EVALUATING A LIFESTYLE INTERVENTION DURING PREGNANCY AIMED AT REDUCING CHILD OBESITY RISK

By

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ABSTRACT

Gestational weight gain (GWG) is a normal and expected component of a healthy pregnancy; however, gaining too much or too little weight poses significant risks to maternal and fetal health including fetal under - or overgrowth, downstream obesity, and cardio-metabolic disease. Children born to mothers who exceed the Institute of Medicine GWG recommendations are significantly more likely to have higher birth weights, classify as large for gestational age (LGA) and develop overweight/obesity in infancy, childhood, and adulthood. Furthermore, rapid increases in infant growth weight trajectory, defined by weight-for-length (WFL), as early as six months of life are also associated with obesity in childhood.

Energy expenditure and energy intake are known contributors to weight management, have been identified as predictors of excess GWG (eGWG) and are mediators of metabolic dysregulation affecting maternal-fetal health, perhaps independently of eGWG. The ACOG and the Society of Obstetricians and Gynecologists of Canada/Canadian Society for Exercise Physiology (SOGC/CSEP) currently endorse exercising for 30-minute sessions four times a week during the prenatal period. However, the guidelines are currently being reviewed to update recommendations based on more recent literature.

A two-arm, parallel group randomized controlled trial (RCT; the Maternal Obesity Management (MOM) trial), was established to mediate GWG and prevent downstream child obesity. Adult pregnant women mean age 32.6 ± 4.4 years, with pre-gravid BMI > 18.5 kg/m2, between 12 and 20 weeks gestation were randomized into one of two groups: lifestyle intervention (n = 41) who received a structured physical activity (PA) and nutrition program in addition to the MOM trial healthy pregnancy handbook, or a standard clinical care control group (n = 35). The intervention took place throughout pregnancy (~ 6 mos.), with postpartum follow-up assessments on mother and child. GWG and PA were objectively measured at three-time points in pregnancy (prior to intervention, second trimester 26-28 weeks, third trimester 36-40 weeks). Offspring WFL was directly measured at 3 and 6 mos postpartum. We hypothesized that women who participated in the lifestyle intervention including regular PA with a structured prenatal exercise class in combination with a nutrition intervention would be more likely to have offspring follow a healthy growth trajectory as measured by offspring WFL z-score between 3 to 6 months of age

We assessed and compared PA which was directly measured at three time points throughout the study (baseline, second trimester between 26-28 weeks, and third trimester between 36-40 weeks gestation) using accelerometers and supported by PA recall for activities not captured by the accelerometer. Compliance to exercise classes was recorded by the instructor. Total GWG was calculated in kilograms, by subtracting weight measured at the first prenatal visit from the last visit as part of the study or last prenatal visit, before birth, to capture the full extent of GWG throughout pregnancy. GWG was also evaluated categorically based on being under, meeting, or exceeding the IOM GWG guidelines. Offspring neonatal birth weight was measured in grams as an absolute value and was obtained from antenatal obstetrical records. Infant birth weight was also evaluated categorically as small for gestational age (SGA), average for gestational age (AGA) or large for gestational age (LGA). Infant body length was collected using a tape measure; two measurements were taken to the nearest 0.5 cm and the mean value was taken as true. The tape measure method has been validated against a measuring board which found no statistically significant difference between the two methods.

There were no significant differences in GWG between intervention group and control group (mean difference = 0.3 kg, 95% CI, -2.5 – 3.1, $p = 0.838$). There were also no significant differences in moderate to vigorous physical activity (MVPA) during the second trimester ($Z = -0.3408$, $p = 0.733$) and the third trimester of pregnancy ($Z = -0.0121$, $p = 0.9904$). However, an increase in light PA from the first study visit in early pregnancy to the second study visit at the end of the second trimester was significantly associated with decreased final GWG in the intervention group, but not in the control group ($p = 0.014$). Furthermore, a Wilcoxon Rank-Sum Test indicated that the change in weight-for-length z-score from 3 months to 6 months was significantly lower in children born to mothers in the intervention group compared to the children in the control group $Ws = 481.00$, $z = 2.67$, $p = 0.007$. Although GWG did not change, an improved early growth trajectory for offspring born to women engaged in the intervention was observed supporting that early exposures to PA, even light PA, may play a role in downstream child growth and development.

Future research should further evaluate optimal tools and counselling techniques that help women make the best possible nutrition and PA choices throughout pregnancy in the best interest of maternal and child health.

GLOSSARY OF TERMS

ACOG	American College of Obstetricians and Gynecologists
AGA	Appropriate for Gestational Age
BMI	Body Mass Index, a weight-to-height ratio calculated by the division in one's weight measured in kilograms by the square of one's height measured in meters $\mathrm{BMI} = \frac{\mathrm{mass_{kg}}}{\mathrm{height^2_m}}$
cm	Centimetre
CSEP	Canadian Society for Exercise Physiology
EGWG	Excessive Gestational Weight Gain
GDM	Gestational Diabetes Mellitus
GWG	Gestational Weight Gain is defined herein as the amount of weight gained by a pregnant woman between conception and the birth of her baby
HELLP	Hemolysis, Elevated Liver enzyme levels and a Low Platelet count
ICF	Informed Consent Form
IOM	Institute of Medicine
ITT	Intention-To-Treat
kg	Kilogram
Kg/m2	Kilogram Per Meter Squared
LGA	Large for Gestational Age, infant birth weight > 90th percentile
LPA	Light Physical Activity
Macrosomia	Infant birth weight > 4000 g
MPA	Moderate intensity Physical Activity
MVPA	Moderate to Vigorous Physical Activity is a term that encompasses both MPA and VPA in one summative measure
NW	Normal Weight, BMI = 18.5 to 24.9 kg/m^2
OW	Overweight, BMI = 25 to 29.9 kg/m^2
OB	Obese, BMI greater than 30 kg/m^2
PA	Physical Activity, the movement produced by skeletal muscles that increases heart rate and breathing and requires energy expenditure
PE	Preeclampsia
PPWR	Post-partum Weight Retention
REB	Research Ethics Board
SES	Socioeconomic Status
SGA	Small for Gestational Age
SOGC	Society of Obstetricians and Gynaecologists of Canada
UW	Underweight, BMI less than 18.5 kg/m^2
VPA	Vigorous intensity Physical Activity

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CHAPTER 1: INTRODUCTION

Obesity is a global problem, costing approximately $2-trillion worldwide and affecting 2.1 billion people (J. M. Dodd et al., 2014; Institute, 2015; Morgan, Zamora, & Hindmarsh, 2007). Despite increased awareness, the prevalence of obesity continues to escalate (Haslam & James, 2005) and is one of the most significant health issues of the 21st century (Han, Lawlor, & Kimm, 2010; Koh, 2010; Wojcicki & Heyman, 2010). Over 170 million children under the age of 18 are estimated to be overweight (OW) or obese (OB) based on a body mass index (BMI) ≥ 25.0 kg/m^2 (Lobstein, Baur, Uauy, & TaskForce, 2004), with nearly 43 million children under the age of 5 implicated in this ominous rise (de Onis & Blossner, 2000). Canada does not fare better than other developed nations, with 26% of children and youth classified as OW or OB (M Shields, 2008). Individuals with obesity can be afflicted by a multitude of health complications due to the complexity of the disease, including increased cardiovascular risk, type 2 diabetes, sleep problems, mental health challenges, psychosocial problems, and musculoskeletal conditions (Lifshitz, 2008).

In 2011, the World Health Organization (WHO) drew attention to the major causes of death in developed countries and noted that 47% of the global burden of disease and 60% of the 56 million deaths per year were related to non-communicable diseases (NCDs). The WHO declared that the "prevention of childhood obesity needs high priority" (World Health Organization, 2010) and called for a global response to develop national strategies, policies, and action plans to support this initiative. Representing Canada in this mandate, the Public Health Agency of Canada (PHAC) which aims to "promote and protect the health of Canadians" has developed a policy framework and action plan on how to best intervene and prevent obesity as part of their number one strategic objective from 2007 – 2016 (P. H. A. o. Canada, 2007, 2013). Further, PHAC aims to continue their current obesity prevention strategy well into the future with their Preventing Chronic Disease Plan for 2016 – 2019 (P. H. A. o. Canada, 2015).

Determining best practices to mitigate the early onset of obesity could save lives (Bass & Eneli, 2015) and could potentially halt the intergenerational cycle of obesity, recognizing that children as early as 24 months with higher range BMIs are more likely to be OW at age 12 (Nader et al., 2006). OW and OB children often carry their excess weight throughout life (D. S. Freedman

et al., 2005), and more than two-thirds of OB children will remain OB as adults (D.S. Freedman, Khan, Dietz, Srinivasan, & Berenson, 2001; Magarey, Daniels, Boulton, & Cockington, 2003; Must, 2003).

Epidemiological, animal model and experimental studies provide strong evidence implicating pregnancy in downstream child obesity. Such studies indicate that early life events (i.e., *in utero* and early postpartum) can affect chronic disease susceptibility later in life (D.J. Barker, 2000; D.J. Barker, Bull, Osmond, & Simmonds, 1990; Dabelea et al., 2000; Gluckman, Hanson, Cooper, & Thornburg, 2008; R. C. Huang et al., 2007; Murtaugh, Jacobs, Moran, Steinberger, & Sinaiko, 2003; Wilkin et al., 2002). This concept is commonly referred to as developmental plasticity and is the ability of an organism to respond to and develop from external environmental stimuli (e.g., toxins, hormones, nutrient stress, etc.) (Ferraro, Gruslin, & Adamo, 2012). As fetal growth is arguably the most critical phase of development experienced throughout the lifespan, pregnancy represents the ideal period for obesity prevention efforts (Gluckman & Hanson, 2008; Heerwagen, Miller, Barbour, & Friedman, 2010). In fact, enhanced prenatal care for women was identified by the 2013 *Ontario Healthy Kids Panel Report*, as the most important and economical strategy in tackling childhood obesity (Panel, 2013).

1.1. Implications of Overweight and Obesity on Maternal-Fetal Health

Given the percentage of North Americans that struggle with maintaining a healthy weight, it is not surprising that two-thirds of women of reproductive age are OW or OB (Yogev & Catalano, 2009). Epidemiological data from the U.S. indicate that between 1993 and 2003, pre-pregnancy obesity increased by 69% (S.Y. Kim, P.M. Dietz, L. England, B. Morrow, & W.M. Callaghan, 2007), with approximately 54.5% of women in this age group classified as OW, 29% OB and 6% morbidly obese (Hedley et al., 2004).

Over the last few decades, the rise in maternal bodyweight has been accompanied by a concurrent upsurge in maternal and fetal risk factors and complications. In the Confidential Enquiry into Maternal and Child Health (CEMACH) within the United Kingdom, a review of maternal deaths between 2003 – 2005 found a direct or indirect association with obesity in 52% of cases with women having a BMI > 25 and 27% of cases with women having a BMI > 30 (Lewis, 2007). The risk of dying during childbirth in North America is higher now than it was two decades

ago (World Health Organization, 2015). Maternal obesity is the leading modifiable risk factor contributing to approximately 8000 stillbirths per year (Flenady et al., 2011). In a multivariate logistic regression analysis of 1.2 million births between 2003 - 2011 in the United States (U.S.), babies born to women with a pre-pregnancy BMI $\geq$ 30 kg/m^2 were 40% more likely to die than babies born to normal weight (NW) women (Meehan, Beck, Mair-Jenkins, Leonardi-Bee, & Puleston, 2014). OB women, even those with optimized GWG had a predicted risk of infant death greater than most NW women (Bodnar et al., 2016). While maternal and neonatal death are the most severe negative outcomes associated with obesity (S. N. Hinkle, Sjaarda, Albert, Mendola, & Grantz, 2016), there is a multitude of risk factors and complications (Ferraro, Gaudet, & Adamo, 2012), both acute and downstream.

1.2 Maternal BMI and Gestational Diabetes Mellitus

There has been a significant proliferation in the rate of gestational diabetes mellitus (GDM) which now affects 1 in 20 pregnancies in the general population (Light, 2018). Insulin resistance is strongly correlated with obesity (Ferraro, Gaudet, et al., 2012), and given the relationship between insulin resistance and diabetes, it is not surprising that women with OW and OB have an increased incidence of gestational diabetes mellitus (GDM) (Kim et al., 2010). In fact, as BMI increases, the risk of developing GDM escalates. Women categorized as overweight have twice the risk of developing GDM, those women with moderate OB are three times more likely, and morbidly OB are more than five times more likely compared to NW women (Torloni et al., 2009). We know that maternal circulating glucose levels play a key role in fetal growth (Crume et al., 2015). Among women with diabetes, maternal glycemia increases infant birthweight (Evers, De Valk, Mol, Ter Braak, & Visser, 2002) and even with glycemic control, those with diabetes have an increased risk of delivering a macrosomic baby (Evers et al., 2002; Schwartz et al., 1994). In women without diabetes, as glucose levels increase within a normal range, birthweights (BW) and neonatal body fat mass (FM) also increase ("Hyperglycemia and Adverse Pregnancy Outcome (HAPO) Study: associations with neonatal anthropometrics," 2009). Furthermore, in late pregnancy, maternal glycemia (even within the normal range) is positively related to increases in baby FM accretion (B.E. Metzger et al., 2008; Sewell, Huston-Presley, Super, & Catalano, 2006; Tallarigo et al., 1986). Tyrrell *et al*. very recently published an evaluation of 30,487 women in 18 studies, looking at genetic evidence for causal relationships connecting maternal obesity-related

traits and neonatal birth weight. Specifically looking at neonatal birthweight, there were five studies involving a total of 11,822 women. Using Mendelian randomization to evaluate the relationship between a series of single nucleotide polymorphisms (SNPs) strongly associated ($p < 0.0000$) with BMI and specific obesity obesity-related traits, they found a correlation between a ~4 point higher maternal BMI and a higher neonatal birth weight of 55 g. They further found higher maternal fasting glucose concentrations of 7.2 mg/dL was correlated with higher neonatal birth weight of 114 g (Tyrrell et al., 2016).

However, glucose is only one of the many available fuel substrates impacting fetal growth. Women with obesity and normal glucose levels also have an increased risk of having a macrosomic baby. The role of lipids is also crucial, with maternal triglycerides (TG) in mid-late pregnancy associated with increased neonatal birth weight even after adjusting for pre-pregnancy BMI (Di Cianni et al., 2005; Kitajima et al., 2001; Nolan, Riley, Sheedy, Walstab, & Beischer, 1995). Crume et al. recently found that independent of pregravid BMI and GWG, maternal insulin resistance in peri-pregnancy predicted neonatal FM (Crume et al., 2015). These data on insulin resistance add to the existing knowledge in animal models that maternal insulin resistance (HOMA-IR) enhances maternal adipose tissue lipolysis, increasing free fatty acids (FFA) which would then be available to cross the placenta and increase fetal growth and perhaps adiposity (Nolan et al., 1995).

1.3. Maternal BMI association with Hypertension and Preeclampsia

The complications associated with OW/OB pregnancy also include gestational hypertension and preeclampsia (O'Brien, Ray, & Chan, 2003; Stuber et al., 2015), in some instances showing more than a six-fold higher risk for pregnancy-induced hypertension and chronic hypertension (Van Der Linden et al., 2016). Preeclampsia (PE) is one of the principal causes of maternal and fetal morbidity and mortality worldwide (Ospina-Prieto et al., 2016) and has been increasing at a steady rate in the United States, between 1987 – 2004, at 25% with gestational hypertension rising even more dramatically at 184% (Wallis, Saftlas, Hsia, & Atrash, 2008). Women with persistent hypertensive blood pressures have a 2-3 times higher risk of having a SGA neonate compared to normotensive women (Block-Abraham et al., 2016). Furthermore, a 1-SD (≈ 10 mm Hg) genetically higher maternal systolic blood pressure is correlated with a lower neonatal birth weight by 208-g (Tyrrell et al., 2016).

1.4 Effect of Maternal BMI on Neonatal and Downstream Child Outcomes

Offspring of women classified as OW/OB are often born larger and at higher risk for birth complications (Tyrrell et al., 2016). In addition, women with overweight or obesity have an increased probability of fetal overgrowth including macrosomia (> 4000 g) (Van Der Linden et al., 2016), their neonates are more likely to have higher fat mass ($p < 0.008$) and percent body fat ($p < 0.006$) with no lean mass no differences (Sewell et al., 2006), alluding to maternal BMI favourably impacting neonatal adiposity (Sewell et al., 2006; Shapiro et al., 2015; Starling et al., 2015). In a study of women with OB versus women of NW, Catalano *et al.* found a strong positive association between maternal pre-pregnancy BMI and fetal insulin resistance ($r = 0.31$, $p = 0.007$) as well as fetal adiposity and fetal insulin resistance ($r = 0.32$, $p = 0.0008$) even after adjusting for confounders (P.M. Catalano, Presley, Minium, & Hauguel-de, 2009). However, not all women with OW/OB have large for gestational age (LGA) infants. They are also at risk of having intrauterine growth restriction (IUGR) and small for gestational age (SGA) offspring (Radulescu, Munteanu, Popa, & Cirstoiu, 2013). Considering the potential risks associated with both SGA and LGA as well as other maternal weight-related correlated risks such as shoulder dystocia, it is not surprising that women who are OW have a 50% increased risk of caesarean delivery and OB women have more than double the risk of NW women (Poobalan, Aucott, Gurung, Smith, & Bhattacharya, 2009; Van Der Linden et al., 2016).

Maternal pre-pregnancy BMI is one of the leading predictors of children developing metabolic disorders and obesity (P.M. Catalano, Farrell, et al., 2009). The literature suggests that women with OW/OB are at greater risk of having LGA and SGA and that both of these conditions put the child at greater risk for downstream obesity. Maternal OW/OB more than doubles the risk of child OB as early as 24 months of age (Whitaker, 2004). Boyle *et al.* very recently published novel findings regarding fetal stem cell programming for adipose tissue which may underlie pediatric obesity, specifically looking at the differences in mesenchymal stem cells (MSCs) in human infants born to NW women (pregravid BMI 21.1 ± 0.3 kg/m^2) versus OB women (pregravid BMI $= 34.6 \pm 1.0$ kg/m^2) (Boyle et al., 2016). Umbilical cord MSCs were cultured, and upon differentiation, they found that OB women's fetal MSCs displayed a greater capacity for adipogenesis – meaning that their stem cells were more likely to become adipose tissue. With this difference, it is not surprising that the infants of OB mothers had greater fat mass (FM) % and

lower fat-free mass (FFM) % at birth ($p \leq 0.05$) than the infants of NW women despite similar birthweights.

While the concept of an LGA neonate growing exponentially and developing obesity may seem logical, that of an SGA developing OB is less intuitive. However, the renowned Barker hypothesis of the "thrifty phenotype" postulates that during pregnancy fetal undernutrition increases the risk of developing obesity, and sets the stage for several cardio-metabolic diseases, as well as an increased rate of mortality (D. J. Barker, 2007). In worldwide longitudinal studies, the relationship between low birthweight and coronary heart disease has been well established (D.J. Barker, 2004; Smith et al., 2016). Additionally, both *in-utero* undernutrition and overnutrition are correlated with type 2 diabetes (Eriksson, Forsen, Tuomilehto, Osmond, & Barker, 2003; Lopez-Bermejo et al., 2004) and insulin resistance (P.M. Catalano, Presley, et al., 2009; Ma et al., 2010). The Barker hypothesis suggests that undernutrition during fetal development may alter fetal insulin production to provide sufficient glucose to the brain for appropriate development. As glucose intake rises in childhood and beyond, those same individuals are not able to adapt and produce sufficient insulin to meet the changing needs of their body in the newfound glucose-rich environment (Dover, 2009). Concerning maternal over-nutrition, reviewing mothers with diabetes can provide essential insight; elevated levels of glucose in the maternal bloodstream are available energy sources for the fetus (Plagemann, Harder, Kohlhoff, Rohde, & Dorner, 1997; Silverman et al., 1991). Glucose readily crosses the placenta from the mother to the fetus, by passive transfer down a concentration gradient (Fowden, 1995) and by facilitated diffusion glucose transporters (Illsley, 2000). Maternal hyperglycemia increases fetal exposure to an increased glucose supply (P.M. Catalano & Ehrenberg, 2006), leading to fetal hyperglycemia and responsive insulin release by the fetal pancreas (B. E. Metzger, 1991) and coined "fuel-mediated teratogenesis". Because of increased fetal insulin concentration, there is greater uptake of glucose and amino acids into insulin-sensitive adipose tissue heightening the risk of fetal overgrowth, neonatal adiposity, and downstream child obesity (Plagemann et al., 1997; Silverman et al., 1991).

Advising, and assisting women with OW and OB to decrease their body weight by 20-30% before conception (Schummers, Hutcheon, Bodnar, Lieberman, & Himes, 2015) may reduce the risks above, but given that 50% of pregnancies are unplanned (Finer & Zolna, 2011), the best

course of action is to prevent the future population from entering pregnancy in the same condition. To do so, we must aid pregnant women who present OW/OB in the best manner possible which is to manage their gestational weight gain (GWG).

1.5. Gestational Weight Gain as an Independent Risk Factor

Gestational weight gain is a normal and expected component of a healthy pregnancy. However, gaining too much or not enough weight during pregnancy poses significant risks to maternal and fetal health (Johnson et al., 2013; Medicine., 2009). Our lab has drawn considerable attention to the fact that GWG is a modifiable risk factor for most women throughout pregnancy and given the plethora of possible associated complications, is worthy of focus (Adamo, Ferraro, & Brett, 2012; Ferraro et al., 2011; Ferraro, Gaudet, et al., 2012). Independent of pre-gravid body mass index (BMI), excessive GWG (eGWG) is associated with GDM (Callaway, Prins, Chang, & McIntyre, 2006; Dabelea et al., 2005; Nucci et al., 2001; Rudra, Williams, Lee, Miller, & Sorensen, 2006; Sebire et al., 2001), maternal hypertension (Gaillard, Steegers, Hofman, & Jaddoe, 2011) and PE (Cedergren, 2006; Frederick, Rudra, Miller, Foster, & Williams, 2006; Nohr et al., 2008; O'Brien et al., 2003), postpartum weight retention (PPWR) (Abrams & Parker, 1990; Gunderson & Abrams, 1999; Gunderson, Abrams, & Selvin, 2000; Keppel & Taffel, 1993; McKEOWN & RECORD, 1957; Nohr et al., 2008; Widen et al., 2015), fetal overgrowth (Ferraro et al., 2011; Mamun, Mannan, & Doi, 2013) and adiposity (Guihard-Costa, Papiernik, & Kolb, 2004), downstream obesity and cardio-metabolic disease in mothers and their offspring (Druet & Ong, 2008; Ong, 2006; Ozanne, Fernandez-Twinn, & Hales, 2004; Pettitt & Jovanovic, 2001; Wei et al., 2003). In addition to maternal and fetal problems, eGWG is associated with labour and delivery complications (Medicine., 2009) including the need for caesarean section (Drehmer, Duncan, Kac, & Schmidt, 2013).

1.5.1 GWG Rising Rates

Average GWG has risen dramatically over the past 4 decades from 10 to 15 kg (Kinnunen, Luoto, Gissler, & Hemminki, 2003), and data indicate that the mean pregnancy weight gain has increased in all pre-pregnancy BMI categories (McKEOWN & RECORD, 1957), with our work indicating that 60% of Canadian women exceed the Institute of Medicine (IOM) GWG guidelines (Ferraro, Gaudet, et al., 2012). The 2009 IOM GWG recommendations were developed using the

existing evidence base around short-term and long-term risks to mother and child. The specific weight gain recommendations are thus relative to pre-pregnancy BMI, see Table 1 (H. Canada).

Table1: IOM GWG Guidelines 2009

Pre-Pregnancy BMI Category	Recommended total weight gain[2]		Mean rate of weight gain in the 2nd and 3rd trimester[1]	
	kg	lbs	kg / week	lb / week
BMI < 18.5 Underweight	12.5 – 18.0	28 – 40	0.5	1.0
BMI 18.5 – 24.9 Normal weight	11.5 – 16.0	25 - 35	0.4	1.0
BMI 25.0 – 29.9 Overweight	7.0 – 11.5	15 - 25	0.3	0.6
BMI ≥ 30.0 Obese[3]	5.0 – 9.0	11 - 20	0.2	0.5

1. Rounded values
2. Calculations for the recommended weight gain range assume a gain of 0.5 to 2 kg (1.1 to 4.4 lbs.) in the first trimester (Siega-Riz et al., 1994; Abrams et al., 1995; Carmichael et al., 1997).
3. These guidelines do not differentiate between Class I obesity (BMI of 30–34.9), Class II obesity (BMI of 35–39.9), and Class III obesity (BMI of 40 or greater) due to insufficient data for further recommendations at the time of print. A lower weight gain may be advised for women with a BMI of 35 or greater, based on clinical judgement and a thorough assessment of the risks and benefits to mother and child (Crane et al., 2009; Oken et al., 2009; Hinkle et al., 2010).

Compared to their NW counterparts (BMI = 18.5-24.9 kg/m^2), overweight women (BMI = 25-29.9 kg/m^2) are twice as likely to exceed GWG guidelines (Gore, Brown, & West, 2003; Olson & Strawderman, 2003; Stotland et al., 2005; Wells, Schwalberg, Noonan, & Gabor, 2006) and OB women (BMI ≥ 30 kg/m^2) are more likely to overestimate the guidelines (Phelan et al., 2011; Shub, Huning, Campbell, & McCarthy, 2013; Stotland et al., 2005), and three times more likely to exceed them (Weisman, Hillemeier, Downs, Chuang, & Dyer, 2010) yet gain less absolute weight at term (Samura et al., 2016).

1.5.2. Effect of GWG on Neonatal and Downstream Child Outcomes

Excessive GWG plays a role in many of the same neonatal complications as pre-gravid OW and OB and coupled with obesity has additive ill-effects on maternal health and fetal health (Durst, Sutton, Cliver, Tita, & Biggio, 2016). Children born to mothers who exceed GWG recommendations (Ferraro et al., 2011) are significantly more likely to have higher birth weight (> 75th percentile (Maier, Schalinski, Gauger, & Hellmeyer, 2015), classify as LGA (Dietz, Callaghan, & Sharma, 2009; Ferraro et al., 2011; Gillman, Rifas-Shiman, Berkey, Field, & Colditz, 2003; Gore et al., 2003; R. C. Huang et al., 2007) and OW/OB in infancy, childhood and adulthood compared to children of NW mothers who meet IOM GWG guidelines (Dubois & Girard, 2006; Gillman et al., 2003; Guihard-Costa et al., 2004; S.Y. Kim et al., 2007; Moreira, Padez, Mourao-Carvalhal, & Rosado, 2007; Moschonis, Grammatikaki, & Manios, 2008; Oken & Gillman, 2003; Oken, Taveras, Kleinman, Rich-Edwards, & Gillman, 2007; Stuebe, Forman, & Michels, 2009; Yaktine & Rasmussen, 2009). With excessive GWG, neonatal fat-free mass has been shown to remain the same, with significant increases in fat mass by 50% (348 vs. 525 g) and percent body fat by 3% (10.7 vs. 13.9%) (Josefson, Hoffmann, & Metzger, 2013). WFL z-scores at 6 months of age is associated with an increased sum of skinfolds of the triceps and sub-scapula (β = 1.30, 95% CI: 0.93–1.67), and odds of obesity (OR: 6.84, 95% CI: 3.84– 12.19) at three years of age (Taveras et al., 2009).

Infant growth rate has been implicated in future obesity development from birth to 6 months (Botton, Heude, Maccario, Ducimetiere, & Charles, 2008; Dubois & Girard, 2006; Ekelund et al., 2006; Rooney, Mathiason, & Schauberger, 2011), each unit increase in 6-month WFL z-score is related to higher BMI z-scores (β = 0.51, 95% CI: 0.43–0.59) (Taveras et al., 2009) and weight status at 6 months and 1 year of age is linked to developing obesity in childhood (He, Guan, Li, Shao, & Hu, 2013; Taveras et al., 2009). Indeed, a recent large health record study of nearly 40,000 mother-child dyads recognized that women who exceeded the IOM GWG guidelines had offspring with significantly higher WFL (Li et al., 2013).

Gestational weight gain has been shown to independently effect preschool weight and BMI with data indicating that women who gain more than the recommended weight during pregnancy increase their risk of having a child who is OW by the age of three (S. Y. Kim, P. M. Dietz, L. England, B. Morrow, & W. M. Callaghan, 2007; Oken et al., 2007). Oken *et al.* found no evidence

for additional interaction between pre-pregnancy BMI and GWG on the effect of child BMI z-score. The odds of overweight in offspring at age seven y increased by 3% for every 1 kg of gestational weight gain (Wilkin et al., 2002). Recent studies suggest the relationship between GWG and fetal overgrowth is independent of genetic susceptibility and largely due to environmental factors (Chew, Bradley, & Boyko, 2004). In an examination of a half a million women and over 1.1 million offspring using a within-family design, Ludwig and Currie demonstrated a consistent relationship between GWG and birthweight independent of genetic factors (Ludwig & Currie, 2010). Furthermore, in a recent systematic review, Viswanathan *et al.* examined the relationship between GWG and birthweight and noted that in all of the 25 studies included, excess GWG was directly linked to increased birthweight (Viswanathan et al., 2008).

Of equally great concern, inadequate GWG is related to growth restriction (Dietz, Callaghan, Smith, & Sharma, 2009) and neonatal mortality (Meehan et al., 2014). While there is conflicting messaging in higher BMI classifications (S.N. Hinkle, Sharma, & Dietz, 2010; Kiel, Dodson, Artal, Boehmer, & Leet, 2007), OW and OB women who gain ≤ 5 kg throughout gestation are significantly more likely to have a SGA neonate (Durst et al., 2016; El Rafei et al., 2016). After adjusting for multiple confounding variables, OW/OB women who gain ≤ 5 kg have neonates with significantly lower birthweight, fat mass, and lean mass, as well as reduced percentage body fat, body length, and head circumference (P. M. Catalano et al., 2014). An inadequate GWG also leads to increased odds of mortality during infancy (Durst et al., 2016), regardless of maternal BMI. Infants born to underweight (UW), NW and OW women with inadequate GWG had 6.18, 1.47, and 2.11 times greater odds of mortality compared to infants born to women with adequate GWG (Davis, Hofferth, & Shenassa, 2014).

1.5.3. Promotion of IOM Guideline Concordant GWG

In summary, the promotion of guideline-concordant GWG is recommended to optimize maternal-fetal outcomes. Currently, prenatal GWG counseling lacks interdisciplinary consistency regardless of geographic region and the patient population (Weeks, Liu, Ferraro, Deonandan, & Adamo, 2018). While the majority of systematic review evidence support interventions to reduce eGWG (Brown et al., 2012; Thangaratinam et al., 2012; Woo Baidal et al., 2016), the only one known to examine both qualitative and quantitative behavioural intervention studies indicated that despite intense and tailored interventions there were no observed significant effects on GWG [52].

Overall findings from their review indicate that women received contradictory and conflicting information and experienced a perceived lack of control which may explain why the interventions were not successful; they further suggest that intervention studies should aim to train and prepare HCPs on best practices for counseling women about healthy pregnancy weight gain.

1.6 Goal of the Investigation

The purpose of this thesis is to examine the impact of a pregnancy-specific lifestyle intervention on maternal weight, PA participation, kcal consumption, and infant growth. The MOM Trial (ISRCTN75323409) was developed by Dr. Kristi Adamo, as a pilot study aimed at managing GWG through a behavioural intervention targeting PA and dietary intake. The primary purpose was to optimize infant growth trajectory and prevent downstream child obesity (Adamo et al., 2013). The trajectory of obesity is difficult to divert once established with more than two-thirds of obese children continuing on the path to becoming obese adults (D.S. Freedman et al., 2001; Magarey et al., 2003; Must, 2003) further illustrating the need for early prevention. Recognizing that maternal obesity and eGWG are positively correlated with neonatal birth weight (P.M. Catalano & Ehrenberg, 2006; Cedergren, 2006; Ekblad & Grenman, 1992; Stevens-Simon & McAnarney, 1992; Wrotniak, Shults, Butts, & Stettler, 2008) and increase the risk of downstream child obesity and metabolic syndrome (Boney, Verma, Tucker, & Vohr, 2005; P.M. Catalano & Ehrenberg, 2006; Cedergren, 2006; Ekblad & Grenman, 1992; Stevens-Simon & McAnarney, 1992; Wrotniak et al., 2008), we are evaluating the feasibility of delivering a structured PA and nutrition intervention to pregnant women throughout gestation with repeated follow-ups until the offspring reached 24 months of age.

In my thesis, the specific aims are 2-fold:

1) To evaluate if participation in regular PA via a structured prenatal exercise class in combination with a nutrition intervention will reduce offspring WFL z-score at six months of age. Thus, the thesis will evaluate the effect of the intervention throughout pregnancy on offspring growth velocity defined by weight-for-length Z-scores between three and six months of age Ong *et al.* (Ong, Ahmed, Emmett, Preece, & Dunger, 2000).

2) To determine if participation in regular PA via a structured prenatal exercise class in combination with a nutrition intervention will influence participants meeting IOM GWG guidelines, infant birth weight (SGA, AGA, LGA, macrosomia), and post-partum weight retention.

I hypothesize that:

1) Women who participated in the intervention will be more likely to have offspring follow a healthy growth trajectory at six months of age.
2) Women who participated in the intervention will be less likely to exceed IOM GWG guidelines, give birth to fewer macrosomic neonates, have fewer pregnancy-related complications, and a reduction in post-partum weight retention compared to women in the control group.

1.7 Rationale for Intervention Design

Pooled results of 12 international PA and dietary interventions reviewed in a meta-analysis conducted by Gardner *et al* showed intervention effectiveness in significantly reducing GWG (Weighted Mean Difference (WMD) = -1.19 kg, [95% CI: -1.74, -0.65], $p < .0001$) (Gardner, Wardle, Poston, & Croker, 2011). Built upon comparable rationale, the MOM Trial intervention incorporated structured PA and nutritional guidance to mothers throughout gestation with repeated follow-ups until the offspring reached 24 months of age. Regular moderate exercise and appropriate dietary intake are known contributors to weight management, have been identified as predictors of eGWG (Olson & Strawderman, 2003; Streuling et al., 2011) and are mediators of metabolic dysregulation affecting maternal-fetal health (Aune, Saugstad, Henriksen, & Tonstad, 2014; Dempsey et al., 2004; Saftlas, Logsden-Sackett, Wang, Woolson, & Bracken, 2004; Sorensen et al., 2003; Wolf, Owe, Juhl, & Hegaard, 2014).

The American College of Obstetricians and Gynecologists (ACOG) encourages women to engage in regular PA, both aerobic and anaerobic (strength conditioning) throughout pregnancy, provided the absence of contraindications (ACOG, 2015) due to the many beneficial physiological effects.

Frequent (3 – 5 days a week), moderate intensity PA conducted in "safe" conditions (non-contact) for 30 – 60 minutes in duration, is correlated with a significant reduction in pregnancy-related complications without increasing the risk of negative maternal-fetal outcomes (Clapp, 1989, 1991; Ferraro, Gaudet, et al., 2012). Regular prenatal exercise has a favourable effect on maternal health, assisting in the management of GWG (Davies, Wolfe, Mottola, & MacKinnon, 2003) and reducing the incidence of hypertension (Davies et al., 2003), PE (Aune et al., 2014; Dempsey, Butler, & Williams, 2005; Dyck, Klomp, Tan, Turnell, & Boctor, 2002; Saftlas et al., 2004; Sorensen et al., 2003; Weissgerber, Wolfe, & Davies, 2004; Wolf et al., 2014) and GDM (Dempsey et al., 2005; Dempsey et al., 2004). Colleagues in prenatal PA interventions have recently shown with a randomized control trial (RCT) of 765 women in Spain, that with compliance to a three day per week PA intervention, significant differences can be found in prenatal hypertension, PE, GDM, and eGWG. Their findings further illustrate that compared to women who engage in regular PA throughout pregnancy, sedentary women were three times more likely to develop hypertension, 1.5 times more likely to exceed GWG guidelines, and 2.5 times more likely to have a macrosomic infant (Barakat et al., 2015). In addition to reducing LGA and macrosomia (Artal, Catanzaro, Gavard, Mostello, & Friganza, 2007; Barakat, Lucia, & Ruiz, 2009; Owe, Nystad, & Bo, 2009), moderate PA also protects against SGA supporting appropriate for gestational age (AGA) neonatal birth weight (Barakat et al., 2009; Hopkins & Cutfield, 2011; Owe et al., 2009) and preventing birth weight extremes. One caveat of the RCT by Barakat *et al.* is that they did not control for diet.

The MOM Trial is one of the first RCTs conducted in Canada targeting GWG management through a PA and dietary intervention focusing on a child growth trajectory. Appropriate nutritional intake is vital to weight management and one of the strongest predictors of GWG management. In a behavioural analysis, Chuang *et al.* recently found that women who exceed GWG guidelines were more likely to report "eating-for-two" than women who met the IOM recommended targets for GWG (Chuang et al., 2014). Quantitative studies further elucidate that eGWG is associated with daily caloric intake (Campbell, Johnson, Messina, Guillaume, & Goyder, 2011; J.M. Dodd, Crowther, & Robinson, 2008) and macronutrient composition (Procter & Campbell, 2014), with significant differences found in women who consume ≥ 300 kilocalories (kcals) above estimated energy requirements (Cohen & Koski, 2013; Olafsdottir, Skuladottir, Thorsdottir, Hauksson, & Steingrimsdottir, 2006). Well-balanced nutritional intake during the

early stages of pregnancy has been shown to prevent perinatal complications, LGA, and macrosomia (Crowther et al., 2005) and is essential for optimizing the health of both mother and child. The MOM Trial intervention aimed at impacting the energy balance equation by managing both energy intake in the form of mediated kcal intake and energy output by increasing PA to create the greatest impact on GWG management.

CHAPTER 2: MATERIALS AND METHODS

2.1 Study Design

The MOM Trial was a prospective, two-arm, parallel group, randomized controlled trial. Given that pre-pregnancy weight may influence the outcomes under investigation, the randomization was stratified by pre-pregnancy BMI classification (normal weight vs. overweight vs. obese). Randomization was conducted using a computer-generated randomization sequence by a data manager not affiliated with the trial. The MOM trial was registered with Current Clinical Trials (ISRCTN75323409). To aid in recruitment, the trial was approved by research ethics boards at the Children's Hospital of Eastern Ontario (CHEO), the Ottawa Hospital, the Montfort Hospital, the Queensway Carleton Hospital and the University of Ottawa. More details can be found in the published protocol (Adamo et al., 2013).

2.2 Recruitment and Eligibility

Women were recruited in the National Capital Region using multiple strategies (i.e., flyers, advertisements, obstetricians, midwives, etc.). Inclusion criteria enabling women to participate in the study included: i) less than 20 weeks gestation, ii) pre-pregnancy BMI 18.5-45 kg/m^2, iii) 18 years or older, iv) carrying a singleton fetus, with intent to deliver at one of the included site hospitals and keep the infant, and iv) given medical clearance by their health care provider, based on their PARmed-X for Pregnancy questionnaire (Physiology). Exclusion criteria preventing women from participating were as follows: i) smoking or consuming drugs or alcohol, at the time of screening ii) having a medical condition that might affect body weight (i.e., untreated thyroid disease, pre-pregnancy insulin-treated diabetes, hypertension requiring medication) or iii) who had known contraindications to exercise according to joint SOGC/CSEP clinical practice guidelines as outlined in the trial protocol publication (Adamo et al., 2013). We intended to recruit 60 women in total, with 30 randomized to intervention and 30 to control. However, 76 women were recruited in total to account for the unexpectedly high rate of loss to follow up, to ensure the study would be appropriately powered in the end.

2.3 INTERVENTION

The trial intervention employed a multi-faceted approach aimed at modifying PA and nutritional intake. Participants in the intervention received a workbook for promoting a healthy pregnancy (MOM Trial—A Healthy Pregnancy Handbook©, Appendix 1), small group exercise classes twice per week, small group nutrition education classes three times during intervention, individualized counseling sessions with a dietitian twice per intervention, and mailed-out post-cards focusing on trimester-specific nutrition and PA guidance monthly throughout intervention.

2.3.1 PA COMPONENT

Physical activity has known physiological health benefits, and in addition to energy intake, it is recognized as a key contributor to weight management in the form of energy output (Jakicic, Marcus, Lang, & Janney, 2008). Physical activity in a healthy pregnancy is associated with better maternal outcomes reducing the following complications: gestational diabetes mellitus (GDM) (Yu, Xie, & Shen) and supplemental insulin in GDM cases (Nascimento, Surita, & Cecatti, 2012)., urinary incontinence, back pain, and depressive symptoms (L. Huang et al., 2017), as well as improving infant outcomes, by mediating full-term birthweight (L. Huang et al., 2017).

PA is a recognized contributor to both maternal and fetal health and GWG management. A recent meta-analysis, published in 2018, including 24 studies intervening in pregnancy with PA only concluded that women in the interventions gained significantly less weight than women in the control groups (WMD: −1.02; 95% CI: −1.56, −0.49, $p < .01$) (Walker et al., 2018). However, studies show that 60% of pregnant women do not meet the PA recommendations (Poudevigne & O'Connor, 2006). The field of exercise science in pregnancy is relatively new, and there is currently no firm consensus on ideal recommendations for PA in pregnancy. However, the American College of Obstetricians and Gynecologists (ACOG) and the Society of Obstetricians and Gynecologists of Canada/Canadian Society for Exercise Physiology (SOGC/CSEP) currently endorse exercising for 30-minute sessions four times a week (ACOG, 2015; Artal & O'Toole, 2003; Davies et al., 2003) while the Canadian Physical Activity Guidelines (CPAG) suggest that accumulating 150 minutes/week of moderate-to-vigorous PA in 10-minute bouts may be suitable during the prenatal period (Physiology, 2011).

As part of the intervention, participants were expected to attend two, 60-minute supervised exercise classes per week (including a warm-up and cool-down) during their 2nd and 3rd trimesters. The classes were based on the ACOG guidelines for exercise in pregnancy, indicating that moderate-intensity physical activity provided the optimal zone for increasing energy output while minimizing risks to the unborn fetus (≤ 70% maximal heart rate) (Artal & O'Toole, 2003), combined aerobic and resistance training components and based upon safe pregnancy-specific exercises from the SOGC/CSEP Canadian National Guidelines for Exercise during pregnancy and post-partum (Davies et al., 2003). Women were encouraged to engage in independent PA (e.g., walking, aqua fitness) on at least three additional days/week for 30 minutes duration at a moderate intensity to meet Canadian adult PA guidelines (≥ 30 min of moderate PA on most days of the week).

PA was directly measured at multiple time points throughout the study (Appendix 2) for both the control and intervention participants, using reliable and accurate accelerometers (Esliger, Copeland, Barnes, & Tremblay, 2005; Esliger et al., 2007). As part of the intervention, class attendance was recorded by the instructor, with an additional self-report log for independent PA completed by the participants.

2.3.2 NUTRITION COMPONENT

The premise of the nutritional intervention was to educate participants on healthy eating and understanding their energy (kcal) needs, clearly defining realistic and manageable goals while supporting continued adherence to help them stay on track. Dietary interventions have been shown to influence GWG compared to controls, (WMD: −3.27; 95% CI: −4.96, −1.58, $p < .01$) but without certainty regarding the most effective approach. A meta-analysis involving dietary interventions aimed at managing GWG illustrated that neither the type of diet nor the method of delivery (individual or group) consistently influenced the outcome (Walker et al., 2018). As a result, we employed a well-rounded approach including individual (Susanne Wolff, Jesper Legarth, K Vangsgaard, Søren Toubro, & Arne Astrup, 2008) and group sessions as well as postcard mail-outs sent on a monthly basis, with all information based upon Health Canada recommendations (H. Canada, 1999) and Canada's Food Guide (H. Canada, 2007).

At the first visit, intervention participants completed a resting energy expenditure (REE) measurement utilizing indirect calorimetry to predict daily energy demands (Roffey, Byrne, & Hills, 2006) and determine daily caloric requirements. Dietary consumption was recorded using a 7-day food record (Appendix 3), with analysis on total calorie consumption, macronutrient intake (percent of total daily caloric intake from fats, carbohydrates and protein) and micronutrient intake (sodium, calcium, etc.) and provided to the Registered Dietitian (RD) prior to the nutritional counseling sessions. Diet recalls were conducted at each measurement period throughout the study, for a total of 7 appraisals and analyzed using the Food Processor SQL dietary analysis software (ESHA Research, Salem, OR) based on the 2007 Canadian Nutrient File.

Our nutritional counseling incorporated personalized, individual counseling with a Registered Dietitian immediately following baseline data collection with a subsequent appointment halfway through the study (see Appendix 2 for timeline) in conjunction with a more economical and supportive group approach lead by a Graduate student (either at the Master's or PhD level) with an undergraduate degree in Nutrition, at three time-points throughout the study, as continued reinforcement. Frequent reinforcement of messaging has been shown to predict greater success in weight management (Fitzwater et al., 1991).

The dietitian met with the participants (and their partners when desired) and discussed weight management and diet history, current eating habits (food choices, fast food consumption, portion control) and provided them with Health Canada's nutritional guidelines for pregnancy and postpartum (H. Canada, 1999) and Canada's Food Guide for Healthy Eating. Individualized needs were assessed and the dietitian outlined strategies for addressing the participant's specific challenges for healthy eating and GWG management. The RD addressed the importance of eating regularly throughout the day, consuming a balanced diet, and resisting sugary beverages.

At the inception of the MOM Trial there was no consensus on dietary guidelines, and Canada's prenatal guidelines were under review. As a result, we based our recommendations on the findings of Artal *et al.* and Butte *et al.* (Artal & O'Toole, 2003; Butte, 2005), specifying that a caloric increase of 300 kcals/day above non-pregnant energy requirements, should occur during the 2nd and 3rd trimesters. Healthy eating is not simply dependent upon caloric intake, but rather the composition of those calories in the form of fat, carbohydrates, and protein. Our macronutrient recommendations were for 20% of energy derived from protein (Astrup, 2008; Noakes, 2008),

50% from carbohydrates, with an emphasis on fruit and vegetables, whole grains and high fibre, and 30% from fat (Greenwood & Stanford, 2008; Piirainen, Isolauri, Lagstrom, & Laitinen, 2006).

The small group sessions provided general nutritional advice concerning understanding nutrition labels and portion sizes, as well as troubleshooting how to overcome barriers associated with healthy eating. Moreover, it offered an economical approach to regularly meeting with the participants in the intervention group to address the importance of healthy eating throughout pregnancy.

2.4 Standard of Care Comparison Group

Standard prenatal care is provided to all residents of Ontario, covered by Ontario Health Insurance Plan (OHIP) and made available to both the standard care control group and the intervention group. As part of the standard care comparison group, women received pre-natal care from their health care provider, not affiliated with the trial were provided with a resource from the study team written by Health Canada, *"A Sensible Guide to a Healthy Pregnancy*", a resource available for all Canadian women at the time of the trial http://www.phac-aspc.gc.ca/hp-gs/guide-eng.php.

2.5 Blinding

Due to the nature of the trial, neither participants nor the study team implementing the intervention could not be blinded to randomization allocation. Randomization allocation was concealed and revealed only after participants consented to participate in the study and study personnel collected the baseline anthropometric data. All outcomes utilized objective measures thereby significantly reducing bias as outlined by the CONSORT statement (Moher et al., 2012).

2.6 Measurements

Appendix 2 summarizes the baseline, trial intervention and comparison timeline, and follow-up evaluations. Details on outcome measures are illustrated below.

2.6.1 Maternal Outcomes

2.6.1.1. Body Weight & Height

Anthropometrics were measured using the validated CSEP methodology (CSEP, 2013). Maternal height was measured by trained personnel using a wall-mounted stadiometer (HR-200 Wall-Mounted Height Rod, Tanita Corporation of America Inc., Illinois, USA). Measurements were taken twice and recorded to the nearest 0.1 cm. Body weight was measured in kg utilizing an electronic scale while participants adorned light clothing and after having removed their footwear. Body weight was recorded to the nearest 0.1 kg.

2.6.1.2. Gestational Weight Gain (GWG)

Total GWG in kg was calculated by subtracting self-reported pre-pregnancy body weight, taken by the study team at the baseline visit from last measured weight taken either at last visit with the study team or weight measured by a physician before delivery.

- GWG was compared between groups (with covariate adjustment for gestational age at delivery, maternal caloric intake & PA)
- Weekly rate of GWG was calculated continuously as kg/week.
- GWG was also calculated categorically in terms being under, meeting or exceeding the IOM GWG guidelines determined by pre-pregnancy BMI classification.

2.6.1.3 Postpartum Weight Retention (PPWR)

PPWR in kg was calculated by subtracting measured weight at the final study visit or at birth, whichever value was recorded later, from baseline weight.

2.6.1.4. Physical Activity (PA)

Objectively measured PA was obtained using omni-directional Actical® accelerometers (Phillips – Respironics, Ore., USA). At each study visit, the participants were instructed to wear the Actical® accelerometers as per the manufacturer's instructions, on the right hip for 7 consecutive days during waking hours following each study visit. Data was collected for the 7-day period, captured in 60-second epochs while the participant was awake, using published cut-points. Non-

weartime was determined by continuously measured zero counts for longer than 60 minutes and was removed from the weartime analysis. Valid days were determined with at least ten hours of accelerometer weartime per day. At least 4 valid days of the 7-day measurement were required in order to be included in the study visit analysis. Data reduction procedures are consistent with the Canadian Health Measures Survey methodology (Colley et al., 2011).

Self-reported PA was collected using a 7-day PA recall form which the participant completed each day during the data collection periods, used in conjunction with the accelerometers. The PA recall form captured the participant's daily activities, defined by type, duration, and self-perceived level of effort, based on a scale of 1 (very light) to 4 (very strenuous).

2.6.1.5. NUTRITION

Dietary consumption was recorded using a 7-day food record following each study visit throughout the study, for a total of 7 appraisals. If the participant did not record data for all seven days, records were included in the analysis if at least three days of food intake were recorded. Analysis of total kilocalorie consumption, macronutrient intake (both absolute values and percent of total daily caloric intake from fats, carbohydrates, and protein) and micronutrient intake (sodium, calcium, etc) was conducted using the Food Processor SQL (ESHA research) dietary analysis software based on the 2007 Canadian Nutrient File.

2.6.2. INFANT OUTCOMES

2.6.2.1. INFANT BIRTH WEIGHT

Infant birth weight was extracted from the antenatal obstetrical charts. Birth weight is reported as a continuous variable in grams and as a categorical variable age based on Statistics Canada generic centile charts representing weight in relation to gestational age (Hutcheon, Zhang, Cnattingius, Kramer, & Platt, 2008). Categories include small-for-gestational-age (SGA), appropriate-for-gestational age (AGA) and large-for-gestational-age (LGA).

2.6.2.2. INFANT GROWTH

The strength of an evaluation is dependent upon the measures utilized to determine the findings. Infant adiposity is better defined by weight-for-length, rather than weight alone, given the

distribution and proportion of weight related to the "height", considered "length" in this population (Benn, 1971).

Infant weight was measured using a portable electronic baby scale (MyWeigh® Ultrascale ® MBSC 55, Phoenix, Arizona) to the nearest 1 g (<3 kg), 2 g (3-6 kg), or 5 g (> 6 kg). Infant length, measured crown-heel in a recumbent supine position, to the nearest 1 mm, with the final variable equal to the mean of two measures.

Weight-for-length (WFL) z-scores are reported as per the World Health Organization Training Course on Child Growth Assessment. Geneva, WHO, 2008 (Organization, 2006). WFL depends upon age and sex, and as a result, age-and-sex-specific WFL z-scores are ideal for evaluating adiposity at a single time-point (Cole, Faith, Pietrobelli, & Heo, 2005). WFL z-scores are calculated at birth, three months of age, six months of age, 12 months of age and 24 months of age.

Additional body composition calculations were conducted using the sum of skinfolds method, calculated taking and average from 2-3 measurements at four measurement sites on the right side of the body (biceps, triceps, subscapular and supra-iliac) to the nearest 0.1 mm with Harpenden skin fold calipers (Karaolis-Danckert et al., 2008).

2.7. Statistical Analyses

The MOM Trial protocol was developed to be analyzed using the intention-to-treat principle (ITT). As a result, outcomes in this thesis are reported as ITT based on randomization group, intervention versus control, regardless of adherence, loss-to-follow-up (LTFU) or withdrawal. However, given issues surrounding adherence to the intervention (see section 3.2), additional analysis on the group as a whole was conducted on specific variables of interest to further elucidate the effects of PA and nutritional intake on outcomes regardless of randomization group.

In advance of analysis, all variables of interest were assessed for normality. Non-normally distributed data were analyzed using non-parametric tests. Outlying values greater than three standard deviations (SD) from the mean were reviewed for anomaly and removed from further analysis if warranted, for example, participant ID MOM-073 required emergency gallbladder

surgery between V6 and V7 subsequently lost 43 kg, which would have biased the outcome for PPWR.

2.7.1. Descriptive Analyses

Descriptive summaries are processed for both the groups – intervention and control in Table 2 and Table 3. Continuous variables are summarized using mean, standard deviation, median, interquartile range, and range. Histograms and quantile-quantile plots are used to assess distributional properties. Categorical variables are summarized using frequencies and percentages. Continuous variables were assessed using a Student's t-test or Mann-Whitney U test, and/or a *Chi*-square goodness of fit test. Categorical variables were analyzed by Kruskal-Wallis H test, Chi-square test, or Mann-Whitney U test.

Adherence to the MOM Trial dietary and PA protocol was calculated based upon all the components of the intervention:

a) Exercise class attendance for the duration of the intervention, based on the percent of weekly classes attended throughout their pregnancy, from the point of recruitment to the date of delivery.
b) Self-reported PA based upon the recommendations to engage in at least three days per week of 30 minutes in duration, with a modified rate perceived exertion (RPE) on a scale of 1 (very light) to 4 (very strenuous) reported. Light PA was denoted as RPE 1 – 2, moderate PA RPE 3, vigorous PA RPE 4.
c) Nutrition intervention component was calculated based on their attendance at the two private nutrition counseling sessions with the registered dietitian as well as their attendance at three booster nutrition modules.

2.7.2. Primary and Secondary Outcome Analyses

Data under evaluation was assessed for normality using the Shapiro-Wilk test. Data meeting the assumptions of normality were assessed using Student's t-tests and ANOVA for continuous variables. Where data violated the assumption of normality and/or were categorical,

non-parametric tests were utilized, including Mann-Whitney U test, Wilcoxon Rank-Sums test, *Chi*-Square test, Kruskal-Wallis H test, and Friedman's test. To test multiple maternal and infant interactions, mixed-effects models analysis was conducted.

In this thesis, the primary outcome of interest is offspring WFL z-score of infants born to mother's in the MOM Trial, measured between 3 to 6 months of age. Comparisons have been conducted between intervention and control groups using a Wilcoxon Rank-Sums test.

Infant birthweight variables of SGA, AGA, LGA are categorical and were analyzed using a Kruskal-Wallis H Test. Determination of macrosomia based on intervention or control group was defined in categorical terms by Mann-Whitney U test.

Maternal PA was assessed using a Friedman Test, and a Wilcoxon Signed-Rank test with Bonferroni correction and tested interactions between PA and GWG assessed by mixed-effects model analysis. Maternal nutrition was analyzed using a mixed-effects model analysis, Friedman test, and a Wilcoxon Signed-Rank Test with Bonferroni correction. Maternal GWG was evaluated using a Student's t-test and Mann-Whitney U test as well as odds ratio analysis.

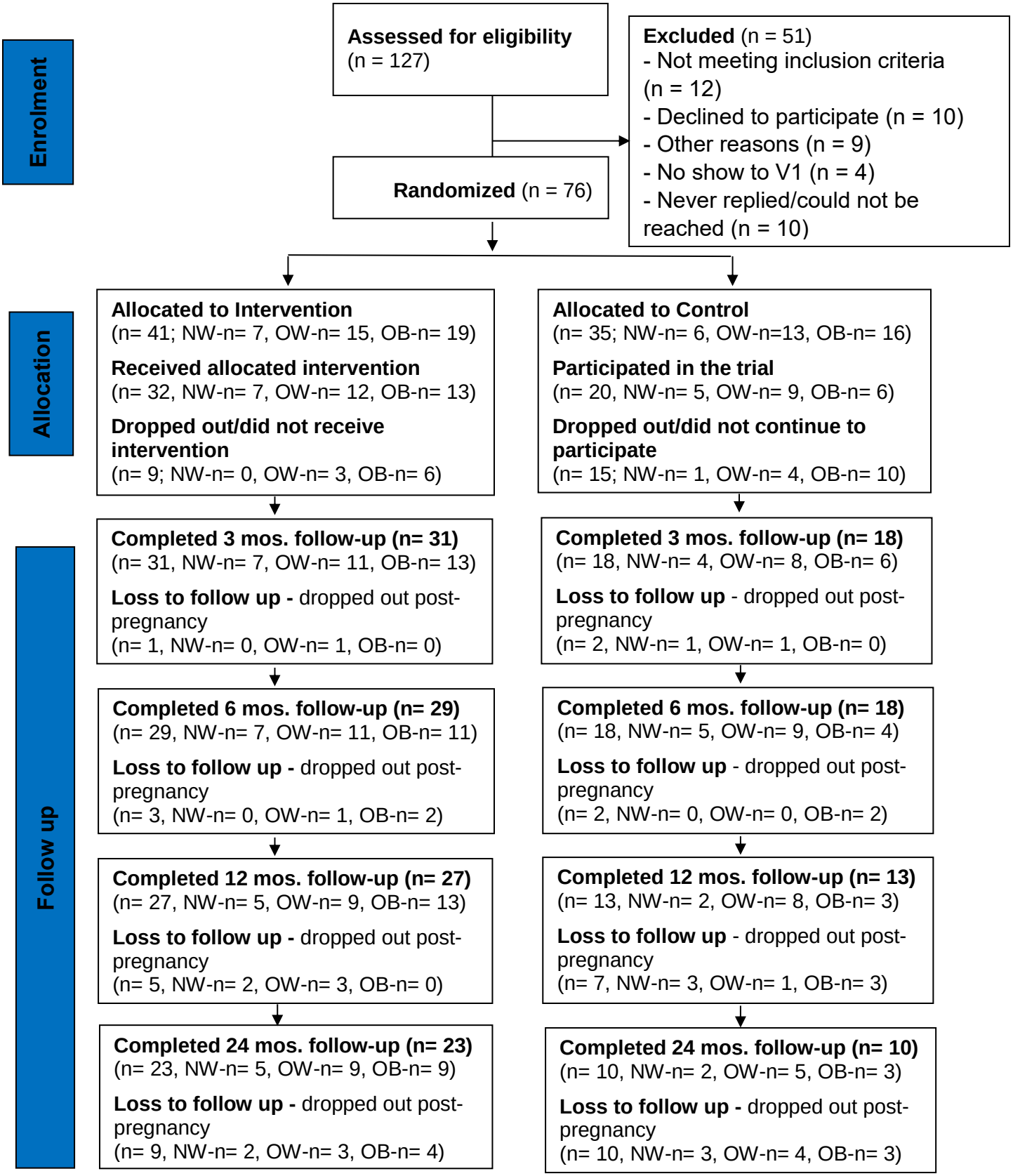
In all analyses, two-sided p-values $< .05$ were deemed statistically significant.

CHAPTER 3: RESULTS

3.1. PARTICIPANT ALLOCATION AND BASELINE CHARACTERISTICS

The CONSORT diagram in Figure 1 illustrates participant screening, recruitment, randomization, and loss to follow up. In total, 76 women were randomized; 41 to the intervention and 35 to the standard care comparison group. Due to the longevity of the study, 14 women were lost to follow up or withdrew, and one woman was randomized for the study but did not complete any assessments or receive any materials. Most of withdrawals in the control group occurred because of not being assigned to the intervention and losing interest in attending assessments. In the intervention group, most of the withdrawals were a result of scheduling difficulties with class attendance, complications unrelated to the study, and losing interest in attending assessments. There were some cases where the participants became pregnant with subsequent children and no longer had relevant PPWR measures. An additional 4 participants were excluded from the analysis because of self-reported smoking status either on the study-specific questionnaire or their antenatal record. Therefore, the analysis includes a total of 57 women: 33 intervention and 24 standard care comparison controls.

Figure 1. CONSORT Diagram: Participant screening, recruitment, and randomization



Maternal socio-demographics are presented in Table 3. There were no statistically significant differences between the two groups for the participant demographics except parity which showed a higher proportion of nulliparous women in the intervention group,

Labour and infant birth characteristics are presented in Table 2. There were no significant differences between the groups in any of the labour or birth parameters.

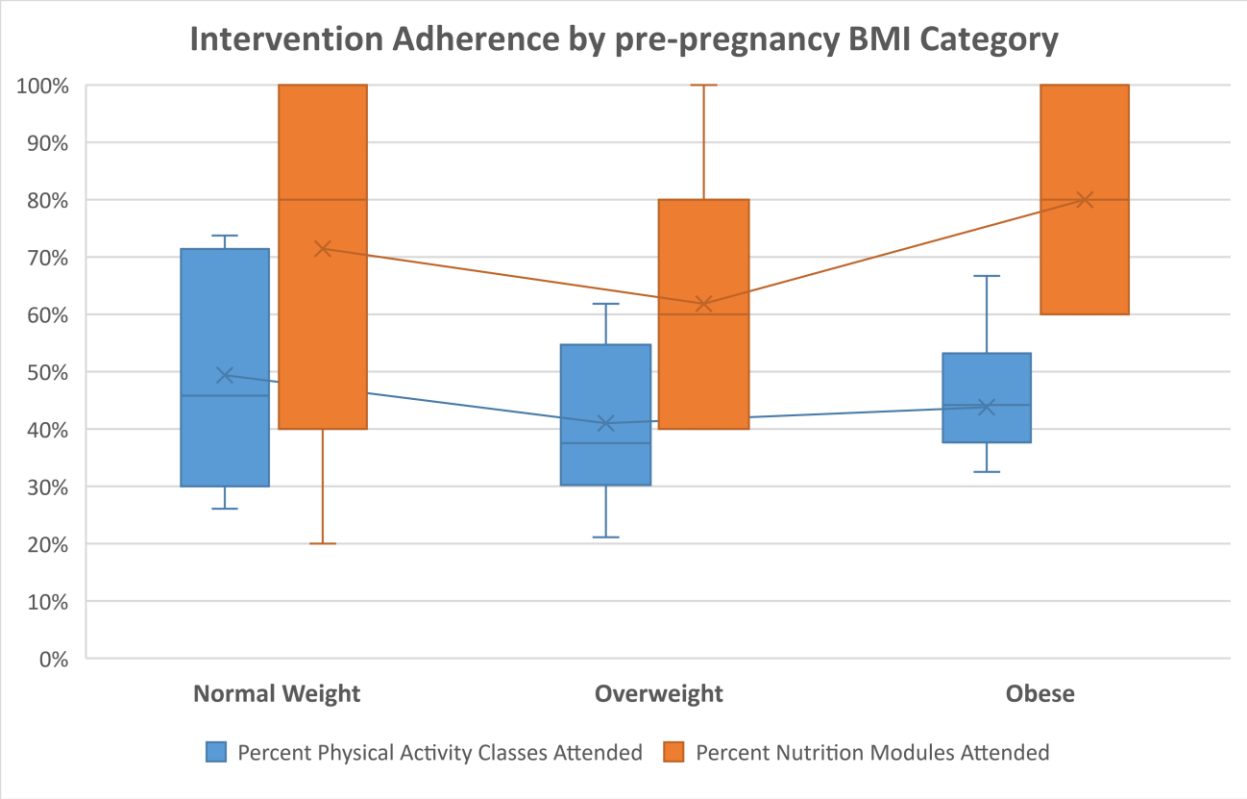
3.2. ADHERENCE/COMPLIANCE

Despite being randomized to the intervention group, at the end of the second trimester, only 6.25% of participants fulfilled the PA component by attending the PA classes and completing moderate PA on three additional days per week for 30 minutes. At the end of the third trimester, 0% of the participants were meeting the PA requirements for the intervention.

In a review of adherence to PA classes, disregarding additional self-lead PA, the mean attendance was 44% of classes, with 3 participants (9%) attending less than 25% of classes, 19 participants (59%) attending between 25 – 50% of classes, and 10 participants (31%) attending between 50 – 75% of classes. No participants attended more than 75% of classes.

Mean participation in nutritional sessions was 71% attendance. Only 1 participant (3%) attended fewer than 25% of classes, 4 participants (14%) attended between 25 – 50% of classes, 9 participants (31%) attended between 50 – 75% of sessions and 15 (52%) of participants attended more than 75% of classes – with 7 (24%) of the last quartile attending 100% of nutritional classes and appointments.

Figure 2. Intervention Adherence by BMI



3.3. Infant Outcomes

Table 2 illustrates the birth characteristics for infants. There were no significant differences in variables between groups.

Table 2. Birth characteristics

	Control (n = 19)	Intervention (n = 28)
Gestational Age at Delivery (weeks)	$\bar{x}$: 39.77 [1.12]	$\bar{x}$: 39.31 [2.11]
	Mdn: 39.71	Mdn: 40.00
Type of Delivery		
Vaginal Birth	14 (74%)	17 (61%)
Caesarean Section	5 (26%)	11 (39%)
Infant Sex[a]		
Male	15 (79%)	21 (68%)
Female	4 (21%)	10 (32%)
Birth Weight (g)[b]	3492 [668]	3360 [571]
Birth Weight (Category)		
SGA	2 (11%)	4 (14%)
AGA	16 (84%)	22 (79%)
LGA	1 (5%)	2 (7%)
Macrosomic (from LGA)	1 (5% total)	2 (7%)
APGAR score at birth (1min)		
3	0 (0%)	1 (4%)
6	1 (5%)	2 (7%)
7	0 (0%)	2 (7%)
8	3 (16%)	4 (14%)
9	15 (79%)	18 (64%)
10	0 (0%)	1 (4%)
APGAR score at birth (5min)		
5	0 (0%)	1 (4%)
7	0 (0%)	2 (7%)
8	1 (5%)	1 (4%)
9	16 (84%)	22 (79%)
10	2 (11%)	2 (7%)

Results are presented as n (%) for categorical variables. Continuous variables presented as mean $\bar{x}$ [SD] and median (Mdn). *Statistically significant at $p < .05$. [a] Sample size for intervention group (n = 31). Macrosomic > 4000 g. [b] Sample size for intervention group (n = 32).

3.3.1. Primary Outcome: Weight-for-Length

As per the hypothesis, a Wilcoxon Rank-Sum Test indicated that the change in weight-for-length z-score from 3 months to 6 months was statistically significantly lower in children born to mothers in the intervention group compared to the children in the control group Ws = 481.00, z = 2.67, p = 0.007.

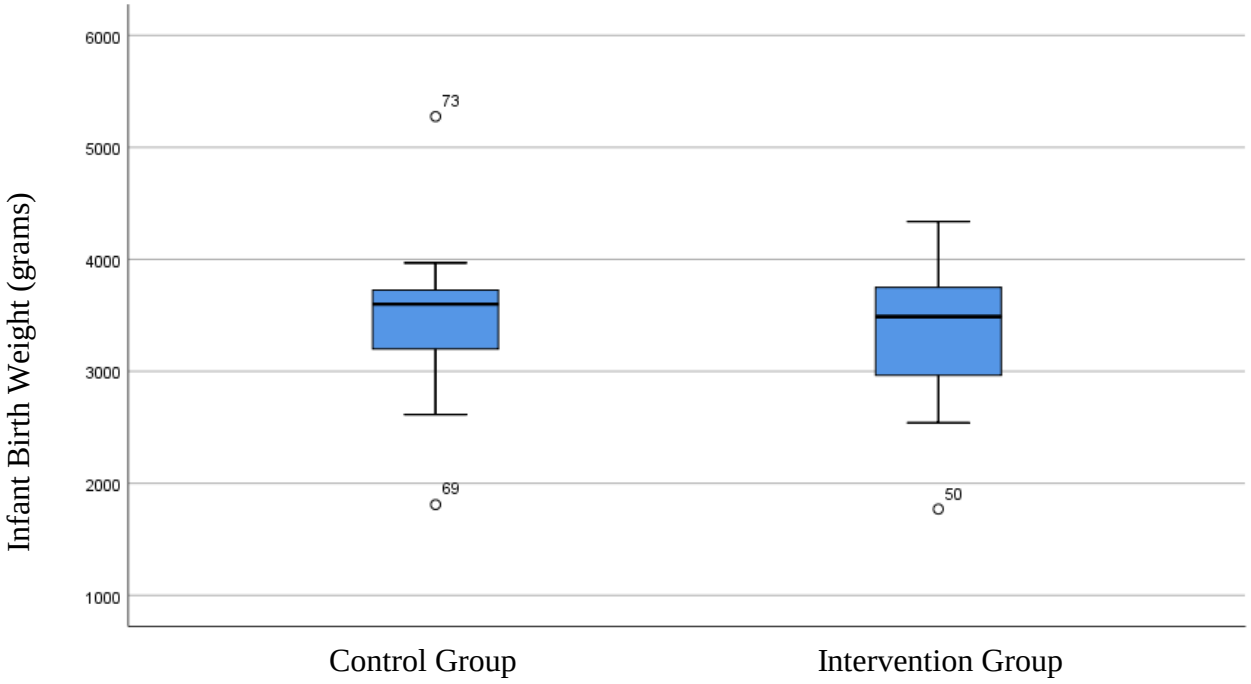
3.3.2. Secondary Outcomes: Infant Birthweight Outcomes

There were no significant differences between groups on infant birthweight; control group (n = 19) had neonates with an average birthweight of 3492.63 g (668.14), compared with the intervention group (n = 32) who had neonates with an average birthweight of 3360.37 (571.93). A Mann-Whitney U test demonstrates no significant differences between the control (3600) and intervention groups (3383), $\chi 2(2) = -1.198$, $p = 0.231$.

A Kruskal-Wallis H test showed that there were no significant differences between the control and intervention group in infant birthweight categorization for SGA, AGA or LGA, $\chi 2(1) = 0.025$, $p = 0.874$.

Based on a Mann-Whitney U test, there was no significant difference between the control (n = 19) and intervention group (n = 32) concerning having a macrosomic neonate, U = 282, p = 0.405.

Figure 3. Infant Birthweight based on Group



3.4. Secondary Outcomes: Maternal

3.4.1. Baseline Characteristics

Table 3 illustrates the maternal baseline characteristics. At the outset of baseline measurements, there were no significant differences between groups, aside from parity. The parity data was analyzed using a *chi*-square goodness of fit test. The null hypothesis was rejected, whereby the control group (n = 32) were more likely to be multiparous than the intervention group (n = 40), $\chi^2(1) = 5.896$, $p = 0.015$.

Table 3. Maternal baseline socio-demographics

	Control (n = 24)	Intervention (n = 33)
Age (yrs) [a]	32.63 [30.88, 34.39]	33.01 [31.65, 34.36]
Parity * [b]		
Nulliparous	10 (31.3%)	24 (60.0%)
Multiparous	22 (68.8%)	16 (40.0%)
Gestational age at study entry (weeks) [a]	16.13 [15.08, 17.18]	15.77 [14.90, 16.58]
Pre-gravid BMI (kg/m^2) [b]	29.75 [27.55, 31.94]	30.98 [28.73,31.98]
BMI Categorization [b]		
Normal weight	5 (15.6%)	7 (17.5%)
Overweight	12 (37.5%)	14 (35.0%)
Obese	15 (46.9%)	19 (47.5%)
Ethnicity [c]		
White	25 (78.1%)	28 (71.8%)
Black	2 (6.3%)	1 (2.6%)
Aboriginal Peoples of North America	0 (0.0%)	2 (5.1%)
South Asian	0 (0.0%)	1 (2.6%)
Southeast Asian	0 (0.0%)	1 (2.6%)
Arab	0 (0.0%)	1 (2.6%))
Latin American	3 (9.4%)	2 (5.1%)
Other	2 (6.3%)	3 (7.7%)
Marital Status [d]		
Married	27 (84.4%)	32 (82.1%)
Living with someone	3 (9.4%)	4 (10.3%)
Single	1 (3.1%)	0 (0.0%)
Other	1 (3.1%)	3 (7.7%)
Education [d]		
Secondary School	1 (3.1%)	1 (2.6%)
College	10 (31.3%)	8 (20.5%)
University	21 (65.6%)	30 (76.9%)
Occupation [d]		
Employed	24 (75.0%)	35 (89.7%)
Unemployed	2 (6.3%)	1 (2.6%)
Student	1 (3.1%)	1 (2.6%)
Work at/from home	1 (3.1%)	2 (5.1%)
Retired	1 (3.1%)	0 (0.0%)
Other	3 (12.5)	0 (0.0%)
Household income [a]		
Less than $20,000	1 (3.2%)	0 (0.0%)
$20,000 to $29,999	1 (3.2%)	0 (0.0%)
$40,000 to $49,999	1 (3.2%)	1 (2.6%)
$50,000 to $99,999	10 (32.3%)	15 (38.5%)
More than $100,000	16 (51.6%)	20 (56.4%)
Don’t know	1 (3.2%)	0 (0.0%)
Refuse to Answer	1 (3.2%)	1 (2.6%)

Results are presented as mean [95% CI lower, upper limits] for continuous variables and n (%) for categorical variables. * Statistically significant at $p < .05$. [a] Control n = 31, Intervention n = 39; [b] Control n = 32, Intervention n = 40; [c] Control n = 25, Intervention n = 28; [d] Control n = 32, Intervention n = 39.

3.4.2. Physical Activity

A different pattern of MVPA emerged within the groups throughout pregnancy. Using a Friedman Test, there was a statistically significant difference in accelerometer collected MVPA in the control group, from baseline (V1) to V2 and V3, $\chi2(2) = 11.167$, $p = 0.004$, but not in the intervention group $\chi2(2) = 3.455$, $p = 0.178$. Post hoc analysis with Wilcoxon signed-rank tests was conducted with a Bonferroni correction applied, resulting in a significance level set at $p < 0.017$. Median (IQR) MVPA in the control group for V1, V2, and V3 were 15.58 (19.05), 15.20 (10.98) and 7.24 (13.92), respectively. Median (IQR) MVPA in the intervention group for V1, V2, and V3 were 16.85 (13.29), 20.42 (19.31) and 13.25 (10.00), respectively. There was a significant difference in MVPA in the control group from V1 to V2 (Z = -3.059, $p = 0.002$) and from V1 to V3 (Z = -3.110 $p = 0.002$), but no significant difference between V2 to V3 (Z = -2.237, $p = 0.025$). In the intervention group there was a significant difference from V1 to V2 (Z = -3.823, $p = 0.0004$) but not from V2 to V3 (Z = -1.782, $p = 0.075$), nor from V1 to V3 (Z = -1.778, $p = 0.075$).

Baseline

A Mann Whitney U test showed at the baseline measurement that there were no significant differences between the control and intervention group in MVPA, (Z = -.614, $p = 0.539$). The control group (n = 13) had a mean score of 22.06 mins/day of MVPA collected via accelerometer compared with the intervention group (n = 19) mean score of 26.15 mins/day.

Second trimester of pregnancy

A Mann Whitney U test showed that there were no significant differences between the control and intervention group in MVPA during the second trimester of pregnancy (Z = -.572, $p = 0.567$).

Indeed, the control group (n = 14) had a mean score of 16.22 mins/day of MVPA collected via accelerometer while the intervention group (n = 21) had a mean score of 19.06 mins/day.

Third trimester of pregnancy

A Mann Whitney U test showed that there were no significant differences between the control and intervention group in MVPA during the third trimester of pregnancy (Z = -0.194, *p* = 0.846). The control group (n = 14) had a mean score of 11.91 mins/day of MVPA by accelerometer while the intervention group (n = 13) had a mean score of 12.57 mins/day.

Figure 4: Objectively measured MVPA by Group

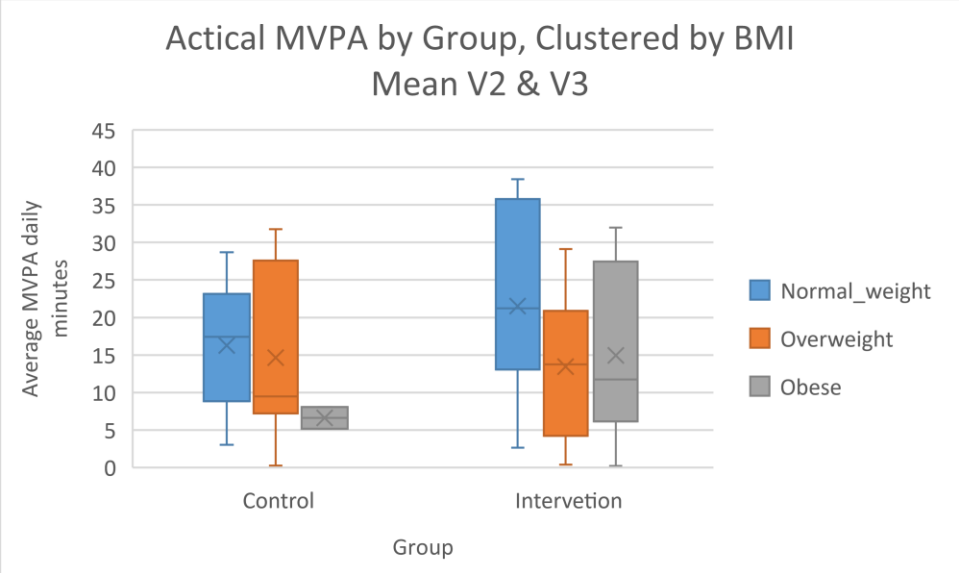


Figure 5: Composite MVPA including Actical measure & Self-reported PA

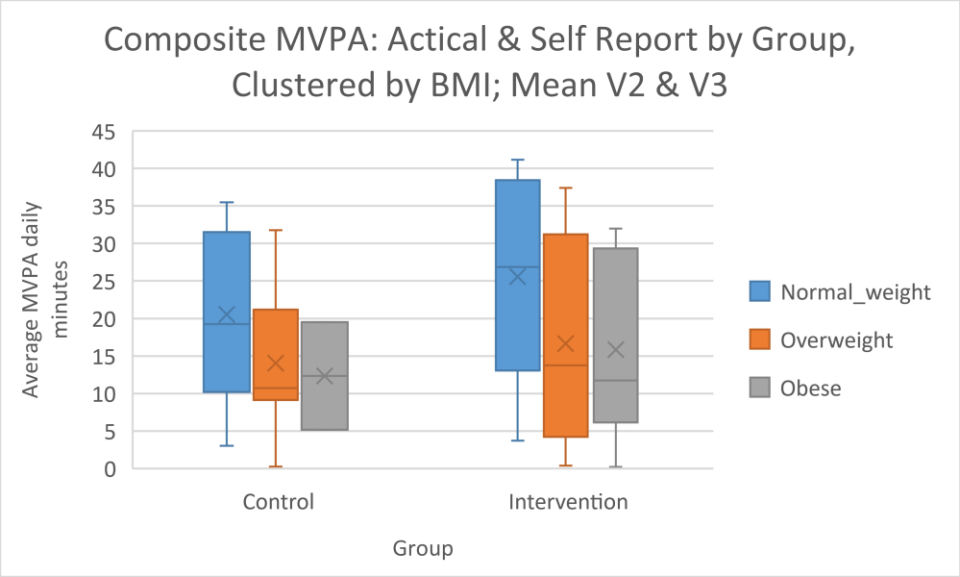


Figure 6: TPA measured by Actical alone, Mean of V2 & V3

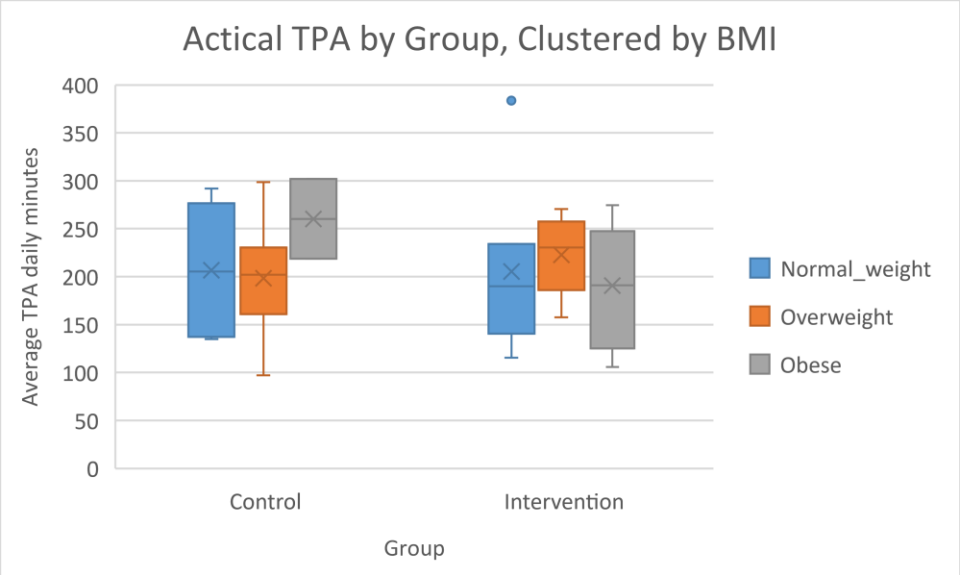
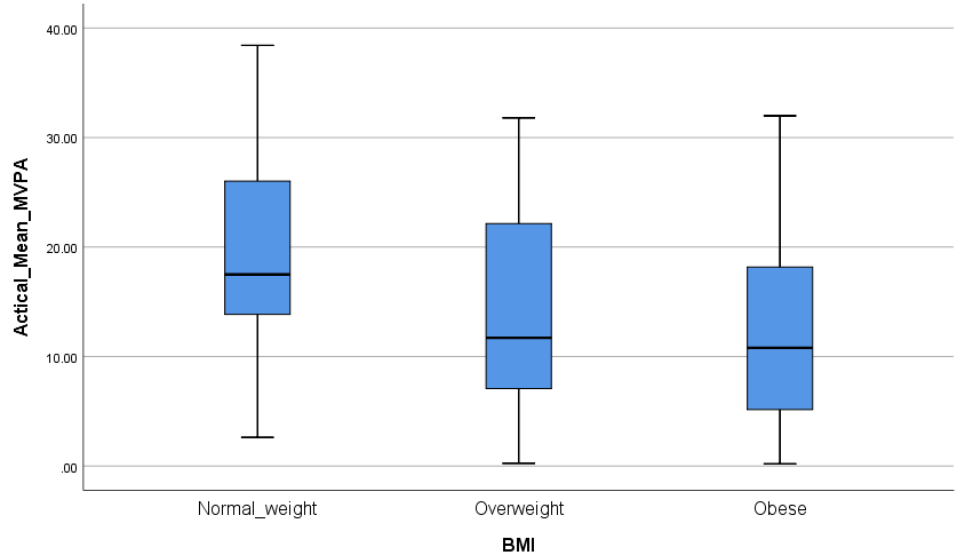


Figure 7: MVPA by BMI, No Group Stratification



While neither absolute nor changes in MVPA during pregnancy were significantly correlated with final pregnancy weight nor change in WFL z-score in either group, the change in LPA from the first trimester to the second trimester was significantly correlated with WFL z-score. A mixed-effects model analysis illustrates that an increase in LPA from the first study visit in early pregnancy to the second study visit at the end of the second trimester is significantly associated with decreased final GWG in the intervention group, but not in the control group (p = 0.014).

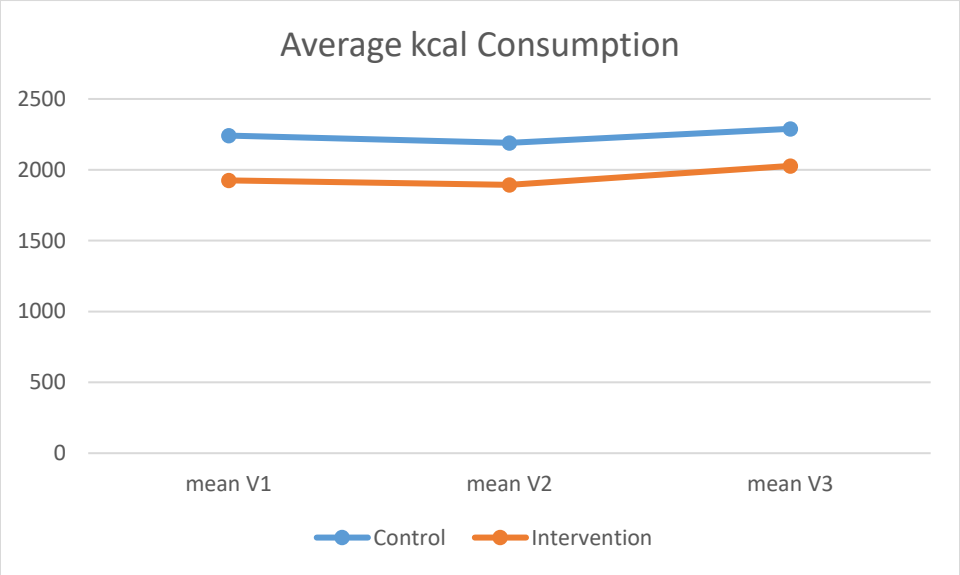
3.4.3. NUTRITION

To ascertain maternal nutritional impact on infant outcome interactions, in the following analysis, cases were removed that did not contain PA or infant WFL z-scores. Despite the hypothesis, there was no significant intervention effect on dietary intake during pregnancy related to the intervention. Using a mixed-effects model analysis, there was no significant difference between kcal consumption as the pregnancy progressed from V1 to V2 to V3 meaning no main effect of time (p = 0.70). Nor was there a significant change in scores over time depending on the group, thus no significant interaction effect, p for group x time interaction = 0.98. Moreover, there were no significant differences between groups in the correlations between kcal intake (absolute or relative over time) and final gestational weight, nor modifications in weight-for-length z-scores.

Table 4. Kcal Consumption throughout Pregnancy

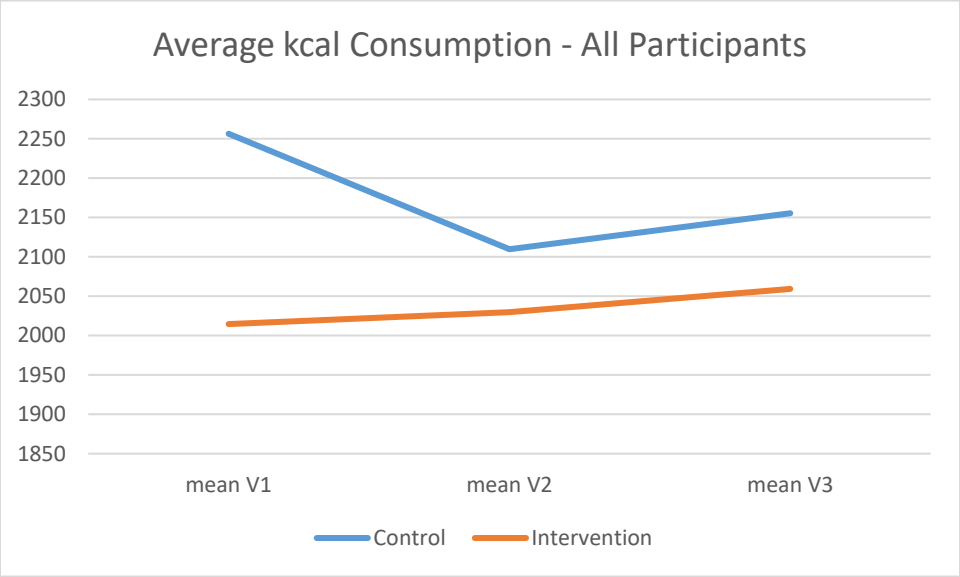
	V1	**V2**	**V3**
Group	**mean (SE)**	**mean (SE)**	**mean (SE)**
Control	2242.4888 (155.44)	2190.3629 (166.17)	2289.2725 (155.44)
Intervention	1924.6628 (117.50)	1893.882 (113.52)	2027.565 (117.50)

Figure 8. Average kcal Consumption by group, full cases



In a descriptive view of the data, without removing cases with missing PA or WFL z-scores to test interactions, the following means for the entire sample as are indicated in the figure below. The control group consumed an average of 246 kcal more than the intervention group in early pregnancy. The control group reduced their caloric intake from the first study visit to the second study visit by 146 kcal, perhaps related to the Hawthorne Effect associated with joining the study (Mayo, 2004; McCarney et al., 2007; Roethlisberger & Dickson, 2003).

Figure 9: Average kcal Consumption for all participants available

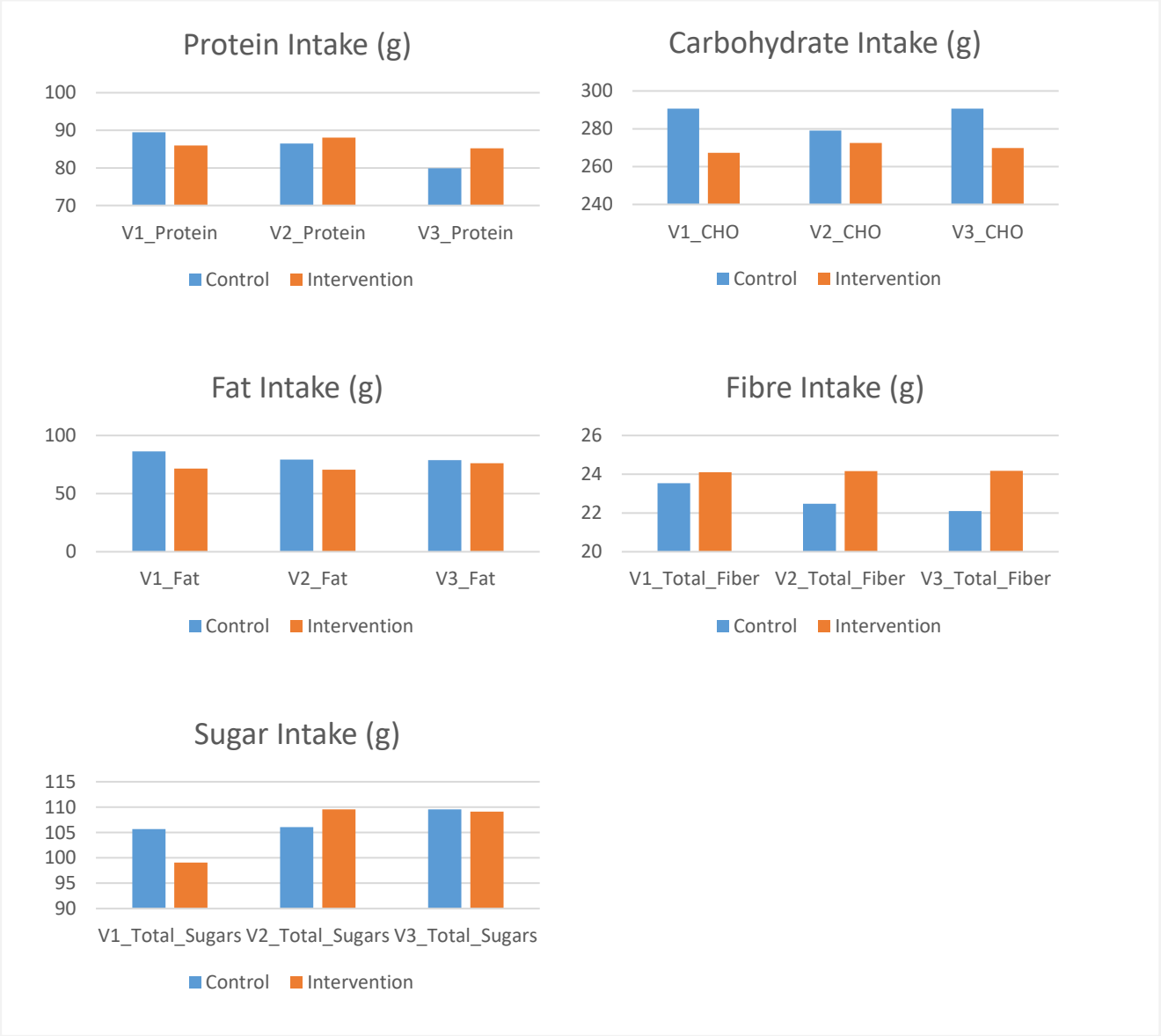


In an evaluation of all cases, including those with missing child outcomes, a Friedman Test indicated a statistically significant difference in kcal consumption within the control group, from V1 to V2 and V3, $\chi2(2) = 8.687$, $p = 0.013$, but not within the intervention group throughout pregnancy, $\chi2(2) = 0.610$, $p = 0.737$. Post hoc analysis with Wilcoxon Signed-Rank Tests was conducted with a Bonferroni correction applied, resulting in a significance level set at $p < 0.017$. Median (IQR) kcal consumption in the control group for V1, V2 and V3 were 2156.62 (362.80), 2038.39 (842.81) and 2015.10 (644.09), respectively. Median (IQR) kcal consumption in the intervention group for V1, V2 and V3 were 1984.75 (519.36), 1849.49 (713.26) and 1883.16 (618.25), respectively. There was a significant difference in kcal consumption in the control group from V1 to V3 (Z = -2.391, $p = 0.00168$) but no significant difference between V1 and V2 (Z = -1.633, $p = 0.102$), nor between V2 and V3 (Z = -0.260, $p = 0.795$). In the intervention group there were no significant differences from V1 to V2 (Z = -0.076, p = 0.940), nor V2 to V3 (Z = -0.224, $p = 0.823$), nor from V1 to V3 (Z = -0.226, $p = 0.821$).

Using a Kruskal-Wallis H Test, there was a significant difference between groups with respect to kcal intake in early pregnancy at V1, $\chi2(2) = 4.894$, $p = 0.027$. There were no significant differences in kcal intake between groups at V2 ($\chi2(2) = 1.752$, $p = 0.186$), nor V3 $\chi2(2) = 0.328$, $p = 0.567$). There were no significant differences in macronutrient intake throughout pregnancy

within or between groups. Protein consumption (g) throughout pregnancy in the control group (n = 17), $\chi 2(2) = 1.882$, $p = 0.390$ and in intervention group (n = 21), $\chi 2(2) = 2.193$, $p = 0.334$. Carbohydrate consumption (g) throughout pregnancy in the control group (n = 17), $\chi 2(2) = 3.176$, $p = 0.204$ and in intervention group (n = 21), $\chi 2(2) = 0.506$, $p = 0.776$. Fat consumption (g) throughout pregnancy in the control group (n = 17), $\chi 2(2) = 5.642$, $p = 0.060$ and in intervention group (n = 21), $\chi 2(2) = 2.193$, $p = 0.334$.

Figure 10. Dietary intake as an absolute value between groups, throughout pregnancy



3.4.4. Gestational Weight Gain

Part of the second aim of the investigation was to determine if the intervention would influence participants meeting IOM GWG guidelines. The hypothesis was that women who participated in the intervention would be less likely to exceed the IOM GWG guidelines. However, there were no significant differences in GWG between intervention group and control group (mean difference

= 0.3 kg, 95% CI, -2.5 – 3.1, $p = 0.838$). Furthermore, there were no significant differences between groups in odds for excessive GWG (unadjusted OR = 0.63, 95% CI 0.19 – 2.04, $p = 0.436$; age and gestational age-adjusted OR = 0.65, 95% 0.17 – 2.52, $p = 0.53$).

Figure 11. GWG IOM Guideline Adherence by Group and by BMI Category

3.4.5. Postpartum Weight Retention

The secondary analyses included the impact of the intervention on PPWR. A non-parametric Friedman test of differences among repeated measures was conducted, and no significant differences were found within groups in PPWR, with the control group rendering $\chi 2(2) = 4.119$, $p = 0.249$, and the intervention group rendering $\chi 2(2) = 3.675$, $p = 0.299$. There were no significant differences between groups at V4, V5, V6, nor V7.

3.4.6. Breastfeeding

Utilizing a Mann Whitney U-test to evaluate final lactation scores between groups, no significant differences were found between groups U = 195.00, z = -0.028, $p = 0.978$.

CHAPTER 4: DISCUSSION

The overarching premise of the intervention was sound, based on the majority of literature on existing interventions aimed at impacting GWG. The MOM Trial intervention aimed to impact infant growth outcomes which is what made this intervention particularly unique and novel. The study was well-intentioned to provide an intervention during pregnancy aimed at impacting both short-term and long-term maternal and child outcomes. Moreover, the comprehensive intervention included both sides of the energy balance equation, in an affordable manner including individual and group sessions to generate the greatest impact. While the intervention was unsuccessful at modifying GWG, it was successful in impacting infant growth outcomes, measured by WFL z-scores as the well-known standard. However, given the lack of significant outcomes in GWG between groups, as well as the lack of significant outcomes in PA and kcal intake the outcome is moderately unexplained.

While pregnancy presents an opportune moment to increase awareness of healthy behaviours as mothers tend to prioritize the wellbeing of their growing fetus (Ordean, Wong, Graves, & Canada, 2017), pregnancy also presents challenges by increasing nausea, joint pain, insomnia and feelings of exhaustion (van Lier, Manteuffel, Dilorio, & Stalcup, 1993). Body weight management is strongly associated with kcal consumption whereby excessive weight gain is primarily attributed to a continued positive energy balance with energy intake surpassing energy expenditure (Janssen et al., 2005). The lack of adherence to the PA and kcal intake recommendations of the nutritional intervention may explain the inability of the program to impact GWG. The goal of the PA intervention was to have the participants attend two group session PA classes, in addition to self-lead PA sessions three days per week for a duration of 30 minutes each. In an evaluation of truly upholding the recommendations, only 5% of intervention participants completed this mandate, further explaining the distinct lack of adherence to the PA component.

While correlations exist between early growth trajectories and weight status in later childhood or adolescence, it is important to note that weight management is an ongoing process throughout the lifespan. Body weight management is multi-faceted with genetic, physiological and behavioural mechanisms involved; however, the first law of thermodynamics always applies. Essentially, the conservation of energy indicates that variations in energy stored are equal to energy intake minus energy expenditure (Jéquier & Tappy, 1999). A positive surplus of energy stored

results either from an excessive energy intake compared to energy needs for homeostasis and/or reduced energy expenditure resulting in an energy surplus. A positive energy balance will result in weight gain whereby a negative energy balance will result in weight loss. Specific to the population under evaluation, if a young child is overweight it is possible to make changes in energy intake and energy output in order to shift the energy balance equation and facilitate weight loss or a healthier growth trajectory (Golley, Magarey, Baur, Steinbeck, & Daniels, 2007) thereby overcoming earlier estimations of predispositions for obesity. While there were no significant differences in breastfeeding patterns between the intervention and control groups, caloric intake for the infants remains a critical component of weight gain. Future recommendations would be to further evaluate kcal intake in infants compared with energy expenditure spent in tummy time. Recent evidence suggests a potential association between tummy time and BMI z-scores in infants (Koren, Kahn-D'angelo, Reece, & Gore, 2019).

4.1. LIMITATIONS

One limitation of this study is that pre-pregnancy body weight was self-reported which is known to be a slight underestimation (Flegal, Carroll, Ogden, & Curtin, 2010; Margot Shields, Gorber, & Tremblay, 2008). Given that the baseline visit occurred around 15 weeks gestation, early in the second trimester, we felt it best to verify the pre-pregnancy self-reported weight and use that instead of the first-trimester proxy weight. Consideration was taken to ensure that the self-reported data did not appear to be a misrepresentation based on objectively measured weigh at V1.

Also, the difference in parity between the control and intervention group, may also have influenced the lack of differences between groups. The intervention group contained more nulliparous women compared with multiparous which may have impacted the comparison group in their ability to access child care and continue to attend the study visits, impacting their rate of loss-to-follow-up.

Growth trajectory as early as six months of age is representative of downstream child outcomes (Ong et al., 2000); however, outcomes measured at 24 months of age would have been even more indicative of long-term child obesity risk factors. The challenge in the MOM Trial was

in engaging women throughout the entire 24-month process. Perhaps regular touch-points with women, via phone call, text and/or email based on participant preference, might have provided a personal method of maintaining relationships beyond the "intervention" period. If ongoing contact information verification and engagement had been part of the trial, fewer women might have been lost-to-follow-up, influencing outcomes overall. While adherence to the intervention was found to be difficult by the intervention group, the control group was found to be less inclined to continue with study visits, and many were lost to follow up. Moreover, despite the random computer-generated sequenced randomization process, fewer women were randomized to the control group at the outset, creating an even larger gap upon loss.

An additional consideration in the uneven balance between groups may have been due to selection bias. Despite best efforts to randomly sample the population engaging in the program, there was a larger percentage of OW women in the intervention group, compared with the control. Given the increased numbers of OW women in this population, one cannot dismiss potential underlying differences in behaviours associated with weight management at the outset of the study thereby causing the shift to increased PA and kcal intake moderation to be perceived as an even greater challenge.

Furthermore, based on the type of intervention, at the point of screening and recruitment, the women who were recruited into this intervention were interested in modifying their individual health behaviours, in an attempt to manage their body weight and improve the health outcomes of their infants in-utero. There was no remuneration for participation in the study and women were personally motivated to join, to obtain the intervention. As a result, many of the comparison control women were engaged in PA activities, one even training for a half-marathon throughout the intervention. Of course, behaviours in the comparison control group were not modified in any way, thereby allowing those women to engage in healthy behaviours of their own volition. However, given the small number of participants overall, even a limited number of differences can impact the overall result of the groups. Also, despite the arms of the trial, women engaged in the control group selected engagement in this trial because of their overall goals and likely modified their behaviours, at a minimum during the times of recording because of the Hawthorne Effect. That being said, pregnancy is a challenging time for women and often presents greater challenges than maintaining weight. Several women disengaged from the trial, missed appointments or had

particular data points removed with medical issues unrelated to the study and/or personal challenges, including: symphysis pubis dysfunction, thin cervix and risk of premature delivery, high scores of depression, prescribed bedrest, symptoms of miscarriage, previously undiagnosed heart condition, GDM, HELLP, leg surgery, gallbladder surgery, subsequent pregnancy during postpartum period, working too many hours and feeling overwhelmed, unable to attend the exercise classes due to work, or feeling that the study was not worth their time because they were not allocated to the intervention group.

4.2. Conclusions

Conducting a lifestyle intervention, aimed at increasing PA and managing kcal intake, during pregnancy requires a multifaceted approach, revolving around the participant's individual needs for support and scheduling availability. While many of the participants were keen to join the research study at the outset, few were prepared to make meaningful changes to their existing PA and dietary habits, despite encouragement and support from the study team. The pregnant women in our study faced numerous challenges including body aches, nausea, exhaustion, and unexpected limitations to PA, often while balancing a regular standard of care appointments with their obstetrician, a full workload, other children at home and trying to prepare for the new baby's arrival. Attending the PA classes due to scheduling conflicts was one of the greatest challenges to the PA component of the intervention.

In a systematic review conducted by Brown *et al (Brown et al., 2012),* she noted that lack of participant retention was a result of the time-consuming nature of lifestyle interventions. Pregnant women find it difficult to commit to the multiple component involvement of lifestyle interventions making these types of studies better suited to well-motivated participants (Guelinckx, Devlieger, Mullie, & Vansant, 2010; S. Wolff, J. Legarth, K. Vangsgaard, S. Toubro, & A. Astrup, 2008). Participants were more likely to attend the sessions if they were paid to attend each session, thereby increasing the rate of retention to 82% (Phelan et al., 2011) compared with the average of 68 – 73 %. Unfortunately, payment for attendance was not a feasible option for the MOM Trial.

My recommendations for the future would be to create smaller, achievable goals and rewards for the participants engaged in the intervention component. For example, wearing a PA

device which provides immediate feedback to the participant and links to an ongoing platform monitoring adherence. Simple PA changes increasing daily step counts may encourage the participants to continue despite their challenges.

I would also recommend regular touch-points with the participants if they were not attending the classes throughout the intervention and postpartum to maintain a relationship with the participant and ensure active contact information.

Further, offering a varied rewards system for participation in PA classes may provide the 'hook' needed to continue to encourage participants to continue to attend classes, relentlessly seeking their next reward (Eyal, 2016). Participants were highly engaged in the sessions with the registered dietitian because they sought personalized information believing it to be the key to their success in managing their GWG and in participants who struggled with their weight before the study, in managing their weight overall. Perhaps if the participants attended a specific number of consecutive classes, they could be rewarded with additional sessions with the dietitian, providing motivation to exercise and increasing their overall likelihood of success.

DECLARATIONS

5.1. Funding

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5.2. Research Ethics Board

The MOM Trial pilot was approved by the Research Ethics Boards associated with the location of study visits and placenta collections, including: Children's Hospital of Eastern Ontario (CHEO) #09/03E, the Ottawa Hospital #20090914-01H, the Montfort Hospital # KA-12-05-11, the Queensway Carleton Hospital #12-04, and the University of Ottawa # A06-15-02.

5.3. Involvement

My personal involvement in the MOM Trial included managing documentation for the REB, developing improvements in the data collection tools and database platforms, meeting with the participants and their children to collect data, teaching exercise classes, training other research personnel in data collection methodology and trial oversight, overseeing and conducting data audit and cleaning as well as analysis.

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APPENDICES

APPENDIX 1: MATERNAL OBESITY MANAGEMENT TRIAL – A HEALTHY PREGNANCY HANDBOOK

The M.O.M Trial:

A Healthy Pregnancy Handbook©

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CHEO Children's Hospital of Eastern Ontario
Centre hospitalier pour enfants de l'est de l'Ontario

uOttawa
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Canada's university

Université de Montréal

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Welcome to the M.O.M Trial's Healthy Pregnancy Handbook!

This handbook is designed to help maintain and improve your health during pregnancy. By achieving balance through regular physical activity and healthy eating practices, it's hoped that women will gain the right amount of weight and give their babies the healthiest environment in which to grow and develop.

This handbook has been carefully designed to help you:

- Learn important information and tips about healthy eating and being active during pregnancy
- Identify YOUR barriers that prevent or make it difficult for you to balance your lifestyle during pregnancy
- Learn techniques to overcome these barriers and how to anticipate new ones that might arise

Healthy Pregnancy Handbook

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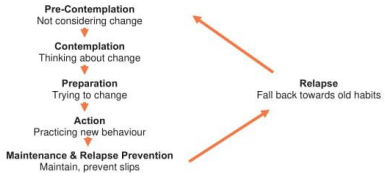
Pregnancy Stages of Change

Are you ready for change?

When women venture into programs designed to change their lifestyle during pregnancy, they go in with the best intentions to make it a change, but then struggle when goals aren't immediately achieved. The reality is, we all encounter obstacles and suffer relapses. Success is realized when you are able to anticipate relapses and put a plan in motion to cycle through the states of change to get back on track.



When it comes to making change and being successful, if you are in the **Pre-contemplation** stage you are not ready to make change yet. E.g. *My doctor told me to exercise more and eat healthier foods.* There is nothing wrong with being in this stage however, in order to move forward, you will have to identify reasons that are important to you to make change.

If you are using language such as "I should improve my eating" or "I really ought to exercise more", then you are in the **Contemplation** stage. You still need to work on your commitment to making the change. Once you have decided to make change you will enter the **Preparation** and **Action** phases: "I am scheduling my exercise" and "I am packing snacks".

If you are in the **Maintenance** and **Relapse Prevention** stage, then you can use this workbook to add variety to your current habits, improve them further, and develop strategies to prevent further relapses.

For those in the Relapse stage, you can be reassured that falling into relapses is very common and as your habits improve, your time spent in relapse will decline.

Your Goals	Stages of Change
None yet	Pre-contemplation
Obtaining information and ideas	Contemplation
Make a plan, get motivated	Preparation

What is Success?

Before committing to any lifestyle change program, it's important to give some thought to how you will know that you have been successful. Many people start with a broad vision of becoming "healthier". That type of goal is not only difficult to measure, it may also take years to fully accomplish. Without carefully thought out, defined and realistic ideas of markers of success, many people will get bored or frustrated and fall back into old habits.

Success represents something different to each person. To set yourself up for long term success, ask yourself the following questions:

1. What is your indicator of success?

_____
_____
_____

2. Can you picture yourself being successful?

_____
_____
_____

3. What are some of the obstacles that have prevented your success in the past?

_____
_____
_____

4. Do you have a support system?

_____
_____
_____

5. Can you keep this up forever?

_____
_____
_____

Setting Goals: Ask yourself *What, Where, When,* and *How*

Most goals start as a very general idea of what you want to do – be more fit, eat healthier, or look better. Because they are not specific, you will find it very difficult to formulate a plan and measure success. To help you develop more focused goals that will ultimately help you accomplish these general ones, ask yourself the following questions:

What exercise are you going to be doing?

Where are you going to do your exercise?

When are you going to do your exercise?

How are you going to fit in exercise?

What are you going to be eating?

Where will you be eating?

When will you be eating?

How are you going to fit your snacks/meals into your busy day?

SMART GOAL SETTING

- **Specific**
- **Measurable**
- **Action-oriented**
- **Realistic**
- **Time-oriented**

We set goals in every aspect of our lives whether we realize it or not. It is often in the form of a "To Do" list, but when it comes to exercise and nutrition, setting goals can be an important tool to help you make healthier food choices, or increase your level of physical activity. It doesn't matter whether you are a beginner or a professional athlete, goal setting is important for fueling motivation and helping you to better yourself.

SMART Goal Setting

SMART goals are ones that capitalize on the above questions involving how, what, when, and where.

SPECIFIC

- Goals must be specific to be achievable
- Think of *what, when, where and how*

Non-specific: I will increase my physical activity

Specific: I will increase the amount of walking I do each day

MEASUREABLE

- It is important that success can be measured.
- If a goal of walking each day is set, has the goal been achieved?

Immeasurable: I will walk more often

Measurable: I will walk 3 times each week for 30 minutes

ACTION-ORIENTED

- Important to set goals that can be directly worked towards

Not Action-Oriented: I want to become more active.

Action-Oriented: I will monitor the number of steps I take each day and increase accordingly

REALISTIC

- Must be able to achieve the goals being set

Unrealistic: I will exercise for 1 hour everyday and sometimes twice each day

Realistic: My schedule and commitments will allow me to exercise 3-5 days each week.

TIME-ORIENTED

- To stay on track, aim to achieve goal in a certain timeframe or by a specific deadline.
- Make sure the timeline is appropriate and reasonable

No Timeframe: I want to increase my endurance

Timeframe: In 3 months, I want to be able to walk 11,500 steps as measured by my pedometer

**** Once goals are achieved, create new ones by building on previous ones.**

OBSTACLES

Aspects of your life, health, or environment that can stand in the way of your fitness and nutrition success. Once you identify your most challenging obstacles, you can plan around them or at least learn to recognize when they could prevent you from exercising or making healthy eating choices.

e.g. Goal: Cook and eat healthier dinners at home.

Obstacle: Will be pressed for time.

Solution: Plan your meals ahead of time and doing your grocery shopping accordingly.

Sample Goal Setting Sheet

General Goal: *Increase lower body strength in 3 months*

Why: *Make going up and down stairs easier, allow me to walk more often instead of driving or taking the escalator*

More Specific Plan/Short Term Goals: *Increase strength in my legs in 3 months. Leg strengthening exercises 4x per week for the next 3 months. 3x per week over the holidays.*

Obstacles	Action Steps
Time to get to the gym	Do exercises at home 3x per week. Plan dinner meals so dinner is early enough. Get to the gym 2x per week.
Knowledge of exercises	Book an appointment with a fitness consultant, read this workbook. Talk to friends who are active themselves.
Boredom, motivation	Get a variety of different exercises and record results. Maybe meet a trainer at gym 1x per month Plan sessions in day time

Success Indicator: *Check off completed workouts in my day timer. Able to climb the stairs at work instead of taking the elevator (3-6 weeks) – measure strength now and in 3 months.*

Reward: *Buy the newest book by your favorite author.*

Goal Setting Sheet

General Goal: _____

Why? _____

More Specific Plan/Short Term Goals:

_____

_____

_____

_____

Obstacles	Action Steps

Success Indicator:

_____

_____

Reward:_____

Witness:_____ **Date**: _____

Stress Less!

Whether it's related to work, your health, finances or relationships, we all experience stress – it's how we deal with it that can make the difference!

Stress is tension or pressure and a common result of or reaction to it is overeating and inactivity.

To help manage one's stress, it's important to know what things cause you to feel stress, what are the feelings you get and the techniques you use to deal with stress.

What kind of things make you feel stressed?

_____

_____

_____

How do you feel when you get stressed? (e.g. impatient, tired, irritable, nauseous)

_____

_____

_____

What do you usually do to deal with the stress?

_____

_____

_____

Stress is the body's reaction to outside factors (pressure at work, health concerns, rush-hour traffic, etc) – it's the "flight-or-flight" response in the body the results in increased heart rate and blood pressure, faster breathing, muscle tension, increased blood sugar, dry mouth. Stress, in short, is the state of the body needing to increase its energy production to defend itself in what it thinks is a time of danger.

Exercise is one of the best ways to deal with this extra energy (even thought that might not be what it feels like!). This is what your body is naturally doing when we pace around or tap our legs and fingers. Channel this extra energy into a more complete form of exercise – a brisk walk, bike ride or swim.

Techniques to Prevent, Reduce and Cope with Stress

- ✓ Practice saying, 'no' because you can't do it all or be in two places at once!
  - Try to say 'yes' only when it is important to you
- ✓ Reduce 'all or nothing' thinking
- ✓ Don't blow things out of proportion
  - If you don't meet your goals on a given day, shake it off, try again tomorrow

Healthy Eating and Physical Activity – don't let these slide!

- Take '10 deep breaths' to release the inner tension
- 'Call it off'…phone a friend who will help get you on track
- 'Be in the moment'…take your lifestyle change 1 step at a time
- 'Walk it off'…take a 10 minute walk to ease tension

- ✓ Share some work with others (e.g. family members, friends, coworkers etc.)
- ✓ Set goals you can reach
- ✓ Take charge of your time.
  - Make schedules with realistic timelines and stay organized
- ✓ Use problem solving:
  - Describe the problem in detail
  - Brainstorm your options (e.g. call a friend when stressed, change locations, etc.)
  - Pick an option and try it! If it doesn't work, don't worry. Try another option!
- ✓ Plan ahead and strategize
  - Identify situations that are likely to cause you stress
  - Plan how to handle them, work around them or avoid them all together
- ✓ Keep it in perspective
  - Remind yourself of the good things you have in your life
  - Remember: the health of you and your child is most important
- ✓ Reach out to people – don't be embarrassed to ask for help

"Stress Less" Action Plan

Identify Stress Trigger (e.g. pressure at work)

_____

My action plan to prevent or reduce the stress is:

_____
_____

Roadblocks that might appear? (e.g. increase in workload)

_____
_____

I will handle each by? (e.g. making sure I write in my calendar when my exercise will be so that I don't miss out on it)

_____
_____

I will increase my success by? (e.g. Asking a co-worker to meet me at lunch for a 20 minute walk)

_____
_____

How can your support (family and friends) help you?

_____
_____

Squash those Negative Thoughts!

Do you ever find yourself using words such as *should have*, or *wish I had*? Not to worry – everyone has these thoughts at times. It's how you choose to deal with them that really matters.

Over time they can lead to self-defeat as you start to believe them and fall into a vicious cycle.

Example:

Negative thought: *I'm never going to reach my goals and I'm sick of always having to work so hard at it!*

Action: You miss your fitness classes and you eat more ice cream than necessary.

Result: You feel even worse and don't do any exercise and eat more food.

Negative thoughts can come in different forms including seeing yourself as a failure, blaming other people for your problems, expecting perfectionism, compare ourselves to others and allowing other kinds of negative thoughts.

Explore your Negative Thoughts and come up with a Plan of Action

Negative Thought	Plan of Action
e.g. I don't have the willpower, I just can't do this	Remind myself of the positive changes I've made and the results I've seen. Remind myself that even small changes will have a huge impact in the long term. Remind myself that I CAN do this.

Change of Pace

You've likely experienced some successes with your new healthy living choices and actions and so, to keep you motivated you need to always consider adjusting your fitness goals and routines in order to fight off boredom!

Boredom Busters

Boredom Buster	Examples
Do something new	
Do the same activity but in a new place	
Try a new recipe	
Challenge yourself	

Challenge Yourself

Focus on improving one aspect of your physical fitness – your flexibility, your aerobic fitness (how well your heart can pump blood) or your muscular strength.

Examples:

- If you have a route you always walk, try and walk the same route, but in less time OR make your route a little bit longer to increase the amount of time you spend making your heart work – even an extra 5 minutes will help!
- Join a yoga class or rent a yoga video from the library that is **specifically for pregnant women** to improve your flexibility and gain better control over your muscles
- If you've been doing some light strength training exercises, look for new ones to try for some variation

The Slippery Slope of Change

"Slips" are:

- Times when you don't follow your plans for healthy eating or being active
- A normal part of change – especially during pregnancy
- To be expected

Slips don't hurt your progress.

What hurts your progress is the way you *react* to slips.

What things caused you to slip from healthy eating:

_____
_____
_____

What things caused you to slip from being active?

_____
_____
_____

What causes you to slip is learned. It is a habit. The way you react to slips is also habit.

You can learn a new way to react to slips to get back on your feet again.

What to do after a slip:

Slips are normal and to be expected

99.99% of all people on their way to changing their lifestyle through healthy eating and active living, have slips.

No one time of eating poorly or not being active, no matter how extreme, will ruin everything.

1. **Talk back to negative thoughts with positive thoughts**

   Negative thoughts can be your worst enemy. Talk back. "*I'm not a failure because I've slipped. I can get back on my feet again.*"

2. **Ask yourself what happened.**

   Learn from the slip. Can you avoid it in the future? Manage it better?

3. **Regain control the very next time you can.**

   Do not tell yourself, "*Well, I blew it for the day.*" Make your very next meal a healthy one. Get back on schedule with your activity plan right away.

4. **Talk to someone supportive.**

   Call another friend. Discuss your new strategy for handling slips. Commit yourself to renewed effort.

5. **Focus on all the positive changes you've made.**

   You are making life-long changes. Slips are just one part of the process.

Slips from Healthy Eating

Can you avoid them (it) in the future? It so, how?

_____

If not, make a plan for how to get back on your feet the next time you slip:

Slips from Being Active

Can you avoid them (it) in the future? It so, how?

_____

If not, make a plan for how to get back on your feet the next time you slip:

To do this week:

Try my two action plans for handling slips

Answer these questions:

Did my action plans work? _____

If not, what went wrong? _____

_____

What could I do differently next time? _____

_____

Gestational Diabetes

What is it?

Women with normal blood sugar levels before pregnancy who then develop higher blood sugar levels than other pregnant women have what's called gestational diabetes (GDM).

All women who are pregnant are tested, with a blood test, for GDM between 24 and 28 weeks of pregnancy – your doctor will arrange this. Women who are at higher risk of developing GDM will be tested in their 1st, 2nd and 3rd trimester.

Should you be worried if you have GDM?

GDM is serious, but can be managed the same way type 2 diabetes is managed.

If not managed properly, there are many risks to both the mother and the child. Children born to mothers with GDM are often large at birth and therefore caesarean deliveries are more common which is risky for both mother and baby during delivery. These babies can also have dangerously low blood sugar levels after birth and very high levels of insulin (hormone that helps control blood sugar levels). These babies are at a higher risk for obesity later on in life and glucose intolerance which could lead to diabetes.

How much Weight should I Gain?

It depends on how much you weighed before you got pregnant. The recommendations in the chart below are based on your Body Mass Index (BMI) before you got pregnant. Your health care provider can help you determine what is the correct amount of weight for you to gain.

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 pounds (12.5-18kg)	1 pound
Normal Weight 18.5 and 24.9 kg/m_2	25-35 pounds (11.5-16kg)	1 pound
Overweight 25.0-29.9 kg/m_2	15-25 pounds (7-11.5kg)	0.6 pounds
Obese ≥ 30.0 kg/m_2	11-20 pounds (5-9)	0.5 pounds

*Calculations assume a 1.1-4.4lbs weight gain in the first trimester

Women who do not gain enough weight during pregnancy may deliver children with a low-birth weight which can lead to death, developmental problems and illnesses for the child.

Women who gain too much weight too much weight during pregnancy may give birth to children with a high birth weight. There are possible complications with high birth weight including longer labour and birth time, birth trauma, caesarean birth and increased risk of death for your child.

It's important that you gain the appropriate amount of weight for you.

Eating For Two, Not Like Two

Pregnant women should "eat for two", but that does not mean eating like two. During pregnancy, you need extra vitamins and minerals and slightly more food – but you do not need to eat twice as much food!

Quality vs. Quantity
The quality of the food you eat during pregnancy is very important. During pregnancy, calcium, Vitamin D, omega-3 fatty acids, folic acid and iron are needed for the growth and development of your baby.

First Trimester
You do not need any extra calories, but it is important to make healthy food choices to ensure your baby is getting enough nutrients.

Second & Third Trimester
Your calorie needs increase only to an extra 300 calories a day – a piece of toast and a banana or a bagel with a little bit of cream cheese can supply those extra calories. As you can see, eating an extra snack during the day will help you get the extra calories your body requires. On the next page, you will find examples of healthy snacks ideas. These snacks are also rich in the necessary nutrients your baby needs and help you meet the daily servings of the four food groups.

Nutrients that are very important during pregnancy:

Nutrient	Found In:	Role
Calcium	Milk, Fortified Soy Milk, Yogurt, Canned Salmon or Sardines with Bones, Tofu made with Calcium, Orange juice with Calcium	• Builds strong bones and teeth for baby • Keeps your bones strong
Vitamin D	Milk, Fortified Soy Milk, Eggs, Fatty Fish	• Works with calcium to build strong bones and teeth for baby • Keeps your bones strong
Folate (called Folic Acid in vitamin supplements)	Dark Green Leafy Vegetables, Lentils, Nuts, Seeds, Orange Juice	• Builds healthy blood for you and your baby • Reduces risk of birth defects that affect the brain and spine
Omega -3 Fats (Essential Fatty Acids)	Salmon, Sardines, Mackerel, Herring	•Important for the development of baby's brain and eyes
Iron	Red Meat, Beans and Lentils, Enriched Breads and Cereals *Pregnant women should eat only one serving (size of a deck of cards) of liver per month.	• Builds healthy blood for you and your baby

Toronto Public Health *www.toronto.ca/health*

Healthy Snacks

An Easy Way to Get the Extra Energy that You and Your Growing Baby Need!

Are you getting enough? See how these snacks can help you meet your daily servings of the four food groups…

	Grain Products	Vegetables & Fruit	Milk & Milk Products	Meat & Alternatives
Whole wheat tortilla rolled with peanut butter and banana	✓	✓		✓
High fibre cereal or granola mixed with yogurt and fruit	✓	✓	✓	
Fresh fruit salad or fruit dipped in vanilla yogurt		✓	✓	
Raw vegetables dipped in hummus		✓		✓
Whole grain crackers with cheddar cheese and apple slices	✓	✓	✓	
Hard boiled egg with whole grain toast and tomato slices	✓	✓		✓
Mixed nuts and dried fruits (raisins, apricots, figs, prunes)		✓		✓
Bean salad with toasted pita wedges	✓			✓
Bran muffin and milk	✓		✓	
Baked potato with plain yogurt and chives		✓	✓	
Cottage cheese with canned peach or pineapple slices		✓	✓	

Toronto Public Health *www.toronto.ca/health*

Hydration

During pregnancy your body needs more fluid to make more blood and your kidneys must work harder during this time as well. Aim to drink 10 cups (1 cup = 250 mL) of fluid per day. Examples of fluids: water, milk, broth, vegetable and fruit juice.

When buying juices, always look to make sure they are 100! pure juice ' fruit punch, fruit drink, and fruit and vegetable cocktails are mostly sugar and water.

Also, remember, any fluid other than water will contain calories. You will need to be sure to include them in your calculation of the extra calories you are consuming so as not to consume extra calories without realizing it–

Apple Juice

1 cup = 120 calories

Foods to Avoid during Pregnancy

- Raw fish, especially shellfish such as oysters and clams
- Undercooked meat, poultry and seafood (e.g. hot dogs, non-dried deli-meats, refrigerated pate, meat spreads and refrigerated smoked seafood and fish)
- All foods made with raw or slightly cooked eggs (e.g. homemade Caesar vinaigrette)
- Unpasteurized milk products and food made from them, including soft and semi-soft cheeses such as Brie or Camembert
- Unpasteurized juices, such as unpasteurized apple cider
- Raw sprouts, especially alfalfa sprouts

Can I use Artificial Sweeteners while I'm pregnant?

Diet pop and other diet products contain artificial sweeteners. When you are pregnant, you should limit your intake of these foods as they could be replacing more nutritious choices. Certain artificial sweeteners are considered safe during pregnancy.

Look at the ingredient list to see what type of artificial sweetener the food contains.

Safe During Pregnancy	Not Recommended During Pregnancy
Acesulfame-potassium Aspartame Sucralose	Cyclamates Saccharin

*Reference: Health Canada, Nutrition for a Healthy Pregnancy updated 2005 and Canadian Diabetes Association, Clinical Practice Guidelines 2003

Do I have to give up coffee while I'm pregnant?

No, but you may want to cut down. Coffee, tea, cola drinks and some medications contain caffeine. Large amounts of caffeine may be harmful to your baby. Limit caffeine to no more than 300mg per day (less than 500mL or two 8-ounce cups of filter drip coffee). Other options include herbal teas, hot milk or hot apple juice

NOTE: be sure that your herbal teas contain no stimulant such as ephedrine. This is a stimulant that is banned in Canada except in nasal decongestants, but it still shows up in many weight loss products. This can be very dangerous, especially when you're pregnant.

*Reference: Health Canada, Nutrition for a Healthy Pregnancy, updated 2005

Eating 4 Energy

Balanced Eating

Long days often leave us feeling sluggish, tired and irritable. Our meals are often spread out by 6-7 hours or worse, we skip meals altogether. Especially when pregnant, it's important for you to better understand the links between meals, snacks, energy and blood sugars. These links are important when trying to manage weight and health concerns.

When we talk about nutrition, we often hear the terms: Carbohydrates, Protein and Fat. But we often don't really understand what they mean. To better understand the roles of these nutrients, think of your body as a car:

Carbohydrates: Your main fuel. You must keep your "gas tank" topped up at all times to avoid "running out of gas", and therefore should eat carbohydrates regularly throughout the day. Choose high quality "fuel" by consuming complex carbohydrates (more on this later).

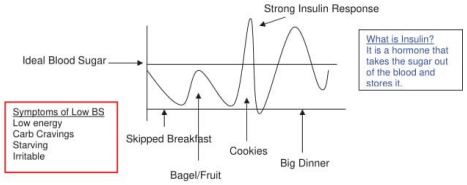
Protein: It's the engine of your car. It helps with repairs – especially muscle repair. It is NOT used as a main fuel therefore you do not need to eat large quantities of it.

Fat: You require a small amount of high quality fats in your diet to keep everything running smoothly, similar to the oil in your car. Of that fats you eat however, you want to be choosing "healthy fats" which we'll discuss a little later on.

BLOOD SUGARS & MEALTIME

Blood glucose is a measure of sugars circulating in the blood. When we digest food, its sugars are broken down and absorbed into the blood stream. These sugars are essential for normal brain function and survival and the body works to maintain stable blood glucose levels (also referred to as blood sugar levels) throughout the day.

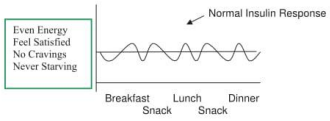
Do your blood sugars radically fluctuate during the day?



Breakfast is one of the most important meals of the day when it comes to maintaining your blood sugar levels – skipping it only results in your blood sugar levels to fall giving you the unpleasant feelings of low blood sugar. If you have trouble eating breakfast in the morning (not hungry, don't feel like well or don't have enough time), try by simply drinking a glass of orange juice, or having a piece of fruit. Your body will start to get used to this and soon you'll want to eat breakfast. Eating balanced meals and snacks (nutrient- and proportion-wise) also helps maintain blood sugar balance.

Ideal Meal Timing and Balance

Maintaining your blood sugars is as easy as eating breakfast and planning balanced meals and snacks. This idea is seen below:



Achieving the Right Balance

Make balanced food choices each time you eat. A balanced snack is one that has carbohydrates and protein. The carbohydrate provides you with some quick energy and the protein helps to make that energy last longer. For example, a piece of fruit (carbohydrate) will provide you with energy for only 1-2 hours. If you add a piece of low-fat cheese (protein) to the piece of fruit, you may stay satisfied for 3-4 hours. The combination helps to maintain a slow rise and fall in blood sugars. Snack ideas and good carbohydrate and protein sources are listed below and on the next page.

Snacks should also be low in sugar with a source of fibre (women = 25grams/day). The fibre, unlike the sugar, slows the rise in blood sugar and therefore helps to extend the energy of the snack.

Balanced Snack Ideas

¼ - ½ c	Trail mix (nuts, raisins, cereal, seeds, soy nuts…)
1 Tbs	Peanut butter with celery, or apple or rolled in a tortilla
1-2 c	Skim milk shake (mix skim milk and chocolate powder)
1	Individual serving of tuna with 4-5 crackers, pita or on salad
1	Yogurt (add granola or bran buds if you like a crunch)
1oz/28g	Cheese (< 21% MF) and apple
¼-½ c	Cottage cheese and fruit
2-4 Tbs	Hummus and veggies or ½ pita to dip
½-1 c	Three bean salad (kidney beans, green/wax beans, vinaigrette dressing)
1	Soup: pea, lentil, bean, chicken (look for brands with 7-15 grams of protein)
2-4 Tbs	Each: salsa, light sour cream, black beans. Dip with baked chips
½-1 c	Potato salad with egg, low-fat mayo and low-fat plain yogurt
2-4 Tbs	Roasted soy nuts and unsweetened applesauce or raisins

Nutrition for the Long Run Heidi Smith, RD

Carbohydrate and Protein Sources

Carbohydrate Sources For lasting energy…	**Protein Sources** With lower fat for heart health…
Grain Products • Whole wheat bread, bagel, crackers • Whole wheat pita, flat bread • Multi-grain cereal, oatmeal • Popcorn (plain) • Pasta, rice • Tortilla wraps • Quinoa, Bulgur	Meat, Poultry, Fish • Tuna packed in water • Roasted chicken/turkey (1-3oz) • Lean beef (roast, ground) • Egg salad with light mayo, boiled egg Dairy Products • Milk (skim, 1%) • Yogurt (0-2% MF), cottage cheese • Low fat cheese (<21% MF)
Fruits & Vegetables • Fresh fruit • Fruit juice • Unsweetened apple sauce • Dried fruit • Chopped raw vegetables • Frozen mixed vegetables • Baked potato • Sweet potato • Tomato sauce	Vegetarian Proteins • Peanut butter, almond butter • Chick peas, roasted soy beans • Hummus • Brown and black beans, lentils • Soy hot dog, soy slices • Soy milk/cheese
High Sugar Carbohydrates Not suitable for lasting snacks…	**High Fat Protein Sources** Use in moderation…
• Granola bars • Canned fruit in syrup • Jelly beans • Gummy bears • Licorice	• Regular cheese (22-40% MF) • Milk (2%-homo) • Nuts (almonds, peanuts, cashews) • Seeds (sunflower, sesame) • Tuna packed in oil • Cream cheese: not a good source of protein

Nutrition for the Long Run Heidi Smith, RD

Did you know…?

Our environment can help us succeed! Keep your running shoes out in plain sight, keep unhealthy foods out of the house to prevent temptation, place fitness articles and other reminders of your goals in plain sight so you are always gently reminded and guided to stay on track to success!

HYDRATION

Water is the foundation of performance in both exercise and in daily life - muscle is made up of 75% water! Many adults are chronically dehydrated and don't even know it. We cannot rely on our thirst to guide our fluid consumption.

"The problem is that our thirst mechanism does not "kick in" until approximately 3% dehydration. That means that by the time you are thirsty, you may have already lost 10% of your performance"

Water is an essential daily nutrient needed for almost every major bodily function. Water is the liquid portion of your blood and, during exercise, is responsible for carrying oxygen and nutrients to the working muscles AND for taking away wastes to be eliminated in the urine.

Tip: a general indicator of good hydration is having a urine colour of "light yellow" or "clear"

Water plays a crucial role in maintaining your body temperature through sweat production.

Blood pressure and heart rate are affected by hydration along with organ cushioning and joint lubrication.

How much do I need?

During the Day: adults need 8-10 cups per day of non-caffeinated fluids (in addition to drinking during and after exercise).

After Exercise: Weigh yourself before and after exercise to determine how much fluid you typically lose – you want to stay between your pre-exercise weight and 2% less. Weight loss during a workout is water loss, not body fat loss. To replenish fluids lost during exercise you need to drink 2-3 cups of fluid for every pound lost.

TIP: have water readily accessible – have a water bottle with you at the office and always bring on with you while you exercise!

NOTE: Factors such as weather, temperature, sweat rate, clothing worn, pre-exercise hydration state and choice of drink will all affect the rate at which you lose fluids during a workout. While you want to ensure that you are drinking enough water, you don't want to overdo it and suffer from hyper-hydration. Maintain balance.

Find water boring?
Add a squeeze of lemon or lime to a glass of water.

Eating At Restaurants

With a full schedule jam packed with work, family and friends, you may find yourself occasionally relying on restaurant foods to get you through a busy week or a reason to socialize. Indulging on these decadent foods from time to time is normal – but remember that they are decadent. A seemingly healthy salad can be a nutrition nightmare when smothered in high fat dressing and fried toppings. Portion control is also a challenge as you are usually served enough food for several meals.

The good news is that by making yourself knowledgeable and choosing carefully when eating out at restaurants you can maintain your healthy eating goals!

When looking at menus, look for key words that describe low fat or high fat foods.

High Fat words

Au gratin
Alfredo
Breaded
Buttered or buttery
Cheese sauce
Creamed, creamy, in cream sauce
Fried, deep fried, french fried, batter fried, pan fried
Gravy
Hollandaise
Parmesan
Pastry
Rich
Sautéed
Escalloped
Scalloped
Seasoned
Southern style

Low Fat word

Baked
Broiled
Boiled
Grilled
Poached
Roasted
Steamed
Stir-fried

The following was compiled by www.helpguide.org - a non-profit resource designed to empower you to understand, prevent and resolve health challenges.

Tips for Choosing Fast Foods

Educate yourself - most establishments will provide you with the nutrition information if requested. **Plan meals that are less than 20 grams of fat and snacks that are less than 10 grams of fat.** Pay attention to the descriptions on the menu – avoid dishes labelled with those high fat words we just learned. Finding satisfying substitutes is worth the time and effort.

Choose chicken - an excellent alternative to the typical high fat burger and fries meal is a grilled chicken sandwich. But, be sure to choose varieties that are not breaded since these are usually deep fried.

"Undress your food" – choose your toppings wisely be aware of calorie- and fat-packed salad dressings, spreads, cheese, mayos, sour cream, etc.

Portion Distortion – at a typical restaurant, a single serving provides enough for two meals. Choose to take home half, divide it with a dinning partner, or aim for the smaller meals rather than a "super size" feast.

Watch your salt – fast food restaurant foods tend to be very high in sodium which is a major contributor to high blood pressure.

Buffet control – it's best to avoid them altogether, even the seemingly healthy salad bars, as you'll likely overeat. If you do go, opt for fresh fruits, salads with low-fat dressing, broiled entrees and steamed vegetables. Resist the temptation to go for seconds or wait at least 20 minutes to make sure you're really still hungry.

Hydration – a huge source of hidden calories is found in beverages with soft drinks being the biggest culprit. One can of coke a day for a year is the equivalent of 55,000 calories which is worth 15 pounds of fat. Choose water with flavour or unsweetened ice tea.

Moderation - if it is a special occasion, or you know you want to order your favourite meal, cut back on your other meals that day – this should not become habit, but it's ok to relax and enjoy your dining experience without feeling like you've sacrificed.

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Burger Joints

Healthier choices	Unhealthy choices
1. Regular, single-patty hamburger without mayo or cheese 2. Grilled chicken sandwich 3. Veggie burger 4. Garden salad with grilled chicken and low-fat dressing 5. Egg on a muffin 6. Baked potato 7. Yogurt parfait 8. Grilled chicken strips 9. Limiting cheese, mayo, and special sauces	1. Double-patty hamburger with cheese, mayo, special sauce, and bacon 2. Fried chicken sandwich 3. Fried fish sandwich 4. Salad with toppings such as bacon, cheese, and ranch dressing 5. Breakfast burrito with steak 6. French fries 7. Milkshake 8. Chicken "nuggets" or tenders 9. Adding cheese, extra mayo, and special sauces

Fried Chicken Chains

Healthier choices	Unhealthy choices
1. Skinless chicken breast without breading 2. Honey BBQ chicken sandwich 3. Garden salad 4. Mashed potatoes 5. Limiting gravy and sauces	1. Fried chicken, original or extra-crispy. 2. Teriyaki wings or popcorn chicken 3. Caesar salad 4. Chicken and biscuit "bowl" 5. Adding extra gravy and sauces

Mexican Dining

Healthier choices	Unhealthy choices
1. Grilled chicken soft taco 2. Black beans 3. Shrimp ensalada 4. Grilled "fresco" style steak burrito 5. Veggie and bean burrito 6. Limiting sour cream, guacamole, or cheese	1. Crispy shell chicken taco 2. Refried beans 3. Steak Chalupa 4. Crunch wraps or gordita-type burritos 5. Nachos with refried beans 6. Adding sour cream, guacamole, or cheese

Italian and Pizza Restaurant Choices

Healthier choices	Unhealthy choices
1. Thin-crust pizza with half the cheese and extra veggies 2. Plain rolls or breadsticks 3. Antipasto with vegetables 4. Pasta with tomato sauce and veggies 5. Entrée with side of veggies 6. Grilled ("Griglia") dishes	1. Thick-crust or butter-crust pizza with extra cheese and meat toppings 2. Garlic bread 3. Antipasto with meat 4. Pasta with cream or butter-based sauce 5. Entrée with side of pasta 6. Fried ("Frito") dishes

Subs, Sandwich and Deli Choices

Healthier choices	Unhealthy choices
1. Six-inch sub 2. Lean meat (roast beef, chicken breast, lean ham) or veggies 3. One or two slices of lower-fat cheese (Swiss or mozzarella) 4. Adding low-fat dressing or mustard instead of mayo 5. Adding extra veggie toppings 6. Choosing whole-grain bread or taking the top slice off your sub and eating it open-faced	1. Foot-long sub 2. High-fat meat such as ham, tuna salad, bacon, meatballs, or steak 3. The "normal" amount of higher-fat (Cheddar, American) cheese 4. Adding mayo and special sauces 5. Keeping the sub "as is" with all toppings 6. Choosing white bread or "wraps" which are often higher in fat than normal bread

Casual-fare Restaurant Choices

Healthier choices	Unhealthy choices
1. Side salad with low-fat dressing or a side of steamed veggies 2. Turkey, roast beef, or grilled chicken sandwich 3. Baked or grilled fish 4. Chicken or turkey wraps w/out mayo or cheese	1. Salads with fried onions, cheeses, meats and high-fat dressings 2. Mayo-heavy tuna or chicken salad sandwich 3. Battered or deep-fried fish 4. Extra-large burgers loaded with cheese and sauces

Asian Food Choices

Healthier choices	Unhealthy choices
1. Egg drop, miso, wonton, or hot & sour soup 2. Stir-fried, steamed, roasted or broiled entrees (Shrimp chow mein, chop suey) 3. Steamed or baked tofu 4. Sauces such as ponzu, rice-wine vinegar, wasabi, ginger, and low-sodium soy sauce 5. Steamed brown rice 6. Edamame, cucumber salad, stir-fried veggies	1. Fried egg rolls, spare ribs, tempura 2. Battered or deep-fried dishes (sweet and sour pork, General Tso's chicken) 3. Deep-fried tofu 4. Coconut milk, sweet and sour sauce, regular soy sauce 5. Fried rice 6. Salads with fried or crispy noodles

Did you know…?

You're on the road, crunched for time and you need something to eat in a hurry so you pull into Tim Horton's and order a cookie from Tim Hortons – it's just ONE, it can't be that bad…right?

Let's compare a Chocolate Chunk cookie from Tim Hortons to one of its 12 grain bagels:

Food	Calories	Fat (g)	Saturated fat (g)	Fibre (g)	Sugar (g)
Chocolate Chunk Cookie	230	9	6	1	19
12 Grain Bagel	330	9	1	6	6

- Both have the same fat content, but almost 70% of the fat in the cookie is saturated fat
- The cookie is much higher in simple sugars that rapidly spike your blood sugars, whereas the bagel is much lower in simple sugars and much higher in fibre that allows for a more slow release of sugar into your blood stream.

By choosing the bagel, you're avoiding consuming unnecessary saturated fat and it will be more satisfying because of the higher fibre and lower simple sugar content.

Sugar, Sugar, Sugar!

Carbohydrates are one of three necessary components of food that provide us with calories – the other two being protein and fat. Carbohydrates are what fuels us with energy – for both normal body functions (breathing, heartbeat, digestion, and brain activity) and for exercise (walking, climbing stairs, carrying groceries, biking, and resistance exercise). We absolutely need to have an adequate amount of carbohydrates in our diet to sustain our existence and a must if your goal is to achieve and maintain a healthy weight and improve your fitness level.

Not all carbohydrates were created equal however, and are considered simple or complex based on their chemical structure. Both contain the same amount of calories and are used the same way by our bodies, but the main difference between them is:

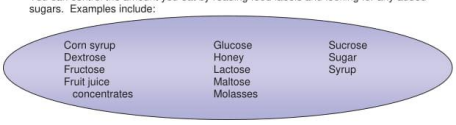
Simple carbohydrates or simple sugars: they are broken down and digested very quickly, but most contain refined sugars and very few essential vitamins and minerals.
e.g. *table sugar, fruit juice, honey, molasses, maple syrup and brown sugar*

Complex carbohydrates: they take longer to digest and contain fibre, vitamins and minerals.
e.g. *vegetables, whole grain breads, oatmeal, brown rice and wheat pasta*

So?

When you eat/drink foods with simple carbohydrates/sugars (can of pop or glass of orange juice) the sugars are quickly digested and released into your bloodstream. You may feel a quick rush of energy and, for the moment, you have significantly higher blood sugar, but then your body releases a large amount of insulin to clear the excess sugar from your blood. The result is a sense or feeling of needing more food, more energy, more calories. You begin to crave more of these quick-release, simple sugars – and so begins the cycle of excess calorie consumption.

You can control the amount you eat by reading food labels and looking for any added sugars. Examples include:



Not ALL simple carbohydrates are unhealthy. Nutritious foods like fruit and milk contain them and should make up the bulk of your simple sugar intake.

Become a Sugar Detective!

Simple sugars can be disguised in food products by being listed by another name – but it's important to remember, they're still simple sugars. Here are some examples:

Fructose	Sweeter than sucrose so you don't need as much, but it's still sugar.
Honey	Made up of multiple simple sugars, predominantly containing glucose and fructose. Has trace calcium, iron and phosphorus however, you'd have to eat 40 cups of honey/day to meet your calcium needs, and 10 cups for your iron.
Brown Sugar	Equivalent to white sugar – is made by adding molasses to white sugar
Corn syrup	Combination of glucose and fructose and has a higher shelf-life than either of those sugars alone.
Molasses	By-product of table sugar from cane sugar.
Raw Sugar	No more nutritious than, and same number of calories as table sugar.

Did you know…?

Liquid Candy - Sugar is usually consumed in a concentrated form, so those calories can add up quickly.

If you drink a 355mL can of Coke each day:

- You'll gulp 150 calories and almost 10 teaspoons of sugar.
- Over the course of one year, that adds up to almost 55,000 calories.
- It takes 3600 calories to make up one pound of body fat, so we're talking about 15 pounds.

Salt Lick

That's what our foods sometimes are! Sodium is a nutrient found in table salt and many other foods and while the body needs some to function, too much can lead to high blood pressure – a major risk factor for stroke, heart disease and kidney disease. Most of us consume far more sodium than is good for our health!

Our bodies, to run smoothly, only need 1500mg of sodium per day. Health Canada states that our upper intake level – the highest level that is likely to pose no threat to our health – is 2300mg. That means that we should not exceed that amount in our daily intake of sodium. But most of us do. And most of us are not aware that we do. Research shows that the average Canadian consumes over 3000mg of sodium per day.

Do you add salt to your foods?

1 teaspoon can hold 6 grams of salt
6 grams of salt contains about 2400mg of sodium

Most of the sodium we consume comes from pre-packaged, ready-to-eat foods and when eating at restaurants, rather than from salt added at the table or in home cooking. Furthermore, sodium is often used by the food industry for taste enhancement or as a preservative so many common foods contain sodium. This makes being knowledgeable about the foods we buy that much more important.

Tips for Reducing your Sodium Intake

- Read nutrition labels to make informed decisions.
- Choose foods that are known to be high in sodium less often. These foods include: *restaurant food, soups, pizza, frozen and ready-to-eat meals, gravies and sauces, processed luncheon meats and snack foods such as crackers, nachos, potato chips and pretzels.*
- Choose fresh, unprocessed foods to eat and prepare more meals at home instead of relying on pre-packaged convenience foods and meals – including canned vegetables.
- Look for foods with claims of "salt-free" (less than 5mg of sodium per serving), "low in sodium" (140mg of sodium or less per serving) or "reduced in sodium" (at least 25% less than the regular product).
- When dining out, order dressings and sauces on the side and use sparingly – and, as always, check the establishment's nutrition information if available to help guide you in your choices.

Know Your Fats

Most of the foods we eat contain different kinds of fat, some of which are better for you than others BUT - ***Don't cut out all of the fat – fat is important!***

- Fat supplies energy
- Fat provides essential fatty acids (omega-3 and omega-6) which are needed throughout life and cannot be made by our bodies
- Fat is needed for proper growth and development in children
- Fat is required for the absorption of vitamins A, D, E, and K

A healthy diet includes choosing a small amount of "healthy fats" while limiting "harmful fats"

Healthy Fats
These include monounsaturated and polyunsaturated fats (including omega-3 fatty acids). By choosing these over others, can lower your risk of heart disease by reducing the levels of bad cholesterol (LDL) in your blood.

The best sources of these healthy fats are as follows:

Type of Fat	Major Food Sources	Health Benefits
Monounsaturated	olive oil, peanut oil, canola oil, avocados, nuts and seeds	Helps lower bad cholesterol
Polyunsaturated • Omega-3 Fat ○ *DHA and EPA* ○ *ALA (linolenic acid)*	Fatty, cold-water fish (salmon, mackerel and herring), certain brands of milk and eggs	Helps lower the risk of heart disease and stroke through lowering trigylcerides, reducing inflammation and keeping artery walls relaxed
• Omega-6 fat	Canola, soybean and flaxseed oils, some nuts and seeds (e.g. walnuts), and some margarines, yogurt, cheese and milk beverages (check the label)	Some research suggests they might reduce the risk of certain cancers and treat depression and arthritis
	Vegetable oils (safflower, corn, sunflower, soy and cottonseed oils)	Helps maintain healthy skin, hair and nails

Harmful Fats
These fats – saturated and trans fats - can increase your risk of heart disease by increasing the levels of your bad cholesterol (LDL) and in fact, trans fats can also decrease your good cholesterol (HDL). Dietary cholesterol, while not technically a fat, is found in foods from animals and can increase blood cholesterols.

Common food sources of these fats are:

Type of Fat	Major Food Sources	Potential Health Risks
Saturated	animal products (meat, poultry, seafood, eggs, dairy products, lard and butter), and coconut, palm and other tropical oils	May raise bad (LDL) cholesterol
Trans	partially hydrogenated vegetable oils, commercial baked goods (crackers, cookies and cakes), fried foods (doughnuts and French fries), shortening and margarine	Raises bad (LDL) cholesterol and lowers good (HDL) cholesterol – high consumption of trans fat increases the risk for heart disease 3-fold!
Dietary Cholesterol	animal products (meat, poultry, seafood, eggs, dairy products, lard and butter)	May raise bad (LDL) cholesterol in the blood of high risk individuals

Tips for Choosing Unsaturated Fats:

Choose…	Instead of…
Soft, non-hydrogenated margarines	Butter, shortening, hard margarine or lard
Olive or canola oil for stir frying and sautéing	Butter, lard, hard margarine
Salad dressings made with olive oil or canola oil	High fat, creamy dressings
Small portions of unsalted nuts, seeds or soy nuts	High fat, salty snack foods such as chips
Fish such as salmon, mackerel or trout	High fat cuts of meat such as ribs or hot dogs
Walnuts or sesame seeds for salad toppings	Croutons or bacon

How much do I need?
Health Canada recommends that adults should limit their fat intake to 35% of their daily calories. To calculate: If your daily caloric intake is 1800: Multiply 1800 by 0.35 to get 630 calories, and divide that number by 9, the number of calories per gram of fat, to get 70 grams total fat.

Label Reading

Fat: remember that you want less than 35% of your daily calories to come from fat (Week 16) and less than 10% to be from saturated fat. Choose products that have no trans fat.

Carbohydrates: look to consume 25 grams of fibre per day and choose products that are low in sugars (e.g. breakfast cereals and granola bars should have no more than 8-10 grams of sugar per serving)

Protein: aim to consume 0.8g of protein per kg of body weight
e.g. if you weigh 100kg:
100 x 0.8 = 80g protein/day
Choose lean sources of protein (low-fat dairy, lean cuts of meat, poultry, fish)

Nutrition Facts

Serving Size 1 ounce	Servings in bag 4
Amount Per Serving	
Calories 155	Calories from Fat 93
	% Daily Value*
Total Fat 11g	16%
Saturated Fat 3g	15%
Trans Fat	
Cholesterol 0mg	0%
Sodium 148mg	6%
Total Carbohydrate 14g	5%
Dietary Fiber 1g	5%
Sugars 1g	
Protein 2g	
Vitamin A 0% • Vitamin C 9%	
Calcium 1% • Iron 3%	

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

Serving Size: the actual package size is not always the same as the serving size and this can be very misleading. Also, the serving size listed might be much smaller than what you would consider a serving size.

Sodium: look to consume a maximum of 2300mg of sodium per day. Remember that sodium is found is common foods and your maximum is easily met (e.g. 1 cup chicken %vegetable soup = 790 mg sodium')

Calcium & Iron: ensure that you're getting adequate amounts of these and talk to your doctor about whether additional supplementation is needed

Did you know…?

When you look at the list of ingredients on a food product, they are listed in order of the ingredient used in the greatest amount first, followed in descending order by those in smaller amounts. This information can be used in addition to the food label to find products that are high in sugar, salt and fat.

The Myths and Facts of Fad Diets

Mayo Clinic. **Dietary Fats: Know which types to choose**.
http://www.mayoclinic.com/health/fat/NU00262

Myth: *Fad diets work for permanent weight loss.*

Fact: Fad diets are not your best choice to reduce weight gain or maintain weight loss. While they offer you a quick fix solution and you may initially have success, these diets usually restrict calories and certain food groups making it hard, if not impossible, to follow long-term. Most people will regain the weight – and often more.

Additionally, these diets do not allow you to consume all the nutrients your body needs and this can be very unhealthy. Watch for diets that result in rapid weight loss (more than 3 pounds per week) as these are likely ones that are not sustainable. If, following pregnancy, you are needing to lose weight, look to lose ½ to 2 pounds per week by following a healthy and balanced eating plan and incorporating physical activity into your lifestyle.

Myth: *High-protein, Low-carbohydrate diets are a healthy way to reduce weight gain or maintain weight.*

Fact: The long-term effects of these diets are unknown and this lack of knowledge is perhaps even more alarming for pregnant women. Regardless, a diet plan that encourages one to get most of their calories by eating high-protein foods such as meat, eggs, and cheese is **NOT a balanced eating plan**. The danger is that you might be eating too much saturated fat thereby raising your bad cholesterol levels. Furthermore, you are not eating enough fruits and vegetables that supply many of our essential nutrients and the fuel/energy that our body needs to function resulting in feeling nauseous, tired and weak.

There is a risk of developing ketosis (a result of too few carbohydrates that can lead to a build-up of partially broken down fats in your blood) that is risky for pregnant women.

A reduced calorie eating plan that includes the recommended amounts of carbohydrates, protein and fat will also allow for reduced weight gain or weight maintenance, will give you the necessary nutrients AND will not make you feel as though you are restricting yourself from certain food groups making it easier for you to stick with the eating plan.

Does low-fat or fat-free mean no calories?

While these products are often lower in calories than the same portion of the regular full-fat product, that isn't always the case. Many of them contain added sugar, flour or thickeners to improve flavour and texture after the fat is removed and these ingredients add calories. It's important to always read the ingredient list and nutrition information panel.

Myth: *Carbohydrates (starches) are fattening.*

Fact: These foods (bread, rice, pasta, cereals, beans, fruits, potatoes, yams) become high in fat only when eaten in large quantities (portion sizes) or when covered in high-fat toppings or sauces (butter, sour cream, mayonnaise). It's important to remember that foods high in starches are also high in energy for your body.

One should choose starchy foods that are high in fibre (fruits, vegetables, whole grains), low in saturated fat (choose low-fat dairy) and low in salt (sodium) and added sugars.

Myth: *Certain foods like grapefruit, celery, or cabbage soup, can burn fat and make you lose weight.*

Fact: No food can "burn fat". Caffeine containing foods may speed up your metabolism thereby increasing the amount of calories your body uses, but this is only temporary and does not cause weight loss.

The best way to lose weight gained during pregnancy is to, following pregnancy, cut back on calories, eat balanced meals, and to increase the amount of physical activity you do.

Myth: *Natural or herbal weight loss products are safe and effective.*

Fact: A claim of "natural" or "herbal" does not necessarily mean that it's safe. These products have not always been scientifically tested or proven and the quality control of their content is lacking. Using these can be very dangerous. **Talk to your physician before using any weight-loss product.**

Is skipping meals a good way to reduce weight gain or maintain weight?

Research has shown that people who skip breakfast and eat fewer times during the day tend to be heavier than those who eat a healthy breakfast and eat four to five times a day.

It's thought that people who skip meals tend to feel hungrier later on, and eat more than they normally would. Also, it might be that eating many small meals throughout the day helps people control their appetites because they are never "starving".

Fabulously Functional Foods

While we enjoy the taste of foods and understand that they give us energy and supply us with necessary vitamins and minerals to keep us healthy, there are some foods that can be called *Functional Foods*. These are foods that, because of some of their components, may provide "extra" health benefits.

Functional foods can also include fruits and vegetables, whole grains, fortified or enhanced food (e.g., cereal), beverages and dietary supplements. Below is a list of functional foods that include specific part of the food that provides the benefit (source), they types of foods they can be found in and their potential health benefit.

Functional Component	Food Source	Potential Benefits
Carotenoids		
• Alpha-carotene • Beta-carotene	• carrots, fruits, vegetables	• Contain antioxidant properties to fight off and prevent damage to our cells
• Lutein	• kale, collards, spinach, corn, eggs, citrus	• May contribute to maintenance of healthy vision (prevent risk of macular degeneration)
Dietary Fibre		
• Insoluble fibre	• wheat bran, corn bran, fruit skins	• Can help maintain a healthy digestive track • May reduce the risk of colon and breast cancer
• Beta glucan	• oat bran, oatmeal, oat flour, barley, rye	• May reduce the risk of cardiovascular disease
• Soluble fibre	• psyllium seed husk, peas, beans, apples, citrus fruit	• Protection against some cancers • Lowers bad cholesterol (LDL)
Fatty Acids		

Monounsaturated	• olive oil, peanut oil, canola oil, avocados, nuts and seeds	• Helps lower bad cholesterol
Polyunsaturated • Omega-3 Fat ○ *DHA and EPA*	• fatty, cold-water fish (salmon, mackerel and herring), certain brands of milk and eggs	• Helps lower the risk of heart disease and stroke through lowering triglycerides, reducing inflammation and keeping artery walls relaxed
○ *ALA (linolenic acid)*	• canola, soybean and flaxseed oils, some nuts and seeds (e.g. walnuts), and some margarines, yogurt, cheese and milk beverages (check the label)	• Some research suggests they might reduce the risk of certain cancers and treat depression and arthritis
• Omega-6 fat	• vegetable oils (safflower, corn, sunflower, soy and cottonseed oils)	• Helps maintain healthy skin, hair and nails
Phenolics		
Anthocyanidins	• fruits	• Contain antioxidant properties to fight off and prevent damage to our cells.
Catechins	• tea	
Flavonones	• citrus	
Flavones	• fruits/vegetables	
Lignans	• flax, rye, vegetables	• May help prevents cancer and renal failure
Tannins	• cranberries, cranberry products, cocoa, chocolate	• May improve urinary tract health • May reduce cardiovascular disease
Plant Sterols		
Stanol ester	• corn, soy, wheat, wood oils	• May lower blood cholesterol levels by inhibiting their absorption

Getting Active!

It's time to get active! Let us help you create your very own fitness plan for you to follow during your pregnancy – one that can be done anywhere and will help improve the health of you *and* your baby.

Health Benefits of Exercise and Physical Activity during Pregnancy:

- Decreased chance of pre-eclampsia (high blood pressure related to pregnancy which can be associated with serious complications to mother and/or baby)
- Decreased chance of caesarean delivery
- Decrease chance of developing gestational diabetes
- Improved mood
- Reduction of pregnancy discomforts – backache and lower extremity swelling
- Possible prevention of Type 2 diabetes
- Possible prevention of chronic hypertension

"*Experts say that there is no better time than during pregnancy to become more active – it improves your health and the health of your baby*"

So where do you begin?

To get your mind in gear, list a few physical activities that you enjoy doing and are able to fit into everyday life:

_____

_____

Why do you enjoy these activities?

_____

_____

How often do you do them per week or month?

_____

_____

In creating my plan, what do I need to include in each of my workouts? And why?

1. Getting Started – **The Warm-Up**

- warms your muscles by increasing blood flow through your body;
- increases delivery of oxygen and nutrients to your muscles by increasing blood flow;
- prepares your muscles for stretching;
- prepares your heart for an increase in activity;
- prepares you mentally for the upcoming exercise; and
- activates your nerve-to-muscle pathways to be ready for exercise.

How do I warm-up?

- To make your warm up effective, you need to do movements that increase your heart rate and breathing, and slightly increase the temperature of your muscles.
- Start slow and gradually increase the intensity of your movements until you feel warm and breathing deeply
- When you have raised a light sweat and have colour in your face you know you've "warmed up"!
- Allow 5 to 10 minutes for your warm-up (or slightly longer in cold weather).

5 minute rule

Even if you feel as though your day couldn't get worse, you're tired and just don't feel like moving…try it. Get up and do 5 minutes of the scheduled activity. Chances are, you'll feel energized and will want to finish. But, if even after 5 minutes, you feel that today just isn't the day and your body says no, then stop and try again tomorrow.

2. Finishing up – **Cool Down + Stretching**

Why cool down?

- helps your heart rate and breathing gradually return towards normal;
- helps prevent fainting or dizziness, which can result from blood pooling in the large muscles of the legs when activity is stopped suddenly;
- helps prepare your muscles for the next exercise session, whether it's the next day or in a few days' time; and
- helps to remove waste products from your muscles, such as lactic acid, which can build up during intense activity.
- PLUS it is relaxing and a good time to reflect on your accomplishments of the workout!

How?

- perform low intensity (concentrate on deep breathing, slowing your heart rate and keeping your hands below your heart) exercise for a minimum of 5 to 10 minutes; and
- follow this with a stretching routine.

Reward Yourself and Stretch

Like aerobic endurance and muscle strength, flexibility provides anti-aging benefits

Everyone can learn to stretch, regardless of age or flexibility. And ANY time during the day is a good time:

- In the morning
- After sitting or standing for long periods
- Any time you feel tense or stiff
- At odd times e.g., watching T.V., reading, or sitting and talking
- Post-exercise

Be careful not to over-stretch. Early in pregnancy, a hormone called relaxin fills your system. This hormone induces hyper-flexibility in the joints and musculature, which allows for the expansion of the uterus and the repositioning of the pelvic floor. It is common for women to strain muscles and ligaments during pregnancy as a result of this new flexibility. It is still important to stretch after exercising- just know your limits and try not to exceed them.

Why Stretch?

As you age or when you don't use your muscles as much, your muscles tighten and the range of motion in a joint can be minimized. This can put a halt to active lifestyles and even hinder day- to- day, normal activities (lifting clothes out of the washing machine).

A regular stretching program can help lengthen your muscles and restore regular activity. However, we must be aware of our individual physical limitations including stage of pregnancy. Stretching can:

- Relax your mind and "tune up" your body
- Preserve your range of motion
- Maintain flexibility
- Prevent injury during activity
- Prepare muscles for more intense activity
- Help develop your body awareness
- Promote circulation

I want to stretch…but am not sure how to stretch safely!

Frequency: *At least 3 days per week*

Intensity: *To your own limits – do not compare and compete with those around you.*

Duration: *Hold stretch for 10 seconds working up to 30 seconds. Relax and repeat 2 more times.*

- *Stretch slowly and smoothly; Never bounce*
- *Maintain normal breathing during each movement*
- *Focus attention on muscle being stretched; try to limit movement in other body parts*
- *Feel the stretch, but don't strain by stretching too far*

In your group exercise sessions you will learn how to perform safe and effective stretches – to ensure get the most benefit, do these same stretches following the physical activity you do on your own! In addition, below and on the following pages, there are stretches listed that you can try on your own.

Shoulder Circles

- While seated or standing, rotate your shoulders backwards and down in the largest circle you can make. This open the chest, counteracting the rounded shoulders so many pregnant women get.

Chest Stretch

- Standing in a doorway, place both hands at shoulder height on either side of the doorway, elbows bent. Step your right foot forward until you feel a slight stretch in the chest muscles (being careful not to stretch too much). Hold for 30 seconds.
- Switch feet, stepping your left foot forward. Hold for 30 seconds.

Roll-down

- Stand with your back against a wall, your feet about shoulder width apart, a comfortable distance form the wall, knees slightly bent. Inhale, then as you exhale, draw in your abdominals, moving your chin toward your chest as you roll your torso down one vertebra at a time. "Roll" as far down as you're comfortable going. Keep your weight centered between your feet.
- Inhale at the bottom or the roll-down, and as you exhale, roll back up, trying to "print" each vertebra on the wall. As you return to an upright position, make sure your head is the last part of your body to uncurl. Repeat.
- Note: as your pregnancy progresses, you can modify this pose by doing it seated in a chair with your feet wide apart to make room for your belly. Sitting right on the edge of the chair, inhale, then exhale as you move your chin toward your chest and roll your body forward and down. Your hand can hang between your legs. Inhale, then exhale as you roll all the way up.

Waist Twist

- Stand with your feet should-width apart for stability, knees slightly bent.
- Extend both of your arms toward your left side at shoulder height while looking over your right shoulder. Hold the stretch and breathe into it.
- Moving slowly, reverse the motion, switching your arms to the right while looking over your left shoulder. Repeat.

Wall push-up and calf stretch

- Stand about 2 feet from a wall with your arms extended in front of your shoulders.
- Reach your hands to the wall and lean forward bending your elbows on an inhale as your body tilts
- Keep your heels on the floor to stretch your calf muscles (Don't do this exercise in socks or slippery shoes; you want to stay put)
- Exhale, contract the abdominals, and slowly push away from the wall to straighten up.

Mermaid

- Sitting on the floor, sit tall with your knees bent to the right and heels close to your bottom.
- With your left hand (note the picture does not show this correctly), hold your left ankle for support as your right hand extends overhead.
- Inhale, then exhale and reach up and over to the left side.
- Inhale and hold the stretch. Exhale to return to an upright position.
- Repeat one more time on your right side before moving to the left.
- You will feel a stretch in the sides of your waist, hip, and lower back. Repeat twice while sitting on your left hip.

Thigh and hip flexor stretch

- Lie on your left side with your head on a pillow or a folded towel. Slightly bend the left leg for stability
- Bend your right leg, moving your foot toward your bottom, and take hold of your right ankle.
- Gently pull the heel closer to your bottom and draw in your abdominals to support your lower back.
- You should feel a stretch in the thigh and deep hip flexors. Hold for 30 seconds.
- Release and switch sides, lying on your right side.

Exercise is SAFE for most pregnant women unless they have been advised by their doctor that a complication of their pregnancy requires them to limit physical activity. However, there are some <u>Exercises to Avoid during Pregnancy</u>:

- Exercises that require you to lie on your back (e.g. sit-ups)
- Excessive turning or twisting activity
- Exercises that require you to hold your breath
- Exercises that require you to stand still or on one leg for a period of time as these can place excessive strain on the joint at the front and pack of your pelvis
- Pushing off with one leg during swimming – try to push off with both feet when you turn at the end of the pool
- Highly choreographed exercises or those which involve sudden changes in direction
- Lifting your hip up to the side (hip abduction) while kneeling on your hands and knees
- Activities that involve sudden changes in intensity
- Exercises which increase the curve in your lower back (your lumbar spine)
- Prolonged bouncing as this can overstretch the pelvic floor muscles

In addition to the group fitness classes you attend twice a week, you are exercising on your own at least 3 other days during the week. To help motivate and track your progress, using a Physical Activity Log can really help!

<u>Physical Activity Log</u>

Week of: *March 2nd*			
Date	**Activity**	**Time**	**Comments**
Monday	*Swimming*	*25 minutes*	*Swam 2 more lengths than normal!*
Tuesday	*Group Fitness*	*45 minutes*	*Had a great time! Felt stronger!*
Wednesday	*Walking*	*20 minutes*	*Wanted to do 30 minutes, but felt very tired and had to cut it short – walked with my best friend.*
Thursday	*Group Fitness*	*45 minutes*	*Had to reduce my intensity a little, but felt about myself for doing the class.*
Friday	*Yoga*	*45 minutes*	*Did my first Yoga for Pregnancy class – found it challenging, but am looking forward to more!*
Saturday	*Chores at home*	*2 hours*	*Have guests coming and had to clean the house! Got my heart rate up!*
Sunday	*REST*		*Enjoyed some down time!*

<u>Note:</u> This is different from the Physical Activity Log you will be asked to complete for the study. This one, is a simpler version and is meant to motivate you, help you find ways to improve your fitness plan and see your success.

Weekly Physical Activity Log

Record the activities you did each day and any comments that will help motivate you for next time or help remind you how to better prepare and do the exercise so that you get the most out of it!

Week of:			
Date	**Activity**	**Time**	**Comments**
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			
Sunday			

What do you plan to do next week?

Monday:_____ Friday:_____

Tuesday:_____ Saturday:_____

Wednesday:_____ Sunday:_____

Thursday:_____

Exercise Safety + Injury prevention

- Drink plenty of water before and after exercise
- Wear socks and shoes that are comfortable (and keep your feet dry if outside)
- Wear comfortable clothing that won't restrict your breathing or prevent your body from cooling itself
- Listen to your body, start off slow, warm-up, cool-down, stretch
- Know when to stop- discomfort, pain, nausea, shortness of breath, feeling light headed
- If you do get a sprain, strain, "pull" or bruise – think R.I.C.E.-
  - Rest
  - Ice
  - Compress
  - Elevate
- Seasonal factors- dress for the weather and avoid extreme hot and cold conditions

If in doubt, call your doctor

Fuelling your Body for Exercise

Before Exercise:

Choose a snack that is mostly carbohydrates (see Week Four – Eating 4 Energy) to give your body the energy it will need. Make sure you eat at least 1 hour before exercise, but be careful not to eat too close to exercise to avoid being uncomfortable with a full stomach.

After Exercise:

Choose a snack or meal that has both proteins and carbohydrates to repair your muscles that have worked very hard and to replenish your energy stores.

Planning your snacks and meals around your physical activity will help give you the right amount of energy at the right time and keep your blood sugar levels balanced!

Snack and Meal Planning for Exercise

If you plan your meals and snacks ahead of time you'll be more likely to have them with you and remember to eat them at the right time.

My pre-exercise snack/meal will be:

_____

(e.g. 1 piece of 100% whole grain bread with 2 tsp of raspberry jam)

I will eat my snack/meal:

_____

(e.g. I will eat it at 4:45pm because I'm meeting my best friend to walk for 30 minutes at 5:30pm)

My post-exercise snack/meal will be:

_____

Remember to eat your post-exercise snack as soon as you can – if you're doing your exercise somewhere other than at home, then be sure to bring it with you!

Aerobic Fitness Frenzy!

What is Aerobic Activity?

Activities that use large muscle groups continuously and force the heart and lungs to work hard is considered aerobic in nature. Aerobic activity is very important to our health and so it's important that we get our bodies moving and hearts pumping!

There are MANY aerobic activities to choose from – the key is to find the ones that you enjoy doing so that you'll want to get out and MOVE to a healthy lifestyle!

What are the benefits of doing Aerobic Activity

- Decreased chance of pre-eclampsia
- Decreased chance of caesarean delivery
- Decrease chance of developing gestational diabetes
- Improved mood
- Reduction of pregnancy discomforts – backache and lower extremity swelling
- Possible prevention of Type 2 diabetes
- Possible prevention of chronic hypertension

How hard should I be working?

The Talk Test

You want to be working at an intensity that increases your breathing rate but still allows you to carry on a light conversation (short sentences) without discomfort. If you can do this, you're working at level that will give you health benefits. However, if you are able to carry on full conversations you should aim to increase your intensity slightly.

If you find yourself unable to do carry on a light conversation because you find it too uncomfortable, slow down to a lower intensity.

Borg Scale

Another way to check in with yourself to make sure your working hard enough (and not working too hard) is with what's called the Borg Scale and the Rate of Perceived Exertion (RPE):

6	No exertion at all
7	Extremely Light
8	
9	Very Light
10	
11	Light
12	
13	Somewhat Hard
14	
15	Hard (heavy)
16	
17	Very Hard
18	
19	Extremely Hard
20	Maximal Exertion

You want to target your workouts so that you feel your exertion to be between 12 and 14 on the scale

Did you know…?

A great post-exercise snack is 1 cup of chocolate milk – it has both the carbohydrates your body needs to replenish its energy stores and the protein required for muscle repair and growth! But, keep it to 1 cup otherwise you'll be consuming more sugar than you need!

Strong, Lean Muscles

Why should I add strength training to my exercise plan?

…Your Strength
You will be able to do everyday tasks, like lifting, carrying and walking up stairs with greater easer

…Your Posture
The way you sit and stand is influenced by a network of neck, shoulder, back, hip and abdominal muscles. Stronger muscles can help you stand and sit straighter and more comfortably.

…Your Muscle Tone
Your muscles, while not perceptibly larger will seem firmer and better defined.

…Your Body Composition
Your overall weight may not change, but you will gain muscle tone and lose fat. Fat loss will be fairly even all over your body, but you will notice it most where you have the most.

…Your Likelihood of Injury
Strong muscles, tendons and ligaments are less likely to give way under stress and cause an injury. This may be important if you are participating in activities like skiing, running, soccer, basketball, tennis or fitness class – but is also important when walking on the icy sidewalk in the winter!

…Your Image of Your Body
You will soon discover a more positive, stronger image of your body as your muscles become stronger and more capable. You may start to see yourself in a more accepting way, rather than finding fault with your body.

Quick Tips:

1. **Challenge yourself!**
   - In order to get results, you must challenge and push your muscles to work a little bit harder than they're used to in everyday lifting and pushing.

2. **How heavy and how many?**
   - While pregnant, focus on lifting lighter weights with more repetitions. What this means is that, for any given exercise, choose a weight with which you can perform 10-15 continuous repetitions for that exercise.

Note: *if you're able to easily do 16, 17, 18, etc repetitions you should consider increasing the weight in order to reap the benefits of your strength training!*

3. **Breathing Right**
   - When lifting weights or working muscles against resistance, exhale through the mouth as you are performing the work (e.g. Bicep Curl: breathe out as you are bringing the weight up and breathe in as you are lowering it back down)

Caution: *Failure to breathe correctly during weight lifting may cause increases in blood pressure that may be harmful. So breathe freely and follow the 'talk test'.*

4. **Putting your workout together**
   - Start with a warm-up - focusing on the muscles groups that will be challenged during your strength training. E.g. if you will be doing upper body exercises, be sure to warm up the upper body sufficiently during the warm up.
   - During your workout – start with exercises that challenge the major muscle groups (legs, chest, back) before moving onto the smaller muscles groups (shoulder, biceps and triceps)
   - Finish with a cool-down and stretching. The cool down will help prevent blood from pooling in your extremities (legs) and the stretching will help increase blood flow to the muscles and increase flexibility and range of motion in the muscles and joints.

References & Resources

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Week 7

PROGRESS CHECK-IN

Changes you've made to be more active:

_____
_____
_____

Changes you've made to eat healthier foods:

_____
_____
_____

Are there any steps you can take to improve your progress?

_____
_____
_____
_____
_____

Have you succeeded in any of your short term goals? If so, what are your new short term goals that will help you achieve your General Goal?

_____
_____
_____
_____

Goal Setting Sheet

General Goal: _____

Why? _____

More Specific Plan/Short Term Goals:

_____

_____

_____

_____

Obstacles	Action Steps

Success Indicator:

_____

_____

Reward: _____

Witness: _____ Date: _____

Week 13

PROGRESS CHECK-IN

Changes you've made to be more active:

_____

_____

_____

Changes you've made to eat healthier foods:

_____

_____

_____

Are there any steps you can take to improve your progress?

_____

_____

_____

_____

Have you succeeded in any of your short term goals? If so, what are your new short term goals that will help you achieve your General Goal?

_____

_____

_____

_____

Goal Setting Sheet

General Goal: _____

Why? _____

More Specific Plan/Short Term Goals:

_____

_____

_____

_____

Obstacles	Action Steps

Success Indicator:

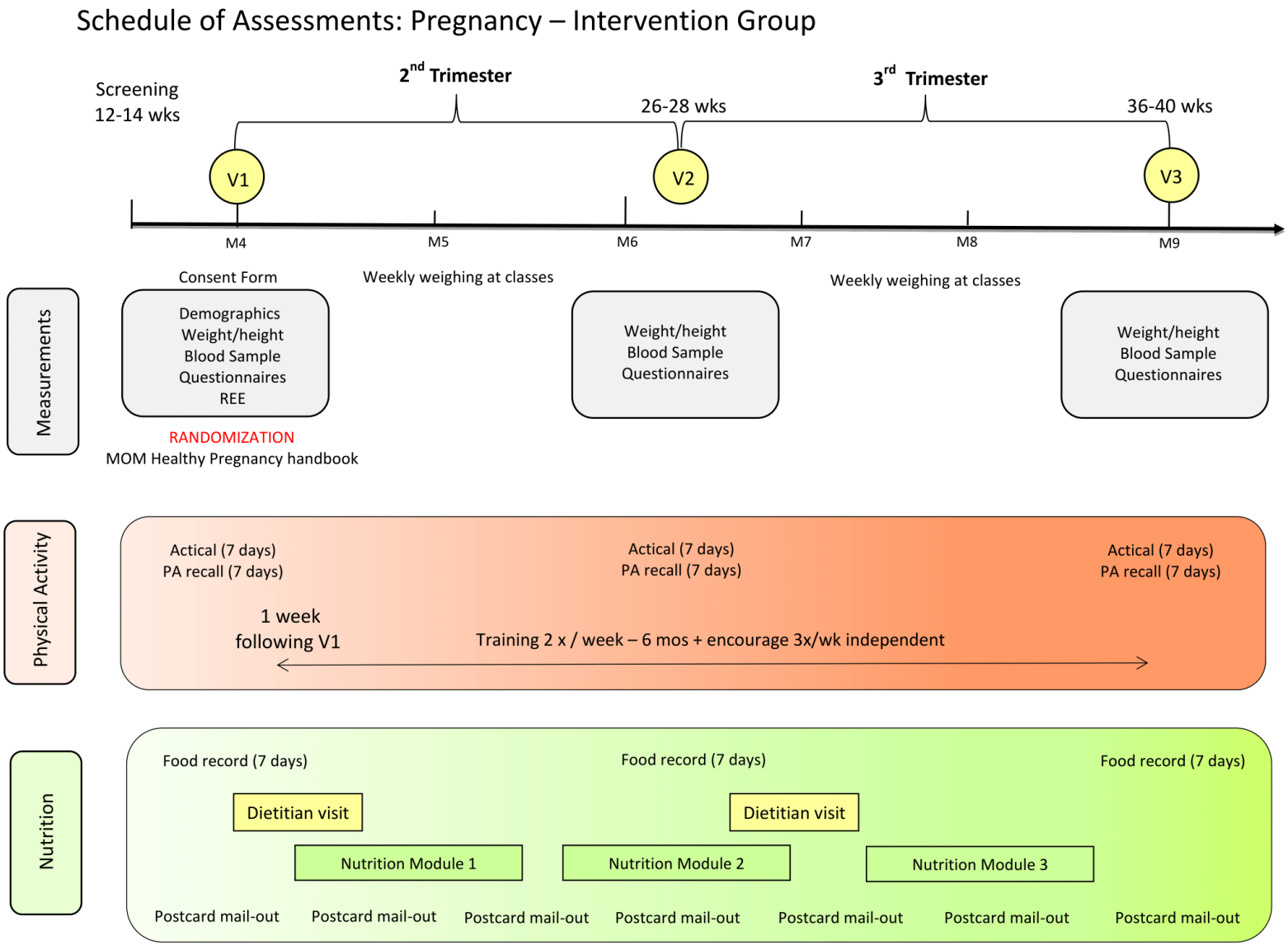
_____

_____

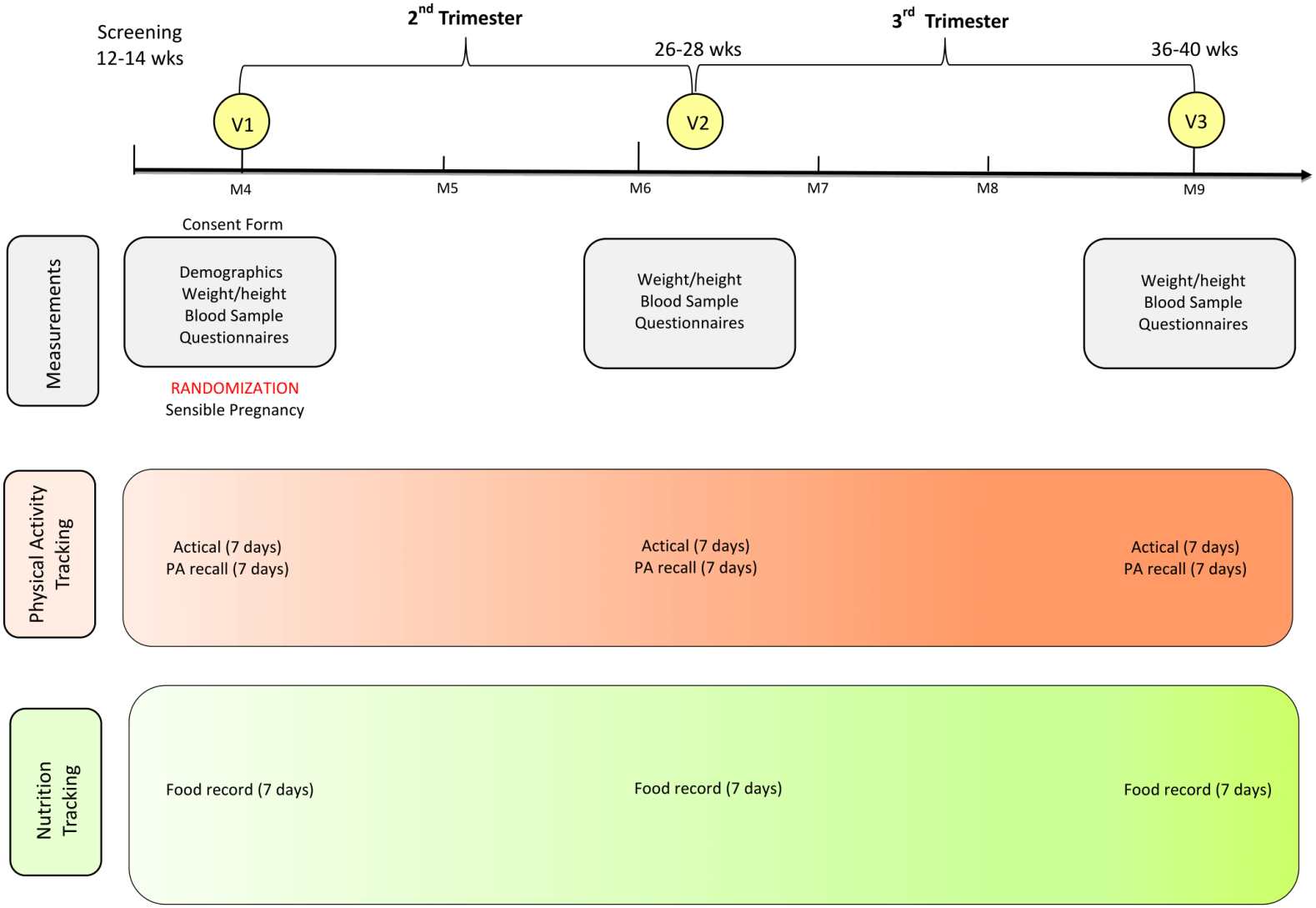
Reward: _____

Witness: _____ Date: _____

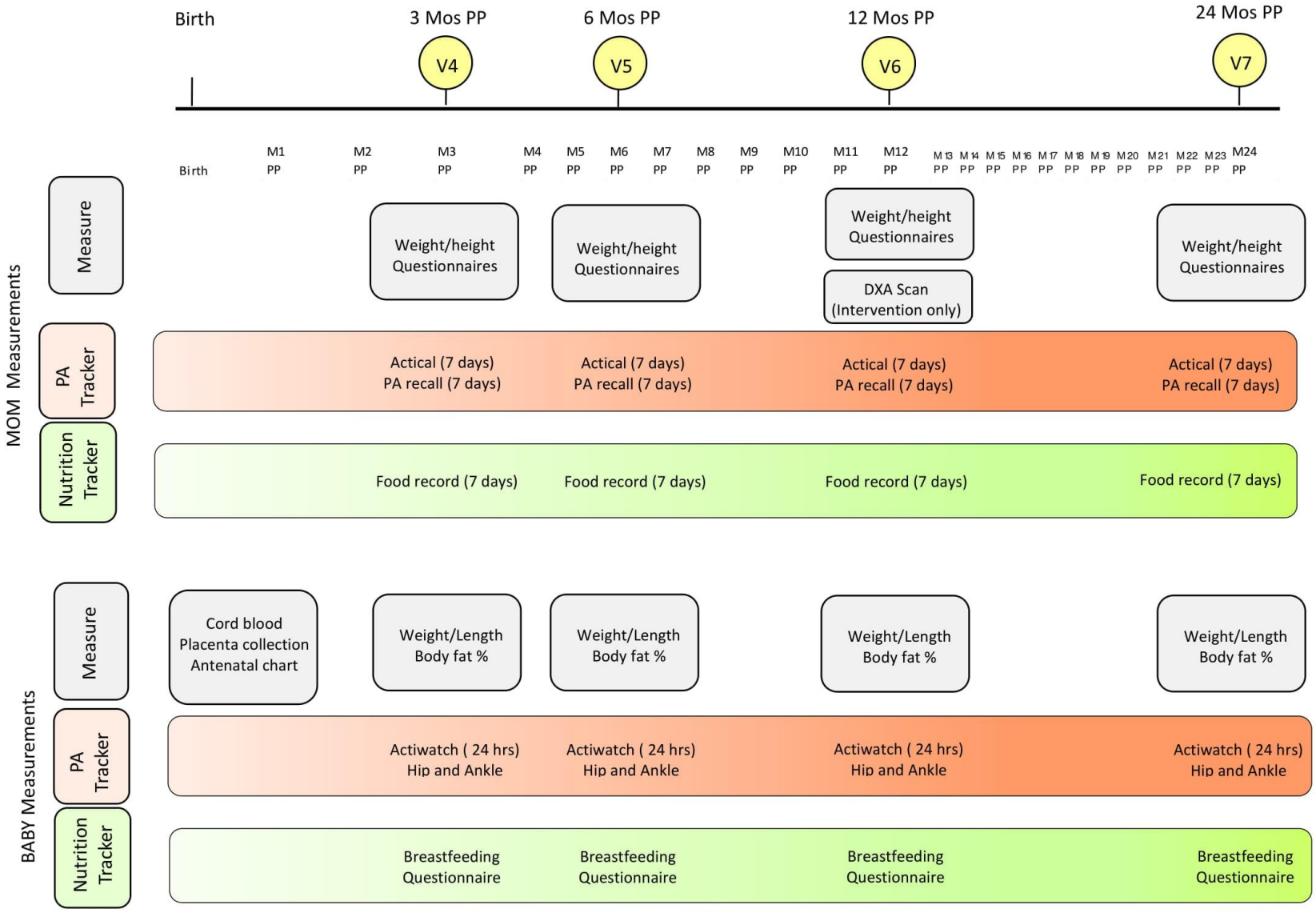
APPENDIX 2: MOM TIMELINE



Schedule of Assessments: Pregnancy – Control Group



Schedule of Assessments: Postpartum – Intervention & Control Groups



APPENDIX 3: 7-DAY FOOD RECORD EXAMPLE

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ID: M O M O V 1

7-day Dietary Record

***Purpose**:* To determine your food consumption with the goal of obtaining an accurate profile of your usual eating habits.

***Instructions**:*

- It is very important that you be as **specific** and **detailed** as possible in your **descriptions of foods** and **quantities consumed (ml, teaspoons, tablespoons, grams, ounces, etc…)**. To help you, questions to trigger your memory have been placed on the right hand side of the page for each meal and snack period.
- Give a detailed description of all foods e.g. if you have a sandwich, list all ingredients (butter/mayonnaise/mustard, lettuce, tomatoes, etc). Use one line per ingredient.
- For recipes, specify the **quantity** of each ingredient (e.g. shepherd pie, lasagna, salads); attach the recipe to this journal.
- Indicate **precisely the method** of preparation (e.g. raw, boiled, steamed, cooked in the microwave, pan-fried, fried in oil, smoked, grilled in a pan, grilled on the BBQ, stewed, poached, roasted…)
- Indicate precisely the temperature and cooking time, when available (eg, chicken breast, roasted in the oven at 425 ° F for 25 min; chicken breast cooked in the microwave at moderate intensity for 5 min).
- Indicate the type and amount of **fat added** (eg. 1 tsp. of olive oil, 2tbsp of non-hydrogenated margarine, 3g of butter) when preparing, cooking and consuming foods. Also indicate condiments added (1tbsp of jam, 2 tbsp of peanut butter, 1tsp.of dressing, 2 tsp. of mustard…).
- Cut out the **food's label** (nutrition information) whenever possible and include them to this journal.
- Indicate **Brand** of products, if possible (e.g. Kraft, Smuckers…).
- If you eat out, specify the name of the **restaurant**.
- We ask you to indicate **all** food intake **(including water, beverages and supplements i.e., vitamins, minerals, natural products, herbal products)** for seven days in the tables provided on the following pages. Write the foods and beverages as soon as possible after their consumption.

The more detailed your dietary recall is,
the more precise will be the profile of your eating habits.

If you have any questions, please do not hesitate to ask

Research Coordinator (613) 737-7600 x3271 Kristi Adamo (613) 737-7600 x4190

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ID: M O M O V 1

EXAMPLE **Week-end? ☐ yes ☐ no**

MEAL	TIME	PLACE	NAME AND DESCRIPTION OF FOOD	QUANTITY	DID YOU REMEMBER THE FOLLOWING?
Breakfast	7h00	home	Bowl of Cereal:		•***Juice?*** *Brand, real juice, from concentrate or not, pulp or no pulp, sugar/no-sugar added, dry mix**,** cocktail*
			Corn Flakes: Kellogs	1 cup	
			Milk 1%	½ cup	
			Colombian coffee	1 cup	
			White Sugar	5 ml	
			Milk 1%	10 ml	
			Silhouette Fat-free strawberry yogurt	125g	
Snack before lunch					

• ***Fruits? Size** / **weight**, with skin or peeled (e.g. apple), with added sugar? (e.g. apple sauce…) **Type:** Fresh, frozen, canned, dry...*

• ***Bread?** white, whole-wheat, multigrain, roasted or not*

• ***Condiments? Quantity and type**: butter, peanut butter, margarine, jam (sweetened/not sweetened), cheese*

• ***Muffin?***
***Size**: small, medium, large**, type:** homemade or commercial**, contents**: fruits, nuts, chocolate, raisins, etc.*

• ***Crepes/Pancakes?** Diameter in cm or inches Pan fry (indicate recipe)*

• ***Eggs?** Size, cooking method (fried boiled, scrambled, poached …)*

• ***Milk products?** Milk, cheese, yogurt, cream and their % of fat*

• ***Yogurt?** Brand, quantity, % fat, with fruit? Sweetened?*

• ***Sugar, cream and syrup added? Quantity and type**: in coffee, cereals, on crepes,...*

• ***Added fat for preparation, cooking and consumption? Quantity and type :** butter, Margarine, or oil*

***Cereal bars?** Brand, contents, coated /not coated (Nuts, peanuts, marshmallows, fruits, chocolate coated or not…)*

Units of measurement

tsp tbsp oz (fluid) milliliters (ml) grams (g) milligrams (mg) oz (weight) slice each whole

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ID: M O M O V 1

EXAMPLE

MEAL	TIME	PLACE	NAME & DESCRIPTION OF FOOD	QUANTITY	DID YOU REMEMBER?
Lunch	12h00	Work	Egg salad sandwich:	1	• ***Soup?*** *homemade, canned, packaged* • ***Salad? Contents:*** *quantity of vegetables, cheese, croutons, grains and nuts (plain or roasted),...**Salad Dressing**: **type**: caesar, Italian,... **quantity**: ml, tsp, tbsp* • ***Sandwich?*** ***Bread:*** *white, whole-wheat, multigrain, roasted or not?* ***Condiments: quantity and type*** *of mayonnaise, butter, mustard…* • ***Meat /poultry/ fish?*** *(Kind of cut, lean, bone-in, eaten with fat and skin?,), indicate cooking method, temperature and time…* ***Added fat during preparation, cooking, consuming? Quantity and type*** *of butter, margarine or oil* • ***Vegetables?*** *Fresh, frozen, canned , raw or cooked (grilled, steamed ...), with or without skin* • ***Fruits? Quantity and type,*** *With or without skin, fresh, frozen, …* • ***Milk products? quantity and type*** *Milk, cheese, yogurt, cream and % fat* • ***Yogurt?*** *Brand, quantity, % fat, with fruit? sweetened?* • ***Dessert?*** *Homemade, commercial…**Size**: in centimeters, in inches, in grams…**Filling/ topping** : icing, cream, ice cream, syrup, sauce, coulis* • ***Cereal bars?*** *Brand, contents, nuts, peanuts, marshmallows, fruits, chocolate, coated /not coated …* • ***Snacks?*** ***Quantity***: *in grams or in units,* ***Type:*** *chips, pretzels, salted crackers…* • ***Alcohol? type*** *(e.g red or white wine, dark or light beer, liquor…),* ***amount****…*
			Dempsters 100% Whole wheat bread, not roasted "Country Harvest"	2 slices	
			Becel regular margarine	10 ml	
			Kraft light mayonnaise	1 tbsp	
			Boiled eggs	2	
Afternoon snack			Triscuits – original whole-grain	5	
			Low-fat cheddar cheese (12%)	1 oz	

Units of measurement

tsp tbsp oz (fluid) milliliters (ml) grams (g) milligrams (mg) oz (weight) slice each whole

EXAMPLE

MEAL	TIME	PLACE	NAME AND DESCRIPTION OF FOOD	QUANTITY	DID YOU REMEMBER THE FOLLOWING?
Supper	5pm	Home	Salad:		• **Soup?** homemade, canned, packaged • **Salad? Contents:** quantity of vegetables, cheese, croutons, grains and nuts (plain or roasted),...**Salad Dressing**: **type**: caesar, Italian,... **quantity**: ml, tsp, tbsp • **Sandwich?** **Bread:** white, whole-wheat, multigrain, roasted or not? **Condiments: quantity and type** of mayonnaise, butter, mustard… • **Meat /poultry/ fish?** (Kind of cut, lean, bone-in, eaten with fat and skin?,), indicate cooking method, temperature and time… **Added fat during preparation, cooking, consuming? Quantity and type** of butter, margarine or oil • **Vegetables?** Fresh, frozen, canned , raw or cooked (grilled, steamed ...), with or without skin • **Fruits? Quantity and type,** With or without skin, fresh, frozen, … • **Milk products? quantity and type** Milk, cheese, yogurt, cream and % fat • **Yogurt?** Brand, quantity, % fat, with fruit? sweetened? • **Dessert?** Homemade, commercial…**Size**: in centimeters, in inches, in grams…**Filling/ topping** : icing, cream, ice cream, syrup, sauce, coulis • **Cereal bars?** Brand, contents, nuts, peanuts, marshmallows, fruits, chocolate, coated /not coated … • **Snacks?** **Quantity**: in grams or in units, **Type:** chips, pretzels, salted crackers… • **Alcohol?** type (e.g red or white wine, dark or light beer, liquor…), amount…
		Romaine lettuce	1 cup		
		Fresh mushroom slices	1/3 cup		
		Fresh Green pepper	¼ cup		
		Kraft "French" calorie-wise salad dressing	1 tbsp		
		Chicken breast skinless, boneless, oven grilled at 350ºF for 25 minutes	3 oz		
Evening Snack		Dare Cookies – strawberry filling	2		

Units of measurement

tsp tbsp oz (fluid) milliliters (ml) grams (g) milligrams (mg) oz (weight) slice each whole

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PARmed-X FOR PREGNANCY

Physical Activity Readiness Medical Examination

PARmed-X for PREGNANCY is a guideline for health screening prior to participation in a prenatal fitness class or other exercise.

Healthy women with uncomplicated pregnancies can integrate physical activity into their daily living and can participate without significant risks either to themselves or to their unborn child. Postulated benefits of such programs include improved aerobic and muscular fitness, promotion of appropriate weight gain, and facilitation of labour. Regular exercise may also help to prevent gestational glucose intolerance and pregnancy-induced hypertension.

The safety of prenatal exercise programs depends on an adequate level of maternal-fetal physiological reserve. PARmed-X for PREGNANCY is a convenient checklist and prescription for use by health care providers to evaluate pregnant patients who want to enter a prenatal fitness program and for ongoing medical surveillance of exercising pregnant patients.

Instructions for use of the 4-page PARmed-X for PREGNANCY are the following:

1. The patient should fill out the section on PATIENT INFORMATION and the PRE-EXERCISE HEALTH CHECKLIST (PART 1, 2, 3, and 4 on p. 1) and give the form to the health care provider monitoring her pregnancy.
2. The health care provider should check the information provided by the patient for accuracy and fill out SECTION C on CONTRAINDICATIONS (p. 2) based on current medical information.
3. If no exercise contraindications exist, the HEALTH EVALUATION FORM (p. 3) should be completed, signed by the health care provider, and given by the patient to her prenatal fitness professional.

In addition to prudent medical care, participation in appropriate types, intensities and amounts of exercise is recommended to increase the likelihood of a beneficial pregnancy outcome. PARmed-X for PREGNANCY provides recommendations for individualized exercise prescription (p. 3) and program safety (p. 4).

*Note: **Sections A and B** should be completed by the patient before the appointment with the health care provider.*

A PATIENT INFORMATION

NAME _____ ADDRESS _____

PHONE _____ BIRTHDATE MM / DD / YEAR HEALTH INSURANCE No. _____

NAME OF PRENATAL FITNESS PROFESSIONAL _____ PHONE NUMBER OF PRENATAL FITNESS PROFESSIONAL _____

B PRE-EXERCISE HEALTH CHECKLIST

PART 1: GENERAL HEALTH STATUS

In the past, have you experienced:	Y	N
1 Miscarriage in an earlier pregnacy?	☐	☐
2 Other pregnancy complications?	☐	☐
3 I have completed a PAR-Q within the last 30 days.	☐	☐

If you answered YES to question 1 or 2, please explain:

Number of previous pregnancies: _____

PART 2: STATUS OF CURRENT PREGNANCY

Due Date: MM / DD / YEAR

During this prenancy, have you experienced:	Y	N
1 Marked fatigue?	☐	☐
2 Bleeding from the vagina ("spotting")?	☐	☐
3 Unexplained faintness or dizziness?	☐	☐
4 Unexplained abdominal pain?	☐	☐
5 Sudden swelling of ankles, hands or face?	☐	☐
6 Persistent headaches or problems with headaches?	☐	☐
7 Swelling, pain or redness in the calf of one leg?	☐	☐
8 Absence of fetal movement after 6th month?	☐	☐
9 Failure to gain weight after 5th month?	☐	☐

If you answered YES to any of the above questions, please explain:

PART 3: ACTIVITY HABITS DURING THE PAST MONTH

1 List only regular fitness/recreational activities:

INTENSITY	FREQUENCY (times/week)			TIME (minutes/day)		
	1-2	2-4	4+	<20	20-40	40+
Heavy						
Medium						
Light						

2 Does your regular occupation (job/home) activity involve:	Y	N
Heavy lifting?	☐	☐
Frequent walking/stair climbing?	☐	☐
Occasional walking (> once/hr)?	☐	☐
Prolonged standing?	☐	☐
Mainly sitting?	☐	☐
Normal daily activity?	☐	☐
3 Do you currently smoke tobacco?*	☐	☐
4 Do you consume alcohol?*	☐	☐

PART 4: PHYSICAL ACTIVITY INTENTIONS

What physical activity do you intend to do?

Is this a change from what you currently do? ☐ YES ☐ NO

**Note: Pregnant women are strongly advised not to smoke or consume alcohol during pregnancy and during lactation.*

CONTRAINDICATIONS TO EXERCISE *To be completed by your health care provider*

ABSOLUTE CONTRAINDICATIONS

Does the patient have:	Y	N
1 Ruptured membranes, premature labour?	☐	☐
2 Persistent second or third trimester bleeding/ placenta previa?	☐	☐
3 Pregnancy-induced hypertension or pre-eclampsia?	☐	☐
4 Incompetent cervix?	☐	☐
5 Evidence of intrauterine growth restriction?	☐	☐
6 High-order pregnancy (e.g., triplets)?	☐	☐
7 Uncontrolled Type I diabetes, hypertension or thyroid disease, other serious cardiovascular, respiratory or systemic disorder?	☐	☐

RELATIVE CONTRAINDICATIONS

Does the patient have:	Y	N
1 History of spontaneous abortion or premature labour in previous pregnancies	☐	☐
2 Mild/moderate cardiovascular or respiratory disease (e.g., chronic hypertension, asthma)?	☐	☐
3 Anemia or iron deficiency? (Hb < 100 g/L)?	☐	☐
4 Malnutrition or eating disorder (anorexia, bulimia)?	☐	☐
5 Twin pregnancy after 28th week?	☐	☐
6 Other significant medical condition? Please specify:	☐	☐

Note: Risk may exceed benefits of regular physical activity. The decision to be physically active or not should be made with qualified medical advice.

PHYSICAL ACTIVITY RECOMMENDATION ☐ Recommended/Approved ☐ Contraindicated

PRESCRIPTION FOR AEROBIC ACTIVITY

RATE OF PROGRESSION: The best time to progress is during the second trimester since risks and discomforts of pregnancy are lowest at that time. Aerobic exercise should be increased gradually during the second trimester from a minimum of 15 minutes per session, 3 times per week (at the appropriate target heart rate or RPE to a maximum of approximately 30 minutes per session, 4 times per week (at the appropriate target heart rate or RPE).

WARM-UP/COOL-DOWN: Aerobic activity should be preceded by a brief (10-15 min.) warm-up and followed by a short (10-15 min.) cool-down. Low intensity calesthenics, stretching and relaxation exercises should be included in the warm-up/cool-down.

F **FREQUENCY**
Begin at 3 times per week and progress to four times per week

I **INTENSITY**
Exercise within an appropriate RPE range and/or target heart rate zone

T **TIME**
Attempt 15 minutes, even if it means reducing the intensity. Rest intervals may be helpful

T **TYPE**
Non weight-bearing or low-impact endurance exercise using large muscle groups (e.g., walking, stationary cycling, swimming, aquatic exercises, low impact aerobics)

"TALK TEST": A final check to avoid overexertion is to use the "talk test". The exercise intensity is excessive if you cannot carry on a verbal conversation while exercising.

PRESCRIPTION/MONITORING OF INTENSITY: The best way to prescribe and monitor exercise is by combining the heart rate and rating of perceived exertion (RPE) methods.

HEART RATE RANGES FOR PREGNANT WOMEN

MATERNAL AGE	FITNESS LEVEL OR BMI	HEART RATE RANGE (beats/minute)
Less than 20	–	140-155
20-29	Low	129-144
	Active	135-150
	Fit	145-160
	BMI > 25kg m^{-2}	102-124
30-39	Low	128-144
	Active	130-145
	Fit	140-156
	BMI > 25kg m^{-2}	101-120

Target HR ranges were derived from peak exercise tests in medically prescreened low-risk women who were pregnant. (Mottola et al., 2006; Davenport et al., 2008).

RATING OF PERCIEVED EXERTION (RPE)

Check the accuracy of your heart rate target zone by comparing it to the scale below. A range of about 12-14 (somewhat hard) is appropriate for most pregnant women.

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Very, very light		Somewhat light		Fairly light		Somewhat hard		Hard		Very hard		Very, very hard	

The original PARmed-X for PREGNANCY was developed by L.A. Wolfe, Ph.D., Queen's University and updated by Dr. M.F. Mottola, Ph.D., University of Western Ontario.

No changes permitted. Translation and reproduction in its entirety is encouraged.

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Additional copies of the PARmed-X for PREGNANCY, can be downloaded from Canadian Society for Exercise Physiology ***www.csep.ca/forms***

PRESCRIPTION FOR MUSCULAR CONDITIONING

It is important to condition all major muscle groups during both prenatal and postnatal periods.

WARM-UPS & COOL DOWN:

Range of Motion: neck, shoulder girdle, back, arms, hips, knees, ankles, etc.

Static Stretching: all major muscle groups

(Do not over stretch!)

EXAMPLES OF MUSCULAR STRENGTHENING EXERCISES

CATEGORY	PURPOSE	EXAMPLE
Upper back	Promotion of good posture	Shoulder shrugs, shoulder blade pinch
Lower back	Promotion of good posture	Modified standing opposite leg & arm lifts
Abdomen	Promotion of good posture, prevent low-back pain, prevent diastasis recti, strengthen muscles of labour	Abdominal tightening, abdominal curl-ups, head raises lying on side or standing position
Pelvic floor ("Kegels")	Promotion of good bladder control, prevention of urinary incontinence	"Wave", "elevator"
Upper body	Improve muscular support for breasts	Shoulder rotations, modified push-ups against a wall
Buttocks, lower limbs	Facilitation of weight-bearing, prevention of varicose veins	Buttocks squeeze, standing leg lifts, heel raises

PRECAUTIONS FOR MUSCULAR CONDITIONING DURING PREGNANCY

VARIABLE	EFFECTS OF PREGNANCY	EXERCISE MODIFICATIONS
Body position	• in the supine position (lying on the back), the enlarged uterus may either decrease the flow of blood returning from the lower half of the body as it presses on a major vein (inferior vena cava) or it may decrease flow to a major artery (abdominal aorta)	• past 4 months of gestation, exercises normally done in the supine position should be altered • such exercises should be done side lying or standing
Joint laxity	• ligaments become relaxed due to increasing hormone levels • joints may be prone to injury	• avoid rapid changes in direction and bouncing during exercises • stretching should be performed with controlled movements
Abdominal muscles	• presence of a rippling (bulging) of connective tissue along the midline of the pregnant abdomen (diastasis recti) may be seen during abdominal exercise	• abdominal exercises are not recommended if diastasis recti develops
Posture	• increasing weight of enlarged breasts and uterus may cause a forward shift in the centre of gravity and may increase the arch in the lower back • this may also cause shoulders to slump forward	• emphasis on correct posture and neutral pelvic alignment. Neutral pelvic alignment is found by bending the knees, feet shoulder width apart, and aligning the pelvis between accentuated lordosis and the posterior pelvic tilt position.
Precautions for resistance exercise	• emphasis must be placed on continuous breathing throughout exercise • exhale on exertion, inhale on relaxation using high repetitions and low weights • Valsalva Manoevre (holding breath while working against a resistance) causes a change in blood pressure and therefore should be avoided • avoid exercise in supine position past 4 months gestation	

PARMED-X FOR PREGNANCY – HEALTH EVALUATION FORM

(to be completed and given to the prenatal fitness professional after obtaining medical clearance to exercise)

I, _____ (please print patient's name), have discussed my plans to participate in physical activity during my current pregnancy with my health care provider and I have obtained his/her approval to begin participation.

PATIENTS SIGNATURE _____ DATE _____

NAME OF HEALTH CARE PROVIDER _____

ADDRESS _____

PHONE _____

HEALTH CARE PROVIDER'S COMMENTS:

_____

_____

HEALTH CARE PROVIDER'S SIGNATURE _____

ADVICE FOR ACTIVE LIVING DURING PREGNANCY

Pregnancy is a time when women can make beneficial changes in their health habits to protect and promote the healthy development of their unborn babies. These changes include adopting improved eating habits, abstinence from smoking and alcohol intake, and participating in regular moderate physical activity. Since all of these changes can be carried over into the postnatal period and beyond, pregnancy is a very good time to adopt healthy lifestyle habits that are permanent by integrating physical activity with enjoyable healthy eating and a positive self and body image.

ACTIVE LIVING

- see your doctor before increasing your activity level during pregnancy
- exercise regularly but don't overexert
- exercise with a pregnant friend or join a prenatal exercise program
- follow FITT principles modified for pregnant women
- know safety considerations for exercise in pregnancy

HEALTHY EATING

- the need for calories is higher (about 300 more per day) than before pregnancy
- follow Canada's Food Guide to Healthy Eating and choose healthy foods from the following groups: whole grain or enriched bread or cereal, fruits and vegetables, milk and milk products, meat, fish, poultry and alternatives
- drink 6-8 glasses of fluid, including water, each day
- salt intake should not be restricted
- limit caffeine intake i.e., coffee, tea, chocolate, and cola drinks
- dieting to lose weight is not recommended during pregnancy

POSITIVE SELF AND BODY IMAGE

- remember that it is normal to gain weight during pregnancy
- accept that your body shape will change during pregnancy
- enjoy your pregnancy as a unique and meaningful experience

For more detailed information and advice about pre- and postnatal exercise, you may wish to obtain a copy of a booklet entitled Active Living During Pregnancy: Physical Activity Guidelines for Mother and Baby © 1999. Available from the Canadian Society for Exercise Physiology, ***www.csep.ca****. Cost: $11.95*

Public Health Agency of Canada. The sensible guide to a healthy pregnancy. Minister of Health, 2012. Ottawa, Ontario K1A 0K9. http://www.phac-aspc.gc.ca/hp-gs/guide/assets/pdf/hpguide-eng.pdf. HC Pub.: 5830 Cat.: HP5-33/2012E. 1 800 O-Canada (1-800-622-6232) TTY: 1-800-926-9105.

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SAFETY CONSIDERATIONS

- Avoid exercise in warm/humid environments, especially during the 1st trimester
- Avoid isometric exercise or straining while holding your breath
- Maintain adequate nutrition and hydration – drink liquids before and after exercise
- Avoid exercise while lying on your back past the 4th month of pregnancy
- Avoid activities which involve physical contact or danger of falling
- Know your limits – pregnancy is not a good time to train for athletic competition
- Know the reasons to stop exercise and consult a qualified health care provider immediately if they occur

REASONS TO STOP EXERCISE AND CONSULT YOUR HEALTH CARE PROVIDER

- Excessive shortness of breath
- Chest pain
- Painful uterine contractions (more than 6-8 per hour)
- Vaginal bleeding
- Any "gush" of fluid from vagina (suggesting premature rupture of the membranes)
- Dizziness or faintness