. [II-2-A]
3. Obesity is a moderate risk factor for thromboembolism. Women with BMI  $\geq 30$  undergoing caesarean section should be encouraged to discuss options for thromboprophylaxis with their consulting obstetrician. [II-2-B]
4. For second trimester ultrasounds reporting sub-optimal visualization, discuss limitations of ultrasound with client and consider offering repeat ultrasound if needed. [III-B]
5. For women in whom abdominal palpation is challenging and/or symphysis-fundal measurements unreliable, discuss risks and benefits of third trimester ultrasound and offer as necessary to address these information gaps. [II-2-B]
6. Midwives should consider offering an antepartum anesthesiology consultation for women planning an epidural or for those who wish to have a more detailed discussion regarding potential anesthesia complications related to BMI  $\geq 30$ . [III-C]
7. Midwives are well suited to help women with BMI  $\geq 30$  who may experience difficulties with breastfeeding to establish good positioning, latch and milk supply. When appropriate, midwives should refer women to a lactation consultant or other specialist who can aid with the breastfeeding process. [III-B]
7. For women with BMI  $\geq 30$ , discuss the benefits of achieving a normal BMI prior to the next conception. [II-2-B]
9. All women with BMI  $\geq 30$  should have an informed choice discussion of increased risks during labour. The following should be included as part of the informed choice discussion:
  - » Increased risk of fetal macrosomia [II-2-B]
  - » Increased risk of postpartum hemorrhage [II-2-B]
  - » Increased difficulty of auscultating the fetal heart [II-2-B] and the potential need for internal fetal heart rate monitoring [III-C]
  - » Increased risk of having a missed abnormality on ultrasound (NTD) [II-2-B]
  - » Increased risk of stillbirth [II-2-B]

Midwives should support the choice of birthplace for women with BMI  $\geq 30$  once increased risks have been discussed.

10. Midwives should ensure that they feel competent to successfully perform venipuncture and gain IV access in women with BMI  $\geq 30$  at home and may consider establishing IV access during labour in women choosing home birth. [III-C]

### **LOW BMI**

1. Midwives should perform a thorough menstrual history with all clients. For women who report menstrual irregularities discuss the risks and benefits of a dating ultrasound preferably prior to 14 weeks' gestation. [I-A]
2. Women with BMI  $< 18.5$  are at higher risk of IUGR, SGA and LBW. If poor fetal growth is suspected, offer third trimester ultrasound or serial growth studies as necessary to rule out IUGR. [II-2-B]

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