Impact of a Family-Based Obesity Prevention Intervention on Parental Body Composition

by

Victoria Ambrose

A Thesis
presented to
The University
Guelph

In partial fulfilment of requirements
for the degree of
Master of Science
In
Family Relations and Applied Nutrition
(Applied Human Nutrition)

Guelph, Ontario, Canada

© Tory Ambrose, June 2017
ABSTRACT

IMPACT OF A FAMILY-BASED OBESITY PREVENTION INTERVENTION ON PARENTAL BODY COMPOSITION

Tory Ambrose

University of Guelph, 2017

Advisors: Dr. Andrea Buchholz
Dr. Jess Haines

Little is known about the effect of family-based, obesity prevention interventions on parental body composition, as studies focus on children’s body composition. The Guelph Family Health Study is a randomized controlled trial focused on creating healthy behaviour change in families with preschool-aged children. Families in the Guelph ON area were randomized to control (no home visits), 2 home visits (2HV) or 4 home visits (4HV) with a health educator, and were followed for 6 months. This sub-study examined the effect of the intervention on parental body composition outcomes, including fat mass (%), measured using a BOD POD™, waist circumference (WC, cm), BMI (kg/m²) and body mass (kg), in a sample of 35 families (26 mothers, 32 fathers). An analysis to determine differences in body composition between intervention groups was performed using generalized estimating equations (GEE) to account for familial correlations (adjusted for parental age, sex, household income and baseline measures).

At 6-month follow-up (immediately post-intervention), the 2HV group had a lower body mass (p=0.0168), and at 18-month follow up, had significantly lower WC (p=0.0197), when compared to control. In a sub-analysis of parents who were overweight/obese at baseline (BMI ≥25 kg/m²), the 2HV group had lower WC (p=0.0029) and body mass (p=0.0400) at 6-month follow-
up when compared to control. At 18-month follow up, the 2HV group had significantly lower WC (p=0.007), BMI (p=0.0139) and body mass (p=0.0068) when compared to control. In parents classified as normal weight at baseline (BMI <25 kg/m²), the 4HV group had lower fat mass (p=0.0371), while the 2HV group had lower BMI (p=0.0159) and body mass (p=0.0064), at 6-month follow-up, both compared to control. There were no significant differences at 18-month follow up. Family-based, obesity prevention interventions have a positive impact on parental body composition, regardless of parents’ baseline weight status. These positive impacts are sustained at 18-month follow up (1-year post-intervention) by those who are overweight/obese at baseline. Our results show that family-based interventions can have positive, unintended results on parental body composition indicating family-based interventions should be explored as a possible intervention approach to improve weight outcomes in parents.
ACKNOWLEDGEMENTS

Graduate school has been the most challenging and rewarding experience. I have learned so much about myself throughout my time at Guelph and am truly thankful for this experience. I would firstly like to thank my advisors Dr. Andrea Buchholz and Dr. Jess Haines for their support throughout my MSc. Without your guidance and knowledge, I would not have been able to complete my research. Secondly, I would like to thank the entire Guelph Family Health Study team. This group of amazing people has taught me so much over the past two years, and I am a better student and person thanks to all of them. I would especially like to thank Angela Annis as the coordinator of the Guelph Family Health Study. Without your support, this amazing research would not be possible.

Finally, I would like to thank my family. My “Guelph family” has welcomed me into their lives and I am thankful for the opportunity to have a second “bonus” family away from home. My mom and my sister have supported me unwaveringly throughout my time at Guelph and have encouraged me to always be my best. The endless support and encouragement of all my family members has gotten me through some of the toughest times during my graduate studies. I am forever grateful to be a part of this wonderful group of loving and supportive people.
# Table of Contents

List of Tables and Figures ........................................................................................................... vii
List of Abbreviations ................................................................................................................ viii

1.0 Introduction ............................................................................................................................. 1

2.0 Review of the Literature ........................................................................................................ 3
  2.1 Obesity in the Canadian Context ......................................................................................... 3
  2.2 Obesity in the Family Context ............................................................................................. 4
    2.2.1 Genetic Influence ........................................................................................................ 4
    2.2.2 Parent Role Modelling of Dietary Behaviours ............................................................. 5
    2.2.3 Parenting Style and Feeding Behaviours ..................................................................... 6
    2.2.4 The Home Environment .............................................................................................. 7
  2.3 Obesity Prevention through Family-Based Interventions .................................................. 8
    2.3.1 Effectiveness of Family-Based Prevention Interventions in Children ......................... 8
    2.3.2 Parental Outcomes of Family-Based Interventions .................................................... 10

3.0 Rationale, Research Objectives and Hypotheses ............................................................... 14
  3.1 Rationale ................................................................................................................................. 14
  3.2 Research Objectives ............................................................................................................. 15
  3.3 Hypotheses ............................................................................................................................ 15

4.0 Methods .................................................................................................................................. 16
  4.1 Recruitment and Eligibility .................................................................................................. 16
  4.2 Study Design ........................................................................................................................ 16
    4.2.2 Treatment Groups ........................................................................................................ 18
  4.3 Measures ............................................................................................................................... 21
  4.4 Statistical Analyses ............................................................................................................. 24

5.0 Results ..................................................................................................................................... 25
5.1 Sample ........................................................................................................................................... 25

5.2 Baseline Body Composition .................................................................................................................. 28

5.3 Effect of the intervention on parental body composition ................................................................. 28

5.3.1 Analysis of all parents in the Guelph Family Health Study ............................................................. 29

5.3.2 Analysis of Overweight/Obese Sub-sample of parents ........................................................................... 33

5.3.3 Analysis of Normal Weight Sub-sample of parents ............................................................................. 37

6.0 Discussion ............................................................................................................................................. 41

6.1 Short Term Effects ................................................................................................................................. 41

6.2 Long Term Effects ............................................................................................................................... 44

6.3 Strengths and Limitations .................................................................................................................... 46

6.4 Next Steps for Future Research .......................................................................................................... 49

7.0 Conclusions ......................................................................................................................................... 52

8.0 References .......................................................................................................................................... 53

9.0 Appendices ......................................................................................................................................... 74

APPENDIX A – GFHS Parental Consent Forms ......................................................................................... 74

APPENDIX B – REB Information for BOD POD Body Composition Measurement .................. 97

APPENDIX C – Standard Operating Procedure for Height and Weight collection from participants who have moved away ............................................................................................................ 99

APPENDIX D – Standard Operating Procedure for BODPOD Body Composition Measurement ................................................................................................................. 101

APPENDIX E – Standard Operating Procedure for Weight Measurement ..................................... 104

APPENDIX F – Standard Operating Procedure for Waist Circumference Measurement 105

APPENDIX G – Standard Operating Procedure for Height Measurement in Adults .......... 107
List of Tables and Figures

Figure 1: Guelph Family Health Study Design and Treatment Groups ........................................ 18

Figure 2: Guelph Family Health Study Behaviour Goals Wheel ...................................................... 19

Table 1: Baseline Demographic Characteristics of Parent Participants in the Guelph Family Health Study ........................................................................................................................................ 26

Figure 3: Guelph Family Health Study Flowchart ........................................................................... 27

Table 2: Baseline body composition data for N=58 parents enrolled in the Guelph Family Health Study (mean (SD)) ......................................................................................................................... 28

Table 3: Anthropometric and body composition measures of entire sample of parents in the Guelph Family Health Study ........................................................................................................ 31

Table 4: GEE Analysis of entire sample of parents in the Guelph Family Health Study .............. 32

Table 5: Anthropometric and body composition measures of sub-sample of overweight/obese at baseline parents ....................................................................................................................... 35

Table 6: GEE sub-analysis of overweight/obese parents at baseline .............................................. 36

Table 7: Anthropometric and body composition measures of sub-analysis of normal weight parents at baseline .......................................................................................................................... 39

Table 8: GEE Analysis of sub-analysis of normal weight parents at baseline sub-sample ........... 40
**List of Abbreviations**

ADP = Air Displacement Plethysmography  
BMI = Body Mass Index  
BP = Blood Pressure  
CI = Confidence Interval  
CRP = C-Reactive Protein  
DXA = Dual-Energy X-ray Absorptiometry  
FFM = Fat-Free Mass  
FM = Fat Mass  
GEE = Generalized Estimating Equations  
GENMOD = Generalized Linear Model  
GFHS = Guelph Family Health Study  
HV = Home Visit  
MI = Motivational Interviewing  
MRI = Magnetic Resonance Imaging  
NHANES = National Health and Nutrition Examination Survey  
SES = Socio-Economic Status  
SSB = Sugar-Sweetened Beverage  
TEE = Total Energy Expenditure  
TGV = Thoracic Gas Volume  
TV = Television  
WC = Waist Circumference  
WHO = World Health Organization
1.0 Introduction

Over the past thirty years, the prevalence of obesity has increased significantly with the current prevalence of adult obesity at 25.4%, and an additional 36% of adults classified as overweight (Statistics Canada, 2010; Canadian Institute for Health Information, & Public Health Agency of Canada, 2011). The severity of obesity has also increased over the past thirty years with a five-fold rise in the number of people being classified as obesity classes II and III, from 0.8% to 3.6% and 0.3% to 1.6%, respectively (Twells, Gregory, Reddigan, & Midodzi, 2014). Not only has obesity become a more predominant problem in adults, it is becoming more prevalent in children. The prevalence of obesity is continuing to rise in children by 2-5% every year (Canadian Community Health Survey, 2011).

The mirroring of rising adult obesity rates among children can be partly attributed to the important role parents play in child weight status. Parents have great influence over their child’s lifestyle habits, including physical activity, sleep, sedentary and dietary behaviours (Burke, Beilin & Dunbar, 2001; Davison & Birch, 2002). Parenting style can affect feeding behaviours, which has been shown to influence child weight status (Gibson et al., 2012). Thus, the family context influences the association between parental behaviours and child dietary intake. The influence of the family context and parent behaviours on children’s lifestyle habits underscores the importance of behaviour change interventions engaging all members of the family to help encourage child behaviour change (Whitaker et al., 1997).

Current literature suggests that family-based interventions can be effective in decreasing childhood obesity (Waters et al., 2011). Several studies have shown that family-based interventions result in positive changes in child lifestyle behaviours. Additionally, there is
evidence that improvements in lifestyle behaviours have led to decreases in adiposity and other health markers among children (Waters et al., 2011).

However, the effects of family-based interventions on parents have not been well researched. Given that family-based interventions aim to change the family/home environment, changes in parents’ behaviours as a result of these interventions would be expected. To date, only one family-based study has examined the impact of an intervention on parental body composition outcomes. Furthermore, this Australian study only assessed change in fathers’ body mass index (Morgan et al., 2014). Thus, an examination of both mothers’ and fathers’ body composition outcomes using rigorous methods is needed to understand the impact of family-based obesity prevention interventions within the Canadian context. The purpose of this research is to examine the effect of a family-based obesity prevention intervention on maternal and paternal body composition among Canadian families with young children.
2.0 Review of the Literature

2.1 Obesity in the Canadian Context

Obesity, as defined by a body mass index (BMI) of greater than 30 kg/m$^2$, has become a global issue affecting adults in many countries, including Canada. Currently, 25.4% of Canadian adults are obese, while an additional 36% are overweight (BMI of 25.0-29.9 kg/m$^2$) (Statistics Canada, 2010; Canadian Institute for Health Information, & Public Health Agency of Canada, 2011). The prevalence of obesity among youth entering adulthood has doubled in the past 30 years, stemming from the increase in rates of childhood obesity (Statistics Canada, 2010). The most recent statistics indicate that 15% of Canadian pre-school aged children are overweight and 10.8% are obese (Statistics Canada, 2004; Statistics Canada, 2009-2013).

Concurrent with the increased prevalence of overweight and obesity in adults, is the increased prevalence of higher BMI values related to higher classes of obesity. Obesity is categorized as class I (BMI 30.0-34.9 kg/m$^2$), class II (BMI 35.0-39.9 kg/m$^2$) and class III (BMI > 40.0 kg/m$^2$) (Mcguire, Shields, Carroll, & Ogden, 2011). From 1985 to 2011, the prevalence of class I obesity in Canada has nearly tripled, from 5.1% to 13.1% (Twells et al., 2014). The prevalence of class II and class III obesity in Canada have both increased nearly five-fold, from 0.8% to 3.6% and 0.3% to 1.6%, respectively (Twells et al., 2014). This increased prevalence in overweight and obesity is concerning because of the numerous negative health consequences associated with obesity.

Adults who are overweight or obese have been shown to have a 1.2-12.4% greater risk for many diseases, including cardiovascular disease, cancer, and diabetes, amongst others (Janssen, 2013). In Canadians aged 20-64 years, the development of these chronic diseases is
associated with a poorer quality of life, as well as an increased prevalence of premature death and cost the Canadian healthcare system an estimated $11 billion dollars annually (Janssen, 2013). Chronic diseases associated with obesity are estimated to result in 48,000-66,000 deaths each year in Canada, in part due to poor metabolic health including cardiovascular disease and diabetes (Mcguire, 2011; Peirson et al., 2014). Furthermore, obesity in young children is associated with obesity later in life, chronic conditions such as hyperlipidemia, hypertension, and type 2 diabetes, and higher morbidity and mortality in adulthood (Baker et al., 2005).

2.2 Obesity in the Family Context

In addition to the negative health consequences associated with obesity, the tendency for overweight and obese parents to have overweight and obese children is also of concern (Birch & Davison, 2001). The literature suggests that this increased risk may be due to several factors, including biological and behavioural aspects.

2.2.1 Genetic Influence

Whitaker and colleagues (1997) found that among children younger than 10 years, parental obesity significantly increased a child’s risk for obesity in adulthood, independent of environmental influences such as physical activity, available food and screen-time. Similarly, longitudinal research has found that children with one obese parent are three to five times more likely to become overweight or obese; when both parents are obese, a child’s risk of becoming overweight or obese is almost 11 times greater (Scaglioni, Arrizza, Vecchi, & Tedeschi, 2011). Likewise, among 1-2 year-olds with at least one obese parent, the risk for developing obesity later in life increases from 10% to 28% when compared to children with normal weight parents (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Furthermore, children aged 3-5 years old with one obese parent have a 62% higher risk of developing obesity compared to children with
parents of normal weight (Whitaker et al., 1997). While these results demonstrate that the population variance in obesity can be determined by familial characteristics, only 50% can be attributed to genetics; the other 50% of population variance can be attributed to behavioural and environmental influences (Beunen et al., 1998; Bodurtha et al., 1990; Faith et al., 1999). Thus, parents influence their child’s risk for obesity not only through genetics, but also through their influence on children’s lifestyle behaviours early in life.

2.2.2 Parent Role Modelling of Dietary Behaviours

In addition to genetics, there are modifiable lifestyle and environmental factors that increase the risk of developing obesity amongst children (Francis, Lee, & Birch, 2003; Whitaker et al., 1997). Research has demonstrated that parents are the primary influence on children’s obesity-related behaviours, especially among preschool-aged children. Parents influence their children through modeling of weight-related behaviours, parenting and feeding practices, and the provision of a home environment that facilitates healthy or unhealthy eating and activity behaviours (Benton, 2004; Birch & Fisher, 1998; Clark, Goyder, Bissell, Blank & Peters, 2007; Russell, Worsley, & Campbell, 2015; Skinner, Carruth, Bounds, & Ziegler, 2002).

Epidemiologic studies have shown that parents serve as role models for their children. Research has found a strong correlation between mothers’ food intake and the nutrient intake of their preschool-aged children (Birch & Fisher, 1998; Olivera et al., 1992). An observational study by Klesges et al. (1991) found that children who eat meals with their parents consume more nutritious foods and fewer calories compared to children who eat without a parent modelling these behaviours. Intervention studies have also shown that behaviour modelling by parents is an effective way to change behaviour in children, especially for obesity prevention (Gibson et al., 2012). Gibson and colleagues (2012) analyzed a previously written review of the
literature and concluded that positive modelling of behaviour by parents is helpful to encourage healthy eating behaviour amongst children. The authors also found that interventions which include parental education about how to model healthy behaviours, are more successful at encouraging behaviour change amongst children, compared to interventions without parental education (Gibson et al., 2012). These findings indicate that the modelling of healthy eating-related behaviours by parents is an important aspect of encouraging healthy eating in children and suggests that the modelling of healthy behaviours by parents should be included in interventions that aim to encourage healthy eating habits among children.

2.2.3 Parenting Style and Feeding Behaviours

While parental modelling of behaviours has a significant influence on children’s dietary behaviours, additional areas of influence are parenting style and feeding behaviours. Parenting style refers to the general style with which parents address the emotional and environmental context for child-rearing (Darling & Steinberg, 1993). Feeding behaviour is defined as the interactions that occur between parent and child around mealtime, and research suggests that feeding behaviours are influenced by parenting style. There are four parenting styles (authoritative, authoritarian, permissive and neglectful) and research has shown that both authoritarian and neglectful parenting styles increase a child’s risk of obesity (Hennessy et al., 2010; Rhee et al., 2006). Ventura and Birch (2008) found that overall parenting style does not change during feeding; parents who are more authoritative in style are more likely to praise and negotiate with children while feeding (beneficial feeding practices), while those who are more authoritarian may punish or coerce children more (negative feeding practices) (Hennessy, Hughes, Goldberg, Hyatt & Economos, 2010). Extensive empirical evidence shows that food parenting practices of the coercive-control domain, such as restriction and parental control of the
home eating environment (i.e., limiting available foods), have a strong influence on young children’s dietary intake and therefore, their weight status and obesity risk (Blissett, Meyer, & Haycraft, 2006; Savage, Fisher, & Birch, 2007; Birch & Fisher, 1998; Faith, Scanlon, Birch, Francis & Sherry, 2004; Scaglioni et al., 2011). Children may also be influenced by food parenting practices (e.g., pressuring, encouraging to “clean” the plate) more so than by internal cues (Birch & Fisher, 1998). The influence of parents on their children is especially evident when parents restrict access to foods, as children’s preference for those foods increase when access is not permitted (Birch, Zimmerman & Hind, 1980). These findings further emphasize the impact that parents have on child obesity and reinforce the importance of educating parents in improving behaviours related to the prevention of obesity.

2.2.4 The Home Environment

While parenting practices, and feeding behaviours can impact meal times and children’s dietary intake, parents also have control over the home environment, including what foods are available for children to consume and children’s access to physical activities. A prospective cohort study of 510 children by Rank et al., (2012) found that when children have a genetic predisposition to obesity, they only progress towards obesity in an obesogenic home environment which supports both unhealthy physical activity and eating behaviours. Individuals who are obese or overweight tend to create environments in which healthy eating and physical activity behaviours are less common, thereby creating a poor environment for children to learn healthy behaviours (Wachs, 1983; Davison & Birch, 2002). Young children who live in environments that do not encourage healthy eating or promote physical activity are, therefore, at higher risk of becoming overweight or obese as early as preschool-age (Wachs, 1983).
Interventions involving the home environment and the entire family are critical to improving the relationship between adults and their children regarding obesity prevention.

2.3 Obesity Prevention through Family-Based Interventions

2.3.1 Effectiveness of Family-Based Prevention Interventions in Children

Family-based interventions are those which involve the family unit to create change amongst its members (Sung-Chan, Sung, Zhao, & Brownson, 2013). These interventions can vary in duration; however, to encourage behaviour change, the interventions commonly include repeated visits with the family by a research team. A Cochrane review of 55 studies (Waters and colleagues (2011)) determined that interventions in the home, community and health-care settings are more effective than those in the school setting for children 0-12 years old. Waters and colleagues (2011) hypothesized that increased parental involvement was a key factor for this increased effectiveness. This review found that adiposity measures (BMI and BMI z-score) in 6-12-year-old children decreased because of the interventions, with an average effect size -0.26 (-0.53 to 0.00). Intervention effects varied by age, with the largest decrease in adiposity occurring in children aged 0-5 years-old (-0.26 kg/m2, 95% CI: -0.53 to 0.00) followed by 6-12-year-olds (-0.15 kg/m2, 95% CI -0.23 to -0.08).

Building on the findings of Waters et al., (2011), a more recent review by Kader et al. (2015) examined 35 studies of parental support interventions, which provided general parenting support with underlying health messages targeting children’s health behaviours. Of the 35 studies in the review, 16 included assessments of child weight status; 5 of these included child weight status as a primary outcome. In contrast to Waters and colleagues (2011), 15 of the 35
studies Kader and colleagues (2015) included involved children 2-5 years old and two of the studies took place in Canada. Kader et al., (2015) found that group education for parents is more effective than individualized counselling in changing children’s diets. However, individualized counselling over the long term is effective in parents with younger children, as demonstrated by a decrease in child adiposity. These findings indicate that individualization is important to help increase effectiveness of parent-based obesity interventions for children.

In their systematic review, Sung-Chan et al. (2012) reviewed 15 randomized controlled trials of obesity-prevention interventions, which focused on both children and adolescents. This review examined the theoretical background behind family-based interventions and which intervention approaches have been proven most effective. The authors studied the different subtypes of family-based interventions, including behavioural approaches and family therapy (working with the family unit to encourage family behaviour change from a psychological perspective). The behavioural approaches included those interventions which are focused on a healthy lifestyle and include a parent education component. The authors found that involvement of at least one parent is critical for effectiveness of the intervention, with studies doing so resulting in a greater decrease in adiposity (as measured by a higher score on the treatment effect scale), compared to the studies which failed to involve parents. This suggests that future studies should ensure parental involvement and focus on behavioural changes to improve outcomes regarding body composition in participants.

Finally, Jull & Chen (2013) examined the effects of parent-only (education sessions focusing on parental behaviour change) vs. family-focused (education sessions focusing on behaviour change for the entire family) treatment interventions to identify the most effective method of reducing obesity in children. This systematic review included four randomized
controlled trials of childhood obesity prevention interventions, all of which compared parent-only vs. family-based interventions. Of these four trials, two were conducted in the United States, one in Israel and one in Switzerland. Jull and Chen (2013) concluded that family-based interventions and parent-only interventions are both equally effective methods to change behaviour in children, as there were no significant differences between intervention groups in BMI z-score at follow-up.

While these reviews provide helpful information regarding the effectiveness of family-based interventions in preventing or reducing childhood obesity, the studies on which they are based have common limitations. Most existing intervention studies were not conducted within the Canadian context. The lack of Canadian data limits the generalizability of the existing intervention studies to Canadian populations, because of potential differences in feeding practices and family structure. There are also few family-based interventions that involve children under the age of 5 years. This body of literature demonstrates that family-based interventions are effective at encouraging behaviour change in families, however it remains relatively unknown whether this is the case with younger children who are not overweight or obese. Further research in this area could expand the scope of these studies to include younger children and examine parental effects of family-based interventions.

2.3.2 Parental Outcomes of Family-Based Interventions

Researchers have begun to recognize the lack of evidence of the effect of family-based obesity prevention interventions on parental body composition outcomes. For example, Minossi & Pellanda (2015) describe in their methods paper an intervention that intends to examine change in parental BMI in their currently ongoing, randomized, clinical trial of a family-based health behaviour intervention. BMI will be assessed in this study as a secondary outcome in
both adults and children, along with waist circumference to indicate overall weight status. Furthermore, a recent systematic review and meta-analysis examined associations between parental and child obesity across the world (Wang, Youfa, Min, Jungwon, Khuri, Jacob, Li, 2016). The meta-analysis by Wang and colleagues (2016) found a strong association between parent and child obesity (95% CI: 2.09, 2.36), with stronger associations in parent obesity ($\beta \pm 0.2660 \pm 0.10$) and child obesity ($\beta \pm 0.2860 \pm 0.12$) than in overweight. This review suggests that the next steps in obesity interventions should be to target families and parents.

Only one study in the current literature has targeted families and examined parental body composition outcomes within the context of a family-based intervention. Morgan and colleagues (2014) conducted a randomized control trial of 93 overweight/obese fathers and their school-aged children in Australia and examined weight changes and behaviour changes among both fathers and children from baseline to post-intervention (3-months), 6-months and 12-months. The primary outcome was change in physical activity. Secondary outcomes included BMI, waist circumference and diet of both fathers and children. Morgan et al. (2014) found that both BMI ($p<0.001$) and waist circumference ($p<0.001$) decreased in fathers in the intervention group, when compared to the control group. Fathers in the intervention group also showed an increase in physical activity and a decrease in energy consumption. This study emphasizes the importance of understanding the impact of interventions involving parents on parental weight status and other health-related behaviours.

While Morgan and colleagues (2014) offer a good starting point for exploring family-based interventions and their effects on parents, there are several limitations. Firstly, given that the study took place in Australia, findings may not be extrapolated to the Canadian population. While there are some similarities between Australian and Canadian cultures, there are also
differences that could influence the results of the intervention, including cultural differences, geographic location and access to different foods. Secondly, Morgan et al., (2014) examined only fathers in their study. Inclusion of both parents would provide a more comprehensive look at the relationship between child and parental body composition as children’s eating-related behaviours are influenced by both mother and father (Whitaker et al., 1997; Francis et al., 2003). Finally, Morgan and colleagues (2014) used BMI as a proxy measure of body composition; there are more accurate measures of adiposity available. This study offers a good starting point for family-based interventions, however there is opportunity for stronger evidence to be collected.

This study will aim to strengthen family-based intervention research, by using more rigorous methods of body composition measurement. The two studies described above rely on BMI. BMI is easy and quick to calculate, requiring only the measurement of height (m²) and weight (kg). However, BMI cannot distinguish between fat mass and fat-free mass. This means that BMI can lead to an under- or over-estimation of body fat, which in turn may lead to misclassification of participants as overweight or obese (Fields, Gunatilake, & Kalaitzoglou, 2015).

The reference standard 2-compartment model of body composition measurement that can distinguish between fat mass and fat-free mass is air displacement plethysmography (Ginde et al., 2005; Fields et al., 2002). This method determines body composition using an instrument called the BOD POD™. The BOD POD measures body volume, used to determine body density. An equation is then used to determine fat mass (that which is made of adipose tissue) and fat free mass (all other tissue including water, muscle, bone and organ) from the density measurement. Air displacement plethysmography is the preferred method of body composition
measurement to BMI because of the detailed results that can be obtained (Fields, Goran, & McCrory, 2002).

Location of adipose tissue is also important to analyze, because of the metabolic consequences associated with increased amounts of adipose tissue in specific regions of the body, especially that which is located around the abdomen (visceral adipose tissue). Measuring waist circumference can help to gauge the amount of visceral adipose tissue located in the abdominal cavity. Visceral adiposity is linked to higher prevalence of cardiovascular disease and other negative health consequences, including decreased insulin sensitivity, increased inflammation and increased risk of mortality (Amato, Guarnotta, & Giordano, 2013; Bays, 2014; Janssen, Shields, Craig, & Tremblay, 2011). This use of multiple measures provides a more comprehensive determination of the severity of obesity than BMI alone. Using multiple assessment methods, such as air displacement plethysmography (and which provides a measure of whole body fat) along with waist circumference (location of body fat) in the examination of parental body composition will give researchers a better understanding of how family-based interventions may affect parental body composition.

This literature review provides evidence to demonstrate the effectiveness of family-based interventions in reducing the incidence of and preventing childhood obesity, and has identified several gaps in this literature with regards to parental outcomes of these same interventions. Given that parents are highly involved in family-based interventions and are educated through these interventions, it would be reasonable to expect some behaviour changes in parents, as well. Little research has examined possible outcomes of behaviour change in parents to date, and further exploration would determine whether family-based interventions can be used to combat adult obesity as well as childhood obesity. This thesis research will address the gaps in the
family-based intervention literature by evaluating the change in mothers’ and fathers’ body composition after a home-based, tailored obesity prevention intervention.

3.0 Rationale, Research Objectives and Hypotheses

3.1 Rationale

Obesity has become a global problem that is currently affecting 25.4% Canadian adults (Statistics Canada, 2010; Canadian Institute for Health Information, & Public Health Agency of Canada, 2011). The prevalence of obesity in Canada is rising, as is the prevalence of negative health consequences associated with obesity, including hypertension, hyperinsulinemia and hypertriglyceridemia (Twells et al., 2014). The obesity epidemic has also affected our youngest populations with approximately 15% and 11% of Canadian preschool-age children being overweight or obese, respectively.

To address the problem of obesity within the family context, we need to intervene at the family level. Research has examined interventions that aim to prevent childhood obesity and show promising results. Family-based interventions appear effective in reducing child adiposity and improving child lifestyle behaviours. While interventions show positive outcomes in children, few studies have examined the effect of family-based interventions on parental body composition. Future research in this area should examine obesity interventions in families and parental obesity (Wang et al., 2016).

The current research explored the effect of a family-based obesity prevention intervention on parental body composition, measured using several methods, collected at baseline, 6-month follow-up (immediately post-intervention) and 18-month follow-up (1-year post-intervention). This research will lead to a better understanding of the effects of family-based interventions on
parental body composition as well as a possible new secondary objective for future family-based interventions. A family-based approach may be effective for obesity prevention in both children and their parents.

### 3.2 Research Objectives

Our analysis examined the effect of a 6-month family-based, obesity-prevention intervention on parental body composition including fat mass (%FM) measured using air displacement plethysmography, waist circumference (WC), BMI and body mass.

### 3.3 Hypotheses

We hypothesized that parents of families randomized to the intervention groups would experience a decrease in %FM, WC, BMI and body mass as compared to those randomized to the control group. Additionally, we hypothesized that the decreases in body composition measures would be greater for those parents randomized to the four home visit group when compared to the two home visit group.

Finally, we hypothesized that the intervention effect would be moderated by participant weight status. That is, the intervention would have a greater effect on those participants who are overweight or obese at baseline (BMI ≥ 25.0kg/m²), when compared to those who are normal weight (BMI < 25.0kg/m²) at baseline.
4.0 Methods

The Guelph Family Health Study (GFHS) is a family-based cohort designed to identify early life factors associated with later obesity and chronic disease and to test family-based strategies to support healthful behaviours early in life. The GFHS is a randomized control trial containing three arms; four home visit intervention (4HV), two home visit intervention (2HV) and control.

4.1 Recruitment and Eligibility

Recruitment for the GFHS took place in Guelph and surrounding area using flyers, social media, and with the support of the Guelph Family Health Team, the Guelph Community Health Centre and local Ontario Early Years Centres. The GFHS recruited 51 families for the pilot study. Families living in Wellington County of southwestern Ontario, Canada (including the cities of Guelph, Rockwood, Fergus, Elora, Mount Forest, Puslinch) with at least one child aged 1.5-5 years at the time of recruitment were eligible to participate. Exclusion criteria included moving out of the Wellington County area within the first year of study participation, not currently living in the Guelph area and not having a child 1.5-5 years at the time of recruitment. Data were collected at the University of Guelph Body Composition Lab. Written, informed consent was obtained from parents prior to study procedures. The University of Guelph Research Ethics Board approved the Guelph Family Health Study (REB14AP009, REB14AP008).

4.2 Study Design

Upon completion of an online eligibility questionnaire, participants were prompted to complete consent forms and demographic questionnaires. The study coordinator then went to
families’ homes to complete the enrollment home visit. The purpose of this home visit was to collect written consent from the families and instruct the parents how to complete the 3-day food records and accelerometer logs for data collected on the children.

As portrayed below in Figure 1, following the enrollment home visit, families visited the University of Guelph for their initial health assessment during which baseline measures were collected. These included height, weight, waist circumference, blood pressure and body composition; these are described fully in section 4.3. As an additional, but optional part of the health assessment, participants were asked to provide blood samples at LifeLabs™ medical laboratory. After the collection of the baseline measurements, families were randomized to one of three groups: control, four home visits or two home visits. The conditions for each group are described in section 4.2.2. Following the 6-month study period, participants returned to the University of Guelph Body Composition Lab for a 6-month follow-up health assessment (or immediately post intervention), during which the same baseline health assessment was repeated. Finally, 18-months following the initial baseline visit (or 1-year post-intervention), families returned to the Body Composition Lab for a final health assessment, during which the baseline health assessment was again repeated. Families were provided with up to $300 in grocery gift card incentives per health assessment.
4.2.2 Treatment Groups

The Guelph Family Health Study pilot consisted of a control group and two intervention groups; a 2HV group and a 4HV group. The 2HV group received two home visits with a Health Educator plus weekly tailored health emails and mailed incentives, and the 4HV group received four home visits with a Health Educator plus weekly tailored health emails and mailed incentives.

Two Home Visits

Families randomized to the 2HV group received two home visits with a health educator, during which a healthy behaviour goal was chosen. Families then received weekly emails that were tailored to their chosen health behaviour goal and a monthly mailed incentive (e.g., ball, crazy straw, colouring book) consistent with the behaviour goal. There were six health behaviour areas on which families could choose to focus: bedtime routine, limiting sugar
sweetened beverages, limiting TV and screen time, increasing family meals, and being more physically active.

Figure 2: Guelph Family Health Study Behaviour Goals Wheel

Home visits were conducted by a Guelph Family Health Study health educator using the technique of motivational interviewing (MI). Health educators received a 2-day MI training from experts at the Monarch System™. Health educators began the first home visit by describing the structure of the visits and the behavioural goals (seen in Figure 2). These initial
home visits usually lasted one hour. Health educators worked through the Family Values Wheel (Figure 2) and had families rate their values based on personal importance. Families were then asked if they wanted to set a health behaviour goal and could choose one area of the Family Values Wheel that they would like to focus their goals around. Health educators worked with the families to identify steps and changes that the families could make to reach their goals. Families could self-monitor their progress on their goals with a family routine tracker. Families were also able to ask for accountability check-ins (e.g., mid-week emails to check on progress) with the health educator, if they desired. Visits concluded by the health educator summarizing the session and reminding families of their goals and next steps to take during the weeks ahead.

The second visit took place at families’ homes and typically lasted 30-60 minutes. Health educators talked with families about their progress towards their health goals and possible ways to work through challenges that may have arisen. Families were then able to set a new goal or revise their previous goal to continue working on it.

In addition to the home visits, families received weekly emails tailored to their behaviour goal. The emails were tailored to match the health behaviours chosen by the families. The emails contained tips to incorporate their behaviour change into daily routines, additional information and how to overcome obstacles that may arise. Families also received mailed incentives to help them achieve their behaviour change goal. The incentives included stickers, Canada’s Food Guide to Healthy Eating, a crazy straw, colourful plates, a storybook, a colouring book, sidewalk chalk and an inflatable beach ball. Each incentive was connected to a behaviour change goal and was mailed to families when they were focused on the respective goal.
**Four Home Visits**

Families in the 4HV group received the same protocol as the 2HV group, but with an additional two home visits from the health educator. During these two additional home visits, families could continue working on the same goals, or add additional health behaviour goals on which they would work.

**Control**

Families in the control group received monthly emails for the duration of the six-month intervention. These emails contained generic health information that is easily accessible to the public (i.e., *Canada’s Food Guide* (Health Canada, 2011)).

**4.3 Measures**

Participant anthropometric and body composition data were collected at the University of Guelph in the Body Composition Lab during health assessment visits held at baseline, 6-month follow-up (immediately post-intervention) and 18-month follow-up (1-year post-intervention).

**Height**

Parent height was measured to the nearest 0.1cm using a wall-mounted stadiometer (Medical Scales and Measuring Devices; Seca Corp., Ontario, CA). Height was measured with participants barefoot or in sock feet and with no hair accessories. Participants were asked to stand with heels together, arms to the side, legs straight, shoulders relaxed, and head in Frankfort horizontal plane. Participants were asked to inhale just as the measure was taken. Two height measurements were taken and if these differed by more than 0.5cm, a third measurement was taken. The average of the two closest measurements was used as the final data point.
Weight/Body Mass

Parent participant weight was measured using the BOD POD™ digital scale prior to the body composition measurement (Cosmed Inc., Concord CA, USA). Participants wore bathing suits (or similar tight-fitting clothing), and were either barefoot or in sock feet. Quality control tests of the scale, using two standardized 10 kg weights, were performed prior to participant weight measurements. Only one weight measurement was taken as the reliability of BOD POD™ scale is high (Fields et al., 2002).

Body Mass Index

Body mass index (kg/m²) was derived using the weight measurement (in kilograms) divided by the average height measurement (in meters squared).

Waist Circumference

Parent waist circumference was measured using a Gulick II measuring tape (Country Technology Inc., Gay Mills, WI, USA). The measurement was taken at the top of the iliac crest as per the Statistics Canada and NHANES recommendations, after expiration and before inhalation, over bare skin (Patry-Parisien, Shields, & Bryan, 2012) (n=57) or over a light clothing layer (n=0). Two waist circumference measurements were taken, to the nearest 0.1 cm. If the two measurements differed by more than 0.5 cm, a third measurement was taken. The average of the closest two measurements was used as the final data point. Inter-tester reliability testing was performed across three technicians on six subjects. The CV was 1.4%, consistent with the reference values (Ulijaszek & Kerr, 1999; Geeta et al., 2009).

BOD POD™ Measurements

The BOD POD was used to determine body composition of parents using air displacement plethysmography. This method involves measurement of body volume, calculating
body density and then using the Siri equation (Siri, 1961) to determine fat mass and fat free mass (kg and % body weight). Reliability testing was performed on the BOD POD. The intra-individual variation of nine subjects (two measures of the same participant, repeated over two days) was 2.1%, and consistent with the acceptable range of 1.7% to 4.5% (Fields et al., 2002). Furthermore, inter-tester reliability across three technicians was performed on five subjects. The CV was 2.6%, consistent with the reference value of 2.7% (Fields et al., 2002). Participants were informed of the BOD POD procedure, including proper attire and the removal of jewelry and glasses and were then asked about claustrophobia prior to the test. Participants were informed about the emergency stop button within the BOD POD and told they could end the test at any time (none chose to do so). Participants were clothed in a bathing suit or compression clothing (i.e., bike shorts) and a bathing cap during the test to minimize the amount of air trapped between clothing and hair. Upon conclusion of the body volume testing, thoracic gas volume (TGV) was also measured using a single-use tube connected to the rear of the interior of the BOD POD. If TGV could not be attained by measuring, a predicted lung volume equation was used based on Crapo and colleagues’ (1981) work accounting for age, height and sex (n=21 at baseline, n=15 at 6-month, n=9 at 18-month). Predicted vs. measured TGV has not been found to be significantly different, with maximum differences in body fat percentages ranging from -2.9 to +3.8% (McCrorry, Molé, Gomez, Dewey, & Bernauer, 1998). The BOD POD lab remained closed during the approximately 15-minute-long measurement, minimizing changes in air flow in the room during the test. Additional details of the BOD POD procedures can be found in APPENDIX B and APPENDIX D.
4.4 Statistical Analyses

Statistical analyses were conducted using SAS University Edition for OS X (SAS Institute Inc., 2015). Normality tests were performed on the data and the data were normally distributed. A generalized estimating equation (GEE) analysis was performed to test for differences in fat mass (%), waist circumference (cm), body mass index (kg/m²) and body mass (kg) between treatment groups at 6-month and 18-month follow-up. A comparison was done between intervention groups with all parents in the sample, then stratified by BMI weight status (overweight/obese and normal weight). Finally, mothers and fathers were pooled together as no significant differences were found when stratifying by gender. Data were analyzed using a GEE to account for the correlation between study participants (i.e., married and cohabiting participants) (Zeger, S. L., & Liang, K. Y. 1986). A p-value of ≤ 0.05 was considered statistically significant.
5.0 Results

5.1 Sample

Table 1 includes demographic information of the Guelph Family Health Study parent participants. The sample consisted of a total of 44 families, comprised of 79 parents (29-41 years, 44 mothers, 35 fathers). Figure 1 depicts the distribution of participants across study groups, and the flow of families included in the study. Of the 44 families at baseline, two families were lost at 6-month follow-up (n=3 participants). Mothers were excluded if they were pregnant or breastfeeding at baseline or 6-month follow-up (n=16). Finally, one family (n=2 parents) did not report income data and could consequently not be included in the model. Therefore, the analytic sample consisted of 58 parents (26 mothers and 32 fathers) with measurements at both the baseline and 6-month time point. Furthermore, 3 families were lost to follow-up after the 6-month follow-up as these families moved out of the Guelph-Wellington area, therefore were unable to complete the 18-month follow-up health assessment on campus. These parents completed self-report weight and sent back to the study team. Due to this, the 18-month follow-up analytic sample comprised of 48 participants for those measurements which required participants to come to campus (%FM and WC) and 54 participants with BMI and body mass.
<table>
<thead>
<tr>
<th></th>
<th>Overall (n=44 families)</th>
<th>Intervention 4HV (n=17 families)</th>
<th>2HV (n=14 families)</th>
<th>Control (n=13 families)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relation to Child</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother</td>
<td>44</td>
<td>16</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Father</td>
<td>35</td>
<td>12</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td><strong>Maternal Marital Status</strong></td>
<td></td>
<td>N = 17</td>
<td>N = 14</td>
<td>N = 13</td>
</tr>
<tr>
<td>Married</td>
<td>39 (88.6%)</td>
<td>15 (88.2%)</td>
<td>12 (85.7%)</td>
<td>12 (92.3%)</td>
</tr>
<tr>
<td>Not married, but living with partner</td>
<td>3 (6.8%)</td>
<td>1 (5.9%)</td>
<td>1 (7.1%)</td>
<td>1 (76.9%)</td>
</tr>
<tr>
<td>Divorced</td>
<td>1 (2.3%)</td>
<td>0</td>
<td>1 (7.1%)</td>
<td>0</td>
</tr>
<tr>
<td>Separated</td>
<td>1 (2.3%)</td>
<td>1 (5.9%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Race/Ethnicity</strong></td>
<td>N = 79</td>
<td>N = 29</td>
<td>N = 25</td>
<td>N = 25</td>
</tr>
<tr>
<td>White</td>
<td>64 (81.0%)</td>
<td>25 (86.2%)</td>
<td>20 (80.0%)</td>
<td>19 (76.0%)</td>
</tr>
<tr>
<td>Aboriginal/First Nations peoples</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Chinese</td>
<td>4 (5.1%)</td>
<td>1 (3.5%)</td>
<td>2 (8.0%)</td>
<td>1 (4.0%)</td>
</tr>
<tr>
<td>Black</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Korean or Japanese</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Latin American</td>
<td>3 (3.8%)</td>
<td>1 (4.0%)</td>
<td>2 (8.0%)</td>
<td>1 (4.0%)</td>
</tr>
<tr>
<td>South Asian (for ex: East Indian, Pakistani, Sri Lankan, etc.)</td>
<td>4 (5.1%)</td>
<td>1 (3.5%)</td>
<td>2 (8.0%)</td>
<td>1 (4.0%)</td>
</tr>
<tr>
<td>Other</td>
<td>3 (3.8%)</td>
<td>2 (6.8%)</td>
<td>0</td>
<td>2 (8.0%)</td>
</tr>
<tr>
<td>N/A</td>
<td>1 (1.3%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total Household Income</strong></td>
<td>N = 44</td>
<td>N = 17</td>
<td>N = 14</td>
<td>N = 13</td>
</tr>
<tr>
<td>Less than $29,999</td>
<td>1 (2.3%)</td>
<td>1 (5.9%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$30,000 to $39,999</td>
<td>2 (4.7%)</td>
<td>1 (5.9%)</td>
<td>1 (7.1%)</td>
<td>0</td>
</tr>
<tr>
<td>$40,000 to $49,999</td>
<td>7 (7.0%)</td>
<td>3 (17.7%)</td>
<td>0</td>
<td>4 (30.8%)</td>
</tr>
<tr>
<td>$50,000 to $59,999</td>
<td>4 (9.3%)</td>
<td>0</td>
<td>3 (21.4%)</td>
<td>1 (7.7%)</td>
</tr>
<tr>
<td>$60,000 to $69,999</td>
<td>1 (2.3%)</td>
<td>0</td>
<td>1 (7.1%)</td>
<td>0</td>
</tr>
<tr>
<td>$70,000 to $79,999</td>
<td>3 (7.0%)</td>
<td>1 (5.9%)</td>
<td>1 (7.1%)</td>
<td>1 (7.7%)</td>
</tr>
<tr>
<td>$80,000 to $89,999</td>
<td>6 (14.0%)</td>
<td>3 (17.7%)</td>
<td>2 (14.3%)</td>
<td>1 (7.7%)</td>
</tr>
<tr>
<td>$90,000 to $99,999</td>
<td>3 (7.0%)</td>
<td>1 (5.9%)</td>
<td>1 (7.1%)</td>
<td>1 (7.7%)</td>
</tr>
<tr>
<td>$100,000 to $149,999</td>
<td>12 (27.9%)</td>
<td>5 (29.4%)</td>
<td>4 (28.6%)</td>
<td>3 (23.1%)</td>
</tr>
<tr>
<td>$150,000 or more</td>
<td>4 (9.3%)</td>
<td>1 (5.9%)</td>
<td>1 (7.1%)</td>
<td>2 (15.4%)</td>
</tr>
<tr>
<td>I don’t know</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N/A</td>
<td>0</td>
<td>1 (5.9%)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Figure 3: Guelph Family Health Study Flowchart
5.2 Baseline Body Composition

Table 2 presents the baseline body composition data for the analytic sample of N=58.

Table 2: Baseline body composition data for N=58 parents enrolled in the Guelph Family Health Study (mean (SD))

<table>
<thead>
<tr>
<th></th>
<th>Overall (n=58)</th>
<th>Intervention 4HV (n=14)</th>
<th>Intervention 2HV (n=23)</th>
<th>Control (n=21)</th>
<th>P value 4HV to Control</th>
<th>2HV to Control</th>
<th>4HV to 2HV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FM (%)</strong></td>
<td>30.6 (11.0)</td>
<td>31.1 (12.1)</td>
<td>31.3 (11.3)</td>
<td>29.5 (10.4)</td>
<td>0.93</td>
<td>0.86</td>
<td>0.998</td>
</tr>
<tr>
<td><strong>WC (cm)</strong></td>
<td>97.4 (17.3)</td>
<td>103.9 (22.8)</td>
<td>96.1 (16.8)</td>
<td>94.3 (12.8)</td>
<td>0.32</td>
<td>0.91</td>
<td>0.49</td>
</tr>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td>28.3 (6.8)</td>
<td>29.9 (8.7)</td>
<td>27.8 (6.8)</td>
<td>27.7 (6.8)</td>
<td>0.73</td>
<td>0.999</td>
<td>0.74</td>
</tr>
<tr>
<td><strong>Body mass (kg)</strong></td>
<td>85.1 (24.5)</td>
<td>94.2 (33.7)</td>
<td>83.9 (23.4)</td>
<td>80.3 (16.9)</td>
<td>0.36</td>
<td>0.81</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Of the 58 parents, 41.4% were normal weight at baseline, 29.3% were overweight and 29.3% were obese per BMI guidelines (Shields, Carroll, & Ogden, 2011). There were no significant differences in any body composition characteristic (%FM, WC, BMI and body mass) across groups at baseline, as shown above in Table 2.

5.3 Effect of the intervention on parental body composition

At baseline, the four body composition outcomes (%FM, WC, BMI and body mass) were found to be normally distributed based on normality plots, skewness and kurtosis, therefore the GENMOD procedure was performed for statistical analysis of the data. The models for each of %FM, WC, BMI and body mass were adjusted for gender, household income, baseline age of participant and baseline measurement (%FM, WC, BMI, body mass as appropriate for the model) to account for any variance in observations. The results of the GEE analysis of covariance model (Tables 4, 6 and 8) show the differences between the 2HV and 4HV groups compared to the control at both 6-month and 18-month follow-up. This analysis was performed...
on the entire sample, and then on two samples stratified by baseline BMI (one analysis for participants who were overweight/obese at baseline (BMI ≥ 25.0 kg/m$^2$) and one analysis for participants who were normal weight at baseline (BMI < 25.0 kg/m$^2$)).

5.3.1 Analysis of all parents in the Guelph Family Health Study

The first analysis included all parents with measurements at the baseline, 6-month (n=58) and 18-month follow-up time points (n=48 for %FM and WC, n=54 for BMI and body mass). The results are shown in Table 3 and 4. These results were adjusted for gender, household income, baseline age of participant and baseline measurement (%FM, WC, BMI, body mass as appropriate for the model).

At 6-month follow-up, the FM(%) in the 2HV ($\hat{\beta}$= -0.76, 95% CI -2.44,0.92) and 4HV ($\hat{\beta}$ = -0.86, 95% CI -2.57,0.84) treatment groups were not significantly different than that of the control group. Following this trend, at 18-month follow-up, the %FM of the 2HV ($\hat{\beta}$= -0.69, 95% CI -4.00,2.62) and 4HV ($\hat{\beta}$= -0.98, 95% CI -3.33, 1.37) treatment groups were not significantly different from that of the control group.

At 6-month follow-up, the WC in the 2HV ($\hat{\beta}$= -1.17, 95% CI -3.38,1.05) and 4HV ($\hat{\beta}$= -0.22, 95% CI -2.52,2.08) treatment groups were not significantly different than that of the control group. In contrast, at 18-month follow-up, the WC of the 2HV ($\hat{\beta}$= -3.47, 95% CI -6.39,-0.55) was significantly lower than that of the control group, however, the 4HV ($\hat{\beta}$= -2.06, 95% CI -4.61,0.49) was not significantly different from control.
At 6-month follow-up, the BMI of the 2HV ($\hat{\beta} -0.64, 95\% \text{ CI} -1.28,0.00$) and 4HV ($\hat{\beta} = -0.15, 95\% \text{ CI} -0.77,0.46$) groups were not significantly different from control. Similarly, at 18-month follow-up, the BMI of the 2HV ($\hat{\beta} = -0.46, 95\% \text{ CI} -1.47,0.55$) and 4HV ($\hat{\beta} = 0.04, 95\% \text{ CI} -0.79,0.87$) treatment groups were not significantly different from that of the control group.

At 6-month follow-up, the body mass of the 2HV ($\hat{\beta} = -2.01, 95\% \text{ CI} -3.66,-0.36$) was significantly lower when compared to control, while the body mass of the 4HV ($\hat{\beta} = -0.82, 95\% \text{ CI} -2.50,0.85$) was not significantly different from control. However, at 18-month follow-up, the body mass of the 2HV ($\hat{\beta} = -1.48, 95\% \text{ CI} -4.23,1.28$) and 4HV ($\hat{\beta} = 0.12, 95\% \text{ CI} -2.35,2.58$) treatment groups were not significantly different than control.
Table 3: Anthropometric and body composition measures of entire sample of parents in the Guelph Family Health Study (n=58)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Mean (SD)</th>
<th>Absolute Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0M (n=21)</td>
<td>6M (n=20)</td>
</tr>
<tr>
<td><strong>Fat Mass (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>29.45 (10.37) (n=21)</td>
<td>30.93 (10.65) (n=20)</td>
</tr>
<tr>
<td>2HV</td>
<td>31.31 (11.26) (n=23)</td>
<td>31.74 (9.16) (n=23)</td>
</tr>
<tr>
<td>4HV</td>
<td>31.07 (12.14) (n=14)</td>
<td>31.16 (12.34) (n=14)</td>
</tr>
<tr>
<td><strong>WC (cm)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>94.28 (12.78) (n=21)</td>
<td>96.03 (12.55) (n=19)</td>
</tr>
<tr>
<td>2HV</td>
<td>96.13 (16.77) (n=22)</td>
<td>96.80 (17.17) (n=23)</td>
</tr>
<tr>
<td>4HV</td>
<td>103.88 (22.83) (n=14)</td>
<td>104.45 (23.89) (n=14)</td>
</tr>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>27.70 (5.51) (n=21)</td>
<td>28.39 (5.73) (n=20)</td>
</tr>
<tr>
<td>2HV</td>
<td>27.77 (6.76) (n=23)</td>
<td>27.56 (6.49) (n=23)</td>
</tr>
<tr>
<td>4HV</td>
<td>29.85 (8.73) (n=14)</td>
<td>30.15 (8.96) (n=14)</td>
</tr>
<tr>
<td><strong>Body Mass (kg)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>80.31 (16.89) (n=21)</td>
<td>82.26 (17.50) (n=20)</td>
</tr>
<tr>
<td>2HV</td>
<td>83.85 (23.40) (n=23)</td>
<td>83.20 (23.19) (n=23)</td>
</tr>
<tr>
<td>4HV</td>
<td>94.17 (33.71) (n=14)</td>
<td>94.74 (33.83) (n=14)</td>
</tr>
</tbody>
</table>
Table 4: GEE Analysis of entire sample of parents in the Guelph Family Health Study (n=58)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Unadjusted Estimate (95% Confidence Interval)</th>
<th>Unadjusted P-value</th>
<th>Adjusted Estimate (95% Confidence Interval)**</th>
<th>Adjusted P-value**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 to 6M</td>
<td>0 to 18M</td>
<td>0 to 6M</td>
<td>0 to 18M</td>
</tr>
<tr>
<td>Fat Mass (%)</td>
<td>2HV to Control</td>
<td>-0.64 (-2.27,0.99)</td>
<td>-1.11 (-4.14,1.92)</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>4HV to Control</td>
<td>-1.36 (-2.93,0.22)</td>
<td>-0.81 (-3.24,1.62)</td>
<td>0.09</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>2HV to Control</td>
<td>-1.18 (-3.45,1.09)</td>
<td>-3.84 (-6.72,-0.95)*</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>4HV to Control</td>
<td>-0.36 (-2.84,2.13)</td>
<td>-2.30 (-5.05,0.44)</td>
<td>0.78</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>2HV to Control</td>
<td>-0.66 (-1.33,0.01)</td>
<td>-0.58 (-1.55,0.40)</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>4HV to Control</td>
<td>-0.42 (-1.22,0.37)</td>
<td>0.03 (-0.83,0.90)</td>
<td>0.30</td>
</tr>
<tr>
<td>Body Mass (kg)</td>
<td>2HV to Control</td>
<td>-1.97 (-3.67,-0.28)*</td>
<td>-1.82 (-4.44,0.81)</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>4HV to Control</td>
<td>-1.61 (-3.74,0.52)</td>
<td>-0.06 (-2.55,2.43)</td>
<td>0.14</td>
</tr>
</tbody>
</table>

*Significant at p<0.05 level, **Adjusted models include the covariates gender, baseline age, household income and baseline body composition measurement
5.3.2 Analysis of Overweight/Obese Sub-sample of parents

The second analysis, shown in Table 5 and 6, included only the overweight and obese parents with a BMI ≥25 kg/m² at baseline (n=36). Of these 36 parents, 34 parents completed 6-month measurements and 28 completed the 18-month follow-up visit. These results are adjusted for gender, household income, baseline age of participant and baseline measurement (%FM, WC, BMI, body mass as appropriate for the model).

At 6-month follow-up the %FM of the overweight/obese participants in the 2HV (β̂ = -2.51, 95% CI -5.06,0.05) and the 4HV (β̂ = -0.42, 95% CI -2.82,1.98) treatment groups were not significantly different when compared to the overweight/obese participants in the control group. Furthermore, at 18-month follow-up, the 2HV (β̂ = -2.72, 95% CI -6.58,1.15) and 4HV (β̂ = -1.40, 95% CI -4.85, 2.05) treatment groups did not have significantly different %FM when compared to the control group.

At 6-month follow-up, the 2HV (β̂ = -3.06, 95% CI -5.82,-0.30) had significantly lower WC than the control group, conversely the WC of the 4HV group (β̂ = 0.18, 95% CI -2.20,2.55) was not significantly different, than that of the control group. Continuing this trend, at 18-month follow-up, the 2HV (β̂ = -5.90, 95% CI -9.30,-2.50) had WC values significantly lower than the control and the WC of the 4HV (β̂ = -1.58, 95% CI -4.43, 1.27) was not significantly lower than control.

At 6-month follow-up, the BMI of the 2HV (β̂ = -1.02, 95% CI -2.06,0.03) and the 4HV (β̂ = 0.17, 95% CI -0.76,1.10) treatment groups were not significantly different when compared to
the control group. At 18-month follow-up, the 2HV ($\hat{\beta} = -1.44$, 95% CI -2.59,-0.29) had significantly lower BMI values than control but the BMI of the 4HV ($\hat{\beta} = -0.02$, 95% CI -1.22,1.19) was not significantly different than control.

At 6-month follow-up, the 2HV group ($\hat{\beta} = -2.99$, 95% CI -5.85,-0.14) had significantly lower body mass than control, while the body mass of the 4HV group ($\hat{\beta} = -0.17$, 95% CI -2.79,2.45) was not significantly different from control. Similarly, at 18-month follow-up, the body mass of the 2HV group ($\hat{\beta} = -4.39$, 95% CI -7.57,-1.21) was significantly lower than that of control, whereas the body mass of the 4HV group ($\hat{\beta} = -0.27$, 95% CI -4.04,3.50) was not significantly different than that of the control group.
Table 5: Anthropometric and body composition measures of sub-sample of overweight/obese at baseline parents (n=34)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Mean (SD)</th>
<th>Absolute Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0M</td>
<td>6M</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat Mass (%)</td>
<td>Control</td>
<td>31.79 (11.18)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n=13)</td>
</tr>
<tr>
<td></td>
<td>2HV</td>
<td>38.56 (7.64)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n=12)</td>
</tr>
<tr>
<td></td>
<td>4HV</td>
<td>35.81 (10.37)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n=9)</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>Control</td>
<td>99.77 (12.67)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n=13)</td>
</tr>
<tr>
<td></td>
<td>2HV</td>
<td>108.48 (14.59)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n=11)</td>
</tr>
<tr>
<td></td>
<td>4HV</td>
<td>113.02 (23.63)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n=9)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>Control</td>
<td>30.65 (5.01)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n=13)</td>
</tr>
<tr>
<td></td>
<td>2HV</td>
<td>32.58 (5.95)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n=12)</td>
</tr>
<tr>
<td></td>
<td>4HV</td>
<td>34.17 (8.02)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n=9)</td>
</tr>
<tr>
<td>Body Mass (kg)</td>
<td>Control</td>
<td>88.58 (16.37)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n=13)</td>
</tr>
<tr>
<td></td>
<td>2HV</td>
<td>98.94 (21.59)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n=12)</td>
</tr>
<tr>
<td></td>
<td>4HV</td>
<td>109.53 (32.71)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n=9)</td>
</tr>
</tbody>
</table>
Table 6: GEE sub-analysis of overweight/obese parents at baseline (n=34)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Unadjusted Estimate (95% Confidence Interval)</th>
<th>Unadjusted P-value</th>
<th>Adjusted Estimate (95% Confidence Interval)**</th>
<th>Adjusted P-value**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 to 6M</td>
<td>0 to 18M</td>
<td>0 to 6M</td>
<td>0 to 18M</td>
</tr>
<tr>
<td>Fat Mass (%)</td>
<td>2HV to Control</td>
<td>-2.47 (-4.75, -0.18)*</td>
<td>0.03*</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>(n=34 at 6M, n=28 at 18M)</td>
<td>-2.83 (-7.18, 1.52)</td>
<td>0.20</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>4HV to Control</td>
<td>-1.46 (-3.48, 0.55)</td>
<td>0.16</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-1.66 (-4.67, 1.35)</td>
<td>0.28</td>
<td>0.43</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>2HV to Control</td>
<td>-2.78 (-5.21, -0.36)*</td>
<td>0.03*</td>
<td>0.03*</td>
</tr>
<tr>
<td></td>
<td>(n=33 at 6M, n=29 at 18M)</td>
<td>-6.65 (-9.65, -3.65)*</td>
<td>&lt;0.001*</td>
<td>0.00*</td>
</tr>
<tr>
<td></td>
<td>4HV to Control</td>
<td>0.02 (-1.84, 1.87)</td>
<td>0.99</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-2.58 (-5.56, 0.40)</td>
<td>0.09</td>
<td>0.28</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>2HV to Control</td>
<td>-0.86 (-1.98, 0.26)</td>
<td>0.13</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>(n=34 at 6M, n=31 at 18M)</td>
<td>-1.44 (-2.86, -0.02)*</td>
<td>0.05*</td>
<td>0.01*</td>
</tr>
<tr>
<td></td>
<td>4HV to Control</td>
<td>-033 (-1.47, 0.81)</td>
<td>0.57</td>
<td>0.72</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.28 (-1.39, 0.83)</td>
<td>0.62</td>
<td>0.98</td>
</tr>
<tr>
<td>Body Mass (kg)</td>
<td>2HV to Control</td>
<td>-2.60 (-5.42, 0.23)</td>
<td>0.07</td>
<td>0.04*</td>
</tr>
<tr>
<td></td>
<td>(n=34 at 6M, n=31 at 18M)</td>
<td>-4.28 (-8.03, -0.54)</td>
<td>0.03*</td>
<td>0.01*</td>
</tr>
<tr>
<td></td>
<td>4HV to Control</td>
<td>-1.61 (-4.68, 1.47)</td>
<td>0.31</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-1.21 (-4.43, 2.01)</td>
<td>0.46</td>
<td>0.89</td>
</tr>
</tbody>
</table>

*Significant at p<0.05 level. **Adjusted models include the covariates gender, baseline age, household income and baseline body composition measurement.
5.3.3 Analysis of Normal Weight Sub-sample of parents

The third analysis included only the normal weight parents with BMI <25 kg/m² at baseline (n=24). Of these 24 parents, 20 parents completed the 18-month follow-up visit. These results are shown in Table 7 and 8. These results are adjusted for gender, household income, baseline age of participant and baseline measurement (%FM, WC, BMI, body mass as appropriate for the model).

At 6-month follow-up the %FM of the normal weight participants in the 2HV (β= 0.99, 95% CI -1.04,3.01) and the 4HV (β= -2.03, 95% CI -3.94,-0.12) were not significantly different when compared to the overweight/obese participants in the control group. Furthermore, at 18-month follow-up, the %FM of the 2HV (β= 0.62, 95% CI -3.27,4.50) and 4HV (β= 0.24, 95% CI -3.19,3.66) treatment groups were not significantly different than the control group.

At 6-month follow-up, the 2HV (β= -0.65, 95% CI -3.70,2.41) had significantly lower WC than the control group, conversely the WC of the 4HV group (β= -0.40, 95% CI -4.57,3.77) was not significantly different than that of the control group. Continuing this trend, at 18-month follow-up, the 2HV (β= -1.88, 95% CI -5.68,1.91) had WC values significantly lower than the control and the 4HV (β= -1.13, 95% CI -5.16,2.90) did not have WC values significantly lower than control.

At 6-month follow-up, the BMI of the 2HV (β= -0.42, 95% CI -0.77,-0.08) and 4HV (β= -0.34, 95% CI -0.87,0.19) were not significantly different than the control group. At 18-month follow-up, the 2HV (β= 0.10, 95% CI -0.92,1.11) had significantly lower BMI values than
control but the 4HV ($\beta = -0.16$, 95% CI -0.95, 0.63) did not have BMI values that significantly differed from control.

At 6-month follow-up, the 2HV group ($\beta = -1.49$, 95% CI -2.56, -0.42) had significantly lower body mass than the control, while the body mass of the 4HV group ($\beta = -0.95$, 95% CI -2.54, 0.64) was not significantly different from control. Similarly, at 18-month follow-up, the body mass of the 2HV group ($\beta = 0.50$, 95% CI -2.46, 3.46) was significantly lower than that of control, whereas the body mass of the 4HV group ($\beta = -0.16$, 95% CI -2.16, 1.84) was not significantly different than that of the control group.
Table 7: Anthropometric and body composition measures of sub-analysis of normal weight parents at baseline (n=24)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Mean (SD)</th>
<th>Absolute Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0M (n=8)</td>
<td>6M (n=7)</td>
</tr>
<tr>
<td>Fat Mass (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>25.64 (8.11)</td>
<td>26.84 (8.57)</td>
</tr>
<tr>
<td>2HV</td>
<td>23.40 (9.11)</td>
<td>25.94 (7.90)</td>
</tr>
<tr>
<td>4HV</td>
<td>22.54 (11.06)</td>
<td>22.13 (9.79)</td>
</tr>
<tr>
<td>WC (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>85.36 (6.65)</td>
<td>86.06 (3.76)</td>
</tr>
<tr>
<td>2HV</td>
<td>83.77 (6.50)</td>
<td>84.86 (7.16)</td>
</tr>
<tr>
<td>4HV</td>
<td>87.42 (7.06)</td>
<td>85.95 (8.36)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>22.91 (1.12)</td>
<td>23.27 (1.18)</td>
</tr>
<tr>
<td>2HV</td>
<td>22.52 (1.83)</td>
<td>22.58 (1.96)</td>
</tr>
<tr>
<td>4HV</td>
<td>22.07 (1.19)</td>
<td>21.92 (1.25)</td>
</tr>
<tr>
<td>Body Mass (kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>66.87 (4.75)</td>
<td>67.61 (5.46)</td>
</tr>
<tr>
<td>2HV</td>
<td>67.39 (10.98)</td>
<td>67.43 (11.12)</td>
</tr>
<tr>
<td>4HV</td>
<td>66.51 (8.18)</td>
<td>66.05 (8.05)</td>
</tr>
</tbody>
</table>
Table 8: GEE Analysis of sub-analysis of normal weight parents at baseline sub-sample (n=24)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Unadjusted Estimate (95% Confidence Interval)</th>
<th>Unadjusted P-value</th>
<th>Adjusted Estimate (95% Confidence Interval)**</th>
<th>Adjusted P-value**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 to 6M</td>
<td>0 to 18M</td>
<td>0 to 6M</td>
<td>0 to 18M</td>
</tr>
<tr>
<td>Fat Mass (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2HV to Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4HV to Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=23 at 6M, n=20 at 18M</td>
<td>1.20 (-0.61,3.01)</td>
<td>0.73 (-2.32,3.79)</td>
<td>0.19</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>-1.85 (-3.88,0.18)</td>
<td>0.26 (-3.31,3.82)</td>
<td>0.07</td>
<td>0.89</td>
</tr>
<tr>
<td>WC (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2HV to Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4HV to Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=23 6M, n=20 at 18M</td>
<td>0.32 (-3.04,3.67)</td>
<td>-0.46 (-4.53,3.61)</td>
<td>0.85</td>
<td>0.83</td>
</tr>
<tr>
<td></td>
<td>-1.32 (-6.39,3.75)</td>
<td>-1.74 (-6.72,3.25)</td>
<td>0.61</td>
<td>0.50</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2HV to Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4HV to Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=23 at 6M, n=23 at 18M</td>
<td>-0.25 (-0.67,0.16)</td>
<td>0.31 (-0.51,1.13)</td>
<td>0.23</td>
<td>0.46</td>
</tr>
<tr>
<td></td>
<td>-0.46 (-1.09,0.17)</td>
<td>0.07 (-1.24,1.38)</td>
<td>0.16</td>
<td>0.91</td>
</tr>
<tr>
<td>Body Mass (kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2HV to Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4HV to Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=23 at 6M, n=23 at 18M</td>
<td>-0.97 (-2.12,0.17)</td>
<td>0.78 (-1.89,3.45)</td>
<td>0.10</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>-1.49 (-3.48,0.51)</td>
<td>0.69 (-3.01,4.40)</td>
<td>0.14</td>
<td>0.71</td>
</tr>
</tbody>
</table>

*Significant at p<0.05 level, **Adjusted models include the covariates gender, baseline age, household income and baseline body composition measurement
6.0 Discussion

Our analyses examined the effect of the Guelph Family Health Study, a family-based, obesity-prevention intervention, on parental body composition including fat mass (%FM), waist circumference (WC), body mass index (BMI) and body mass. To our knowledge, this is the first study to examine parental body composition as an outcome of a family-based obesity-prevention intervention in Canada. We hypothesized that parents of families randomized to the intervention groups would experience a decrease in %FM, WC, BMI and body mass as compared to those randomized to the control group. We also hypothesized the decreases in body composition measures would be greater for those parents randomized to the 4HV vs. 2HV group. Additionally, we hypothesized that the intervention effect would be moderated by baseline weight status. That is, the intervention would have a greater effect on those participants who were overweight or obese at baseline (BMI ≥ 25.0 kg/m²), when compared to those who were normal weight (BMI < 25.0 kg/m²).

6.1 Short Term Effects

The 6-month follow-up results demonstrate the short-term effects of the intervention. When looking at the body composition measurements after the 6-month intervention period, only the body mass of the 2HV group was significantly different than the control. On average, the 2HV group had a body mass 2 kg lower than that of the control group. The body mass of the 4HV group, while not significant, was still lower by nearly 1 kg. These decreases in body mass translated into decreased BMI, %FM and WC. Although these decreases did not reach statistical significance, these results nonetheless indicate that the intervention had positive benefits on parental body composition. These results also suggest that the 2HV and 4HV groups may have a
similar impact on parental weight status, which was contrary to our hypothesis. The similarity in intervention groups may indicate that the number of home visits is not as important as simply receiving any type of intervention to encourage behaviour changes.

To address our hypothesis about differences in the intervention effect by baseline weight status, a sub-analysis of parents who were overweight/obese at baseline revealed that the 2HV group had significantly lower WC (by 3cm, (p=0.03)) and body mass (by 3kg, (p=0.04)) at 6-month follow-up when compared to the control group. Also, contrary to our hypothesis, the results of the intervention were similar across parental weight status. Of the normal weight parents, the 2HV group had significantly lower BMI (by 0.42kg/m², (p=0.02)) and body mass (by 1.5kg, (p=0.01)) while the 4HV had significantly lower %FM (by 2%, (p=0.04)) when compared to the control group at 6-month follow-up. These improvements in body composition outcomes are independent of gender, income and age, indicating that the changes in body composition may be related to intervention effects rather than these confounding variables. These analyses show that parental weight status does not appear to moderate the impact of a family-based obesity prevention intervention in the short term and means that all parents, regardless of their weight status, can improve their body composition through family-based lifestyle interventions. Thus, regardless of weight status at baseline or the number of home visits, our family-based obesity-prevention intervention appeared to decrease, at least in the short term, various indicators of body fat in parent participants. These changes in body composition are encouraging as they are an unintended benefit of the Guelph Family Health Study intervention.

The trend in decreasing body composition outcomes suggests that parents who received the intervention may have changed their behaviour during the 6-month intervention period. This
trend in outcomes proposes that the intervention may be successful in the short term at encouraging behaviour change amongst parents even though the behaviour change goals target the entire family. Future research could aim to examine which behaviours were changed amongst parents in the intervention groups. The differences seen in BMI and body mass can be directly linked to participants losing weight over the 6-month intervention. Lower BMI and body mass suggest positive secondary intervention effects, especially since the intervention is directed at family behaviour and not targeting the parents directly. Furthermore, the significantly lower WC in the overweight/obese 2HV group may represent a decrease in more metabolically active adipose tissue. This decreased amount of adipose tissue is highly favourable in the prevention of negative outcomes associated with obesity such as the development of diabetes and metabolic syndrome (Janssen, 2013).

It is difficult to compare these findings to the literature as few studies have examined parental body composition as an outcome of family-based interventions. Only one other study by Morgan et al., (2014) has examined parental body composition as an outcome. Morgan et al., (2014) saw similar results in their study of Australian fathers (n=93) in the “Healthy Dads, Healthy Kids” obesity intervention, in which overweight/obese fathers saw significantly lower BMI by 1.0kg/m² (p<.001) and WC by ~4cm (p<.001) in their intervention participants (overweight/obese fathers with school-aged children) compared to control at 14-week follow-up. Our study included air displacement plethysmography as well as body mass, providing a more comprehensive picture of body composition changes. When comparing the Guelph Family Health Study to the Healthy Dads, Healthy Kids study our parents saw similar results in the short term. Our parents had similar waist circumference differences, however these measurements were measured at different anatomic locations. The findings of both studies regarding BMI were
also similar, as both studies saw short term decreases in BMI amongst invention group participants. While our results demonstrated significantly lower body mass and BMI at 6-month follow-up, there were no significant effects on fat mass. Fat mass was numerically, but not statistically lower in the intervention groups when compared to the control indicating that our sample may just be too small and with a larger sample size significance may be found. Finally, these changes in body composition are encouraging as they are an unintended short-term benefit of the Guelph Family Health Study intervention.

6.2 Long Term Effects

The long-term effects of the Guelph Family Health Study intervention were evaluated at 18-month follow-up (1-year post-intervention). The body composition changes seen among all participants in the GFHS at the 6-month follow-up were partly sustained at the 18-month follow-up. Most notably, the 2HV group had lower body composition in all four outcome measurements when compared to the control group at 18-month follow-up. Furthermore, the 4HV group had lower or equal body composition outcomes when compared to the control group, indicating similar benefits to the 2HV group. While most of these differences did not reach statistical significance, decrease in waist circumference in the 2HV group (-3.5 cm) was significantly different that WC in the control at 18-month follow-up.

Parent participants in the GFHS who were overweight/obese at baseline showed positive decreases in body mass and waist circumference at 6-month follow-up, and these changes were sustained one year later. On average, the overweight/obese participants in the 2HV group had significantly lower values than the control group including a 6cm smaller WC, 1.5 kg/m² lower BMI and 4.4 kg lower body mass at the 18-month follow-up. The sub-analysis of normal weight parents found that the significant differences that were present between the intervention groups
and the control group at 6-month follow-up were not sustained at 18-month follow-up. Despite not reaching statistical significance, body composition values were still numerically lower amongst intervention groups and indicate positive intervention effect amongst intervention group parents.

These changes in body composition are an encouraging outcome of the GFHS as they indicate that a family-based obesity prevention intervention may lead to improved weight outcomes for parents and could create the potential for long-term health changes. These sustained changes in body composition amongst parents who were overweight/obese at baseline are especially promising as these participants are at the highest risk for negative health outcomes related to obesity (Katzmarzyk & Mason, 2006). As such, reducing these body composition outcomes may lead to a decreased risk of developing obesity-related chronic diseases. It has been shown that both adults who are overweight, (Janssen, 2013), as well as children with overweight/obese parents, are at higher risk of developing chronic disease (Beech et al., 2003). The GFHS intervention has thus far been successful in positively changing the body composition outcomes of parents in this high-risk group, which may decrease the prevalence of chronic disease.

Comparing these results to the literature is difficult as no studies have yet examined parents one year post intervention. Existing literature only examines adult body composition changes in the context of behavioural weight-loss interventions rather than the family context. A systematic review and meta-analysis by Booth and colleagues (2014) indicated that interventions in primary care settings found similar results to our study at 1-year follow-up, with participants having a mean weight loss of 1.36kg at 1-year follow-up and sustaining this weight loss at 2-year follow-up. In another systematic review, Lemmens and colleagues (2008) found that amongst
the limited number of longitudinal obesity prevention interventions which take place outside of primary care settings and have follow-up at 1-year post-intervention, positive impacts on BMI (differences between intervention and control group ranging from 0.2-1.4kg/m²) were found among adult participants. Furthermore, a systematic review by McLean et al., (2003) found that the effectiveness of interventions varies with family involvement and that spousal inclusion can increase weight loss in both spouses. These reviews provide limited insight as our intervention focuses on children and does not target parents, however the positive impact demonstrated by these reviews in adult body composition outcomes align with our findings. Our study found that involving parents in the family-based intervention could have benefits for parental body composition as well. These results are motivating because they are not only a secondary effect of the family-based intervention, but these improved weight outcomes are also being maintained by parents one year post-intervention. This sustained impact on weight outcomes indicates that significant reduction in the risk of developing obesity-related diseases may be attained by parents by participating in a family-based obesity prevention intervention.

6.3 Strengths and Limitations

There are several strengths of this sub-study of the Guelph Family Health Study. Firstly, this study was novel in that it investigated body composition outcomes of parents resulting from a family-based obesity prevention intervention directed towards preventing childhood obesity. This is only the second study to our knowledge to have examined parental body composition following a family-based obesity prevention intervention. Furthermore, the Guelph Family Health Study evaluates body composition changes in both mothers and fathers, while accounting for gender differences in body composition. The previous study by Morgan et al. (2014) only
evaluated body composition of fathers, which limits the understanding of how family-based interventions affect parents.

Second, this study considered multiple body composition outcomes including body fat percentage, BMI and waist circumference. The ability to analyze multiple measures of body composition allows for a more thorough interpretation of health status. Air displacement plethysmography is a highly accurate and precise method of body composition (Fields et al., 2002), providing detailed information about body density, body fat mass and body fat as a percentage of total mass. This method is preferred to the more commonly used BMI, as it allows for the discrimination of muscle mass from fat mass. However, we continued to use BMI due to its common use in the literature as an indicator of body weight-related health risk, its inexpensive measurement cost and for the continuation of measurements if participants were to move away and were unable to complete the BOD POD measurements. To further strengthen these measurements, height and waist circumference measures were taken multiple times to determine an average data point. This average was then used to calculate BMI. The use of average data points is imperative to ensure intra-rater reliability and leads to greater accuracy of measurements. We also measured waist circumference, which provides information about the location of body fat. Together with air displacement plethysmography, these multiple measures of body composition allow us to determine both total amount and location of body fat, providing a more comprehensive picture of health risk.

Finally, the longitudinal design of this study is a great strength as it provides an opportunity to explore parental body composition changes over time. While the examination of parental body composition changes as a result of a family-based intervention is novel and adds to a substantial gap in the literature, the longitudinal design of this study provides the ability to
investigate long-term effects of the intervention while still allowing the examination of short
term effects. The continual follow-up of families in the Guelph Family Health Study will further
support this strength as the study progresses.

While this study has many strengths, there are limitations that bear mentioning. Firstly,
the analytic sample was relatively small (n=58), especially for the sub-analyses. This small
sample size can lead to an increased occurrence of type 2 error; or falsely accepting the null
hypothesis. However, recruitment in the GFHS is on-going and the cohort is anticipated to
continue to grow. In the future, studies will be able to include more participants in analyses to
decrease the chance of type 2 error. This small sample of mainly Caucasian families may also
limit generalizability of our findings to racially diverse and lower income families. Future
research should seek to engage more racially and socio-economically diverse families.

Another limitation of the current study is the collection of self-reported weight at 1 year
follow-up for the 6 of 57 participants who moved away and were unable attend their health
assessment at the University of Guelph campus. These 6 participants provided self-reported
weight measurements following a moving protocol document that was provided by the research
team (APPENDIX C), and which defines the protocol for reporting weight to help eliminate
errors. The use of self-reported data increases the opportunity for measurement error.

While all participants were instructed about the BOD POD protocol ahead of time,
ocasionally participants had facial hair, wore jewelry that could not be removed or wore
clothing that was not skin tight (n=7). These discrepancies from the recommended BOD POD
protocol may have altered the BOD POD’s accuracy due to isothermic air being trapped within
these garments (Fields, Hunter, & Goran, 2000). By noting which participants wore ill-fitting
clothing, and ensuring that these conditions were replicated for future visits, the inconsistency in measurements was limited.

The final limitation of the GFHS was the methods by which participants were recruited. The use of flyers, social media, local family health teams, the Guelph Community Health Centre and word of mouth likely reached only a subset of families in the Guelph area. This method of recruitment may have led to recruiting more highly motivated individuals and may have led to more positive changes across all treatment groups. These more highly motivated individuals may have been a part of the control group and may have made behaviour changes leading to decreases in body composition. Therefore, the differences between the intervention and control groups may not have been as significant because the control group was also exhibiting positive changes during the intervention period.

6.4 Next Steps for Future Research

While this research shows promising results, further studies should be conducted to validate the positive effects of family-based obesity prevention interventions on parental body composition outcomes. As previously shown, family-based obesity prevention interventions are commonly conducted, however parental body composition is seldom evaluated. Future family-based interventions should examine both child and parental body composition outcomes to identify beneficial changes in body composition for all family members. Future work could also expand to look at benefits in other health-related outcomes, such as prevalence of blood markers of disease including blood insulin, glucose, c-reactive protein and cortisol levels. Finally, the acknowledgement of specific behavioural mechanisms should be examined as a potential influence on health outcomes related to family-based interventions in both children and parents.
The potential benefits to parental body composition resulting from the Guelph Family Health Study may inform future obesity prevention interventions in public health due to the secondary effect of family-based obesity prevention interventions on parental body composition. Future obesity prevention interventions should take place in a family-based setting, to continue to encourage behaviour change and associated benefits to child health, but also impact parent health, as this study has demonstrated. As the effect of the GFHS intervention on parental body composition was a secondary effect of the intervention, future family-based interventions can integrate these findings into their design.

Family-based obesity prevention interventions are especially pertinent as they can benefit both parents and children. While this research demonstrates that parents show decreases in body composition outcome measures, children may also see improved health behaviours as their behaviour is influenced by parents (Birch & Davison, 2001). Therefore, including the entire family in obesity prevention interventions is critical to both parent and child health. Continual follow-up of greater than 1 year may help to reignite parents’ commitment to behaviour change and lead to further changes in body composition. These improvements could lead to a decreased prevalence in obesity and obesity-related diseases in both adults and children.

Future research in this area should include more randomized control trials to uphold the strongest of research designs. Furthermore, longitudinal studies of more than 1 year follow-up are needed to understand the long-term effects of these interventions on parents. The inclusion of both mothers and fathers is also of importance to examine both mothers’ and fathers’ body composition and the relationships between child and parent body composition. Moreover, the continued use of rigorous methods such as air displacement plethysmography is crucial to determine body composition changes in parents. These rigorous methods measure body
composition more accurately and are better able to indicate the associated health benefits to parents (Fields et al., 2002).

Understanding the impact of family-based obesity prevention interventions on parents, as well as children, could lead to family-based interventions becoming a potential avenue for prevention of population-level obesity. Furthermore, these family-based obesity prevention interventions can decrease obesity prevalence through behaviour change in both adults and children, and therefore limit the burden on the healthcare system.
7.0 Conclusions

In summary, this thesis explored the effect of a family-based obesity prevention intervention on the body composition of parents. This was a randomized controlled trial using data from 58 parent participants in the Guelph Family Health Study. Among the entire sample, the intervention significantly and positively impacted body composition in the two home visit group, but not the four home visit group. The intervention was shown to have a positive impact on body composition outcomes in all parents, and subsequently in the analyses stratified by weight status. The statistically significant positive changes in body composition outcomes were sustained at 18-month follow-up only by parents who were overweight/obese at baseline. This study provides insight into the effects of a family-based obesity prevention intervention on parental body composition. More specifically, parents who are overweight/obese at baseline show sustained decreases in body composition outcomes at 18-month follow-up. This study will help to inform future family-based obesity prevention interventions and recognize the opportunity to change health outcomes for both children and parents with these interventions.
8.0 References


APPENDIX A – GFHS Parental Consent Forms

Guelph Family Health Study – Longitudinal Study
Consent to Participate – Parent #1

The purpose of this form is to provide you with the information you need to make an informed decision for you and your family about participating in this research study. Participation in this study is voluntary.

Part 1: Understanding The Study

About the study
The Guelph Family Health Study is a unique research study that is following a large group of families with young children in Guelph over many years.

The study and its related costs are funded through the Better Planet Project at the University of Guelph.

Definitions

Parents: We define parents as the main caregivers of children. Parents can be biological, related or adoptive.

Family: For this study we define family as parents and their children who are 18 months to five years of age. Families can have one or many parents. A maximum of two parents from each family can register in this study.

What’s required?
After you and your family complete your registration in this study, you will be asked to:
1. **Complete online questionnaires**  
   Estimated time: 40 minutes per questionnaire

   This study requires you to answer questions that will help us understand your family’s health behaviours. You will receive a $20 grocery gift card as a thank you for each questionnaire you complete. For more information, visit what's required.

2. **Meet with a member of our study team at your home**  
   Estimated time: 1 hour

   The Study Coordinator will meet you at a convenient time to provide instructions on how to complete the rest of the study.

3. **Track food and activity for a few days**  
   Estimated time: 15 minutes per day

   At your home visit we will teach you how to keep a three-day record of the food eaten by your children. We will also ask your children to wear an activity monitor that looks like a wrist watch for four days. For more information, visit what’s required.

4. **Come to the University of Guelph for a family health assessment**  
   Estimated time: 1.5 hours + travel time

   Your family will be asked to visit the University of Guelph for a health assessment to:
   - Measure your height and weight using a scale and height board, similar to the ones at your doctor’s office.
   - Measure waist using a tape measure.
   - Measure body fat and muscle.
     
   **For adults**, this will be done using a machine called a BOD POD™. For more information, visit How do you measure body fat and muscle?
For children, this will be done using a machine called a Bioelectric Impedance Analyzer (BIA). BIA uses small patches that produce an electrical signal. For more information, visit How do you measure body fat and muscle?

- Measure blood pressure using a cuff that wraps around your arm, similar to the one at your doctor’s office.
- Collect a saliva sample. For more information, visit How do you collect saliva?

You will receive a $75 grocery gift card if one parent attends the health assessment or a $100 grocery gift card if two parents attend the health assessment.

5. Provide a blood sample at a local laboratory
   Estimated time: 15 minutes per family member + travel time

You can choose for your family to provide blood samples at a local medical laboratory within three weeks of your health assessment. Giving a blood sample is optional and is not a requirement of the study. You and your family can still participate in the study even if you choose not to provide blood samples. You will receive a $50 grocery gift card as a thank you for completing the laboratory visit. For more information, visit giving blood.

6. Participate in follow up assessments
   Your family will be invited to complete a combination of questionnaires, home visits, food and activity tracking, health assessments and blood samples every six or 12 months for up to 20 years. Your follow up assessments will help us learn how human behaviours affect health over time.

What benefits are associated with this study?
If you choose to participate in this study, you will be part of an important project that is helping us better understand the human behaviours that affect health. We will use this information to develop programs that reduce the risk for disease in families.
What risks are associated with this study?

Measuring body fat and muscle:
- **For parents:** You may experience claustrophobia while sitting in the BOD POD™. You can exit the BOD POD™ at any time. You may feel slightly embarrassed about wearing a bathing suit in the BOD POD™. The BOD POD™ is located in a private room. For more information, visit How do you measure body fat and muscle?

- **For children:** There is a very small risk that your child’s skin may be sensitive to the glue we use to apply the patches. Your child can ask us to remove the patches at any time, if they are uncomfortable.

Giving blood: You may experience the usual pain and bruising that people get when they give blood. You may also experience dizziness. Rarely, giving blood can cause an unusually small vein to collapse. The laboratory staff who will collect your blood have extensive training and experience taking blood in adults and young children.

Privacy: The privacy of your information is very important to us. Any time you allow someone to access your information, there is a small risk to your privacy from human error or technical error. We have taken many precautions to ensure that the information and samples you provide us will remain safe and private, and that your identity will be protected to the extent required by law. For more information, visit privacy.

Who is conducting this study?
This study is being conducted by a team of researchers at the University of Guelph.

Lead Researchers
David Ma, Associate Professor, Human Health & Nutritional Sciences
Jess Haines, Assistant Professor, Family Relations & Applied Nutrition

Research Team
Emma Allen Vercoe, Associate Professor, Molecular and Cellular Biology
Paula Brauer, Associate Professor, Family Relations & Applied Nutrition
Andrea Buchholz, Associate Professor, Family Relations & Applied Nutrition
Alison Duncan, Professor, Human Health & Nutritional Sciences
David Mutch, Associate Professor, Human Health & Nutritional Sciences
Lawrence Spriet, Professor and Chair, Human Health & Nutritional Sciences

Study Coordinator
Angela Annis, Human Health & Nutritional Sciences and Family Relations & Applied Nutrition

Contact us
You can contact the Study Coordinator for the Guelph Family Health Study by email at coordinator@guelphfamilyhealthstudy.com or by telephone at 519-824-4120 ext. 56168.

This study has been approved by the University of Guelph Research Ethics Board. If you have questions about your rights as a research participant, please contact this group by email at reb@uoguelph.ca or by telephone at 519-824-4120 ext. 56606.
Part 2: Agreeing to the study

Click on the box next to each statement that you agree with. When you are done, click ‘Submit’ at the bottom of the page.

By completing this consent form, I declare that:

☐ I understand the Guelph Family Health Study – Longitudinal Study, what is required of my family if we participate, and the benefits and risks. I have had the opportunity to ask questions about the study and have received adequate answers. **I am making an informed decision for myself and on behalf of my children to participate in this study.**

Please provide us with the names of your children:

Child #1 ___________________ Child #2 ___________________ Child #3 ___________________

☐ I understand that participation in this study is voluntary. I know that I can refuse to participate, refuse to answer questions, or withdraw myself or my children from the study at any time with no effect on our future healthcare or relationship with the University of Guelph. I understand that any information or samples I do not ask to be destroyed will remain with the study for future research.

☐ I understand that the study team may withdraw my family from this research at their discretion.

☐ I understand that there may be no clinical benefit to my family by participating in this study.

☐ I understand that the results of my body fat and muscle analysis will be provided to me, if requested. I understand that the results my children’s body fat and muscle analysis will not be provided to me since we do not yet have standards for level of fat and muscle for children.

☐ I understand that our saliva samples will be used to extract DNA and study how the genes we were born with affect our behaviours and responses to food. I understand that the results of our saliva tests will not be provided to me. This is to protect my family from having to potentially provide genetic information to a third party, such as an insurance provider or employer.

☐ I accept that if we provide blood samples, they will be tested for sugars, fats and hormones. I understand that some of my blood tests results will be provided to me if I request them. I understand that my children’s blood test results will not be provided to me because we don’t yet have standards for healthy blood ranges in children. I accept that if any of my blood tests are significantly abnormal, they will be reported to me for discussion with my doctor.
☐ I understand that our tests will not be provided by a medical doctor and cannot be used to diagnose a disease or condition.

☐ I accept that the results of my family’s tests may be used in publications and at conferences for the purpose of learning, only after any information that can identify us has been removed.

☐ I understand that since I could be receiving over $500 worth of incentives for participating in this study, I may need to provide my Social Insurance Number (SIN). I understand my SIN will be kept confidential and will only be shared with the University of Guelph financial office.

☐ I understand that my family will have the opportunity to participate in the Guelph Family Health Study – Pilot Program. This study program will provide 6-months of support to my family for healthy lifestyle choices. I will discuss this with the Study Coordinator during our home visit and I will be able to choose to participate at that time.

☐ I understand that I will have the option to have my family’s blood and saliva samples stored in the Guelph Family Health Study – BioBank. The samples will be used for future research to help better understand the human behaviours that affect health. I will discuss this with the Study Coordinator during our home visit and I will be able to choose to participate at that time.

Parent #1 Name ______________________________

Parent #1 Signature_________________________________ Date ______________________

Study Coordinator Signature ___________________________ Date ______________________
Guelph Family Health Study – Longitudinal Study
Consent to Participate – Parent #2

The purpose of this form is to provide you with the information you need to make an informed decision about participating in this research study. Participation in this study is voluntary.

Part 1: Understanding The Study

About the study:
The Guelph Family Health Study is a unique research study that is following a large group of families with young children in Guelph over many years.

The study and its related costs are funded through the Better Planet Project at the University of Guelph.

Definitions

Parents: We define parents as the main caregivers of children. Parents can be biological, related or adoptive.

Family: For this study we define family as parents and their children who are 18 months to five years of age. Families can have one or many parents. A maximum of two parents from each family can register in this study.

What’s required?
After you and your family complete your registration in this study, you will be asked to:

7. Complete online questionnaires
   Estimated time: 40 minutes per questionnaire
This study requires you to answer questions that will help us understand your family’s health behaviours. You will receive a $20 grocery gift card as a thank you for each questionnaire you complete. For more information, visit what’s required.

8. **Meet with a member of our study team at your home**  
   **Estimated time:** 1 hour

   The Study Coordinator will meet you at a convenient time to provide instructions on how to complete the rest of the study.

9. **Track food and activity for a few days**  
   **Estimated time:** 15 minutes per day

   At your home visit we will teach you how to keep a three-day record of the food eaten by your children. We will also ask your children to wear an activity monitor that looks like a wrist watch for four days. For more information, visit what’s required.

10. **Come to the University of Guelph for a family health assessment**  
    **Estimated time:** 1.5 hours + travel time

    Your family will be asked to visit the University of Guelph for a health assessment to:
    - Measure your height and weight using a scale and height board, similar to the ones at your doctor’s office.
    - Measure waist using a tape measure.
    - Measure body fat and muscle.  
      **For adults,** this will be done using a machine called a BOD POD™. For more information, visit How do you measure body fat and muscle?  
      **For children,** this will be done using a machine called a Bioelectric Impedance Analyzer (BIA). BIA uses small patches that produce an electrical
signal. For more information, visit How do you measure body fat and muscle?

- Measure blood pressure using a cuff that wraps around your arm, similar to the one at your doctor’s office.
- Collect a saliva sample. For more information, visit How do you collect saliva?

You will receive a $75 grocery gift card if one parent attends the health assessment or a $100 grocery gift card if two parents attend the health assessment.

11. **Provide a blood sample at a local laboratory**
   **Estimated time: 15 minutes per family member + travel time**

   You can choose for your family to provide blood samples at a local medical laboratory within three weeks of your health assessment. Giving a blood sample is optional and is not a requirement of the study. You and your family can still participate in the study even if you choose not to provide blood samples. You will receive a $50 grocery gift card as a thank you for completing the laboratory visit. For more information, visit giving blood.

12. **Participate in follow up assessments**
   Your family will be invited to complete a combination of questionnaires, home visits, food and activity tracking, health assessments and blood samples every six or 12 months for up to 20 years. Your follow up assessments will help us learn how human behaviours affect health over time.

**What benefits are associated with this study?**
If you choose to participate in this study, you will be part of an important project that is helping us better understand the human behaviours that affect health. We will use this information to develop programs that reduce the risk for disease in families.
What risks are associated with this study?

**Measuring body fat and muscle:**

- **For parents:** You may experience claustrophobia while sitting in the BOD POD™. You can exit the BOD POD™ at any time. You may feel slightly embarrassed about wearing a bathing suit in the BOD POD™. The BOD POD™ is located in a private room. For more information, visit How do you measure body fat and muscle?

- **For children:** There is a very small risk that your child’s skin may be sensitive to the glue we use to apply the patches. Your child can ask us to remove the patches at any time, if they are uncomfortable.

**Giving blood:** You may experience the usual pain and bruising that people get when they give blood. You may also experience dizziness. Rarely, giving blood can cause an unusually small vein to collapse. The laboratory staff who will collect your blood have extensive training and experience taking blood in adults and young children.

**Privacy:** The privacy of your information is very important to us. Any time you allow someone to access your information, there is a small risk to your privacy from human error or technical error. We have taken many precautions to ensure that the information and samples you provide us will remain safe and private, and that your identity will be protected to the extent required by law. For more information, visit privacy.

**Who is conducting this study?**
This study is being conducted by a team of researchers at the University of Guelph.

**Lead Researchers**
David Ma, Associate Professor, Human Health & Nutritional Sciences
Jess Haines, Assistant Professor, Family Relations & Applied Nutrition

**Research Team**
Emma Allen Vercoe, Associate Professor, Molecular and Cellular Biology
Paula Brauer, Associate Professor, Family Relations & Applied Nutrition
Andrea Buchholz, Associate Professor, Family Relations & Applied Nutrition
Alison Duncan, Professor, Human Health & Nutritional Sciences
David Mutch, Associate Professor, Human Health & Nutritional Sciences
Lawrence Spriet, Professor and Chair, Human Health & Nutritional Sciences

**Study Coordinator**
Angela Annis, Human Health & Nutritional Sciences and Family Relations & Applied Nutrition

**Contact us**
You can contact the Study Coordinator for the Guelph Family Health Study by email at coordinator@guelphfamilyhealthstudy.com or by telephone at 519-824-4120 ext. 56168.

This study has been approved by the University of Guelph Research Ethics Board. If you have questions about your rights as a research participant, please contact this group by email at reb@uoguelph.ca or by telephone at 519-824-4120 ext. 56606.
Part 2: Agreeing to the study

Click on the box next to each statement that you agree with. When you are done, click ‘Submit’ at the bottom of the page.

By completing this consent form, I declare that:

☐ I understand the Guelph Family Health Study – Longitudinal Study, what is required of my family if we participate, and the benefits and risks. I have had the opportunity to ask questions about the study and have received adequate answers. **I am making an informed decision to participate in this study.**

☐ I understand that my spouse/partner has provided consent for my children listed below and that they will be taking part in this study.

Child #1 __________________  Child #2 __________________  Child #3 __________________

☒ I understand that participation in this study is voluntary. I know that I can refuse to participate, refuse to answer questions, or withdraw myself or my children from the study at any time with no effect on our future healthcare or relationship with the University of Guelph. I understand that any information or samples I do not ask to be destroyed will remain with the study for future research.

☒ I understand that the study team may withdraw my family from this research at their discretion.

☒ I understand that there may be no clinical benefit to my family by participating in this study.

☒ I understand that the results of my body fat and muscle analysis will be provided to me, if requested. I understand that the results my children’s body fat and muscle analysis will not be provided to me since we do not yet have standards for level of fat and muscle for children.

☒ I understand that our saliva samples will be used to extract DNA and study how the genes we were born with affect our behaviours and responses to food. I understand that the results of our saliva tests will not be provided to me. This is to protect my family from having to potentially provide genetic information to a third party, such as an insurance provider or employer.

☒ I accept that if we provide blood samples, they will be tested for sugars, fats and hormones. I understand that some of my blood tests results will be provided to me if I request them. I understand that my children’s blood test results will not be provided to me because we don’t yet have standards for healthy blood ranges in children. I accept that if any of my blood tests are significantly abnormal, they will be reported to me for discussion with my doctor.
☐ I understand that our tests will not be provided by a medical doctor and cannot be used to diagnose a disease or condition.

☐ I accept that the results of my family’s tests may be used in publications and at conferences for the purpose of learning, only after any information that can identify us has been removed.

☐ I understand that since I could be receiving over $500 worth of incentives for participating in this study, I need to provide my Social Insurance Number (SIN). I understand my SIN will be kept confidential and will only be shared with the University of Guelph financial office.

☐ I understand that my family will have the opportunity to participate in the Guelph Family Health Study – Pilot Program. This study program will provide 6-months of support to my family for healthy lifestyle choices. I will discuss this with the Study Coordinator during our home visit and I will be able to choose to participate at that time.

☐ I understand that I will have the option to have my family’s blood and saliva samples stored in the Guelph Family Health Study – BioBank. The samples will be used for future research to help better understand the human behaviours that affect health. I will discuss this with the Study Coordinator during our home visit and I will be able to choose to participate at that time.

Parent #2 Name ______________________________

Parent #2 Signature_____________________________   Date ________________

Study Coordinator Signature _______________________   Date ________________
Guelph Family Health Study – Pilot Study
Consent to Participate – Parent #1

The purpose of this form is to provide you with the information you need to make an informed decision for you and your family about participating in this research study. Participation in this study is voluntary.

Part 1: Understanding The Study

About the study:
The Guelph Family Health Study – Pilot Study is a unique research study that is developing and testing ways to help families maintain healthy behaviours over many years. Parents that participate in the Pilot Study will receive personalized information on how to help their family live a healthy life.

The study and its related costs are funded through the Better Planet Project at the University of Guelph.

Definitions

Parents: We define parents as the main caregivers of children. Parents can be biological, related or adoptive.

Family: For this study we define family as parents and their children who are 18 months to five years of age. Families can have one or many parents. A maximum of two parents from each family can register in this study.

What’s required?
Your family will be chosen by chance to receive one of our study programs for healthy family lifestyle. You will receive information from us in the form of e-mails and/or home visits with a health educator for the next 6 months.
What benefits are associated with this study?
If you choose to participate in this study, you will be part of an important project that is helping us better understand the human behaviours that affect health. We will use this information to develop programs that reduce the risk for disease in families.

In addition, your family will receive 6 months of customized health advice from our research experts.

What risks are associated with this study?
Although we have designed our interventions so that they support families in a non-judgemental way, you may feel concerned that you are not doing a good job parenting and/or managing your children’s diet and exercise. You can choose to not participate in any part of the interventions. We can also refer you to other agencies within the area that can provide additional support, if you feel it is needed.

Who is conducting this study?
This study is being conducted by a team of researchers at the University of Guelph.

Lead Researchers
David Ma, Associate Professor, Human Health & Nutritional Sciences
Jess Haines, Assistant Professor, Family Relations & Applied Nutrition

Research Team
Emma Allen Vercoe, Associate Professor, Molecular and Cellular Biology
Paula Brauer, Associate Professor, Family Relations & Applied Nutrition
Andrea Buchholz, Associate Professor, Family Relations & Applied Nutrition
Alison Duncan, Professor, Human Health & Nutritional Sciences
David Mutch, Associate Professor, Human Health & Nutritional Sciences
Lawrence Spriet, Professor and Chair, Human Health & Nutritional Sciences

Study Coordinator
Angela Annis, Human Health & Nutritional Sciences and Family Relations & Applied Nutrition

Contact us
You can contact the Study Coordinator for the Guelph Family Health Study by email at coordinator@guelphfamilyhealthstudy.com or by telephone at 519-824-4120 extension 56168.

This study has been approved by the University of Guelph Research Ethics Board. If you have questions about your rights as a research participant, please contact this group by email at reb@uoguelph.ca or by telephone at 519-824-4120 extension 56606.
Part 2: Agreeing to the study

Check the box next to each statement that you agree with.

By completing this consent form, I declare that:

☐ I understand the Guelph Family Health Study – Pilot Study, what’s required of my family if we participate, and the benefits and risks. I have had the opportunity to ask questions about the study and have received adequate answers. **I am making an informed decision for myself and on behalf of my children to participate in this study, as listed below.**

Please provide us with the names of your children:

Child #1 ________________ Child #2 ___________________ Child #3 ________________

☐ I understand that participation in this study is voluntary. I know I can refuse to participate, refuse to answer questions, or withdraw myself or my children from the study at any time with no effect on our future healthcare or relationship with the University of Guelph. I understand that any information I do not ask to be destroyed will remain with the study for future research.

☐ I understand that the study team may withdraw my family from this research at their discretion.

☐ I understand that the program my family receives is not an established therapy shown to improve health and there may be no clinical benefit to me or to my children for participating in this study.

☐ I understand that our family will be chosen by chance to receive one of the following 6-month programs:

1) 1 e-mail each month that provides general health information, or
2) 1 e-mail each week that provides specific health information for my family, plus 2 home visits with a health educator, or
3) 1 e-mail each week that provides specific health information for my family, plus 4 home visits with a health educator.

☐ I understand that each home visit will take approximately 1 hour and will be completed at a convenient time.

☐ I understand that my family may be contacted after the completion of this study to participate in future assessments. I understand that I will receive a new form that describes these future assessments, including possible risk and benefits, and I will be able to decide at that time whether my family would like to participate.
Parent #1 Name ______________________________

Parent #1 Signature ______________________________ Date

Study Coordinator Signature ______________________________ Date

________________________
Guelph Family Health Study – Pilot Study
Consent to Participate – Parent #2

The purpose of this form is to provide you with the information you need to make an informed decision for you and your family about participating in this research study. Participation in this study is voluntary.

Part 1: Understanding The Study

About the study:
The Guelph Family Health Study – Pilot Study is a unique research study that is developing and testing ways to help families maintain healthy behaviours over many years. Parents that participate in the Pilot Study will receive personalized information on how to help their family live a healthy life.

The study and its related costs are funded through the Better Planet Project at the University of Guelph.

Definitions

Parents: We define parents as the main caregivers of children. Parents can be biological, related or adoptive.

Family: For this study we define family as parents and their children who are 18 months to five years of age. Families can have one or many parents. A maximum of two parents from each family can register in this study.

What’s required?
Your family will be chosen by chance to receive one of three study programs for healthy family lifestyle. You will receive information from us in the form of e-mails and/or home visits with a health educator for the next 6 months.
What benefits are associated with this study?
If you choose to participate in this study, you will be part of an important project that is helping us better understand the human behaviours that affect health. We will use this information to develop programs that reduce the risk for disease in families.

In addition, your family will receive 6 months of customized health advice from our research experts.

What risks are associated with this study?
Although we have designed our interventions so that they support families in a non-judgemental way, you may feel concerned that you are not doing a good job parenting and/or managing your children’s diet and exercise. You can choose to not participate in any part of the interventions. We can also refer you to other agencies within the area that can provide additional support, if you feel it is needed.

Who is conducting this study?
This study is being conducted by a team of researchers at the University of Guelph.

Lead Researchers
David Ma, Associate Professor, Human Health & Nutritional Sciences
Jess Haines, Assistant Professor, Family Relations & Applied Nutrition

Research Team
Emma Allen Vercoe, Associate Professor, Molecular and Cellular Biology
Paula Brauer, Associate Professor, Family Relations & Applied Nutrition
Andrea Buchholz, Associate Professor, Family Relations & Applied Nutrition
Alison Duncan, Professor, Human Health & Nutritional Sciences
David Mutch, Associate Professor, Human Health & Nutritional Sciences
Lawrence Spriet, Professor and Chair, Human Health & Nutritional Sciences

Study Coordinator
Angela Annis, Human Health & Nutritional Sciences and Family Relations & Applied Nutrition

Contact us
You can contact the Study Coordinator for the Guelph Family Health Study by email at coordinator@guelphfamilyhealthstudy.com or by telephone at 519-824-4120 extension 56168.

This study has been approved by the University of Guelph Research Ethics Board. If you have questions about your rights as a research participant, please contact this group by email at reb@uoguelph.ca or by telephone at 519-824-4120 extension 56606.

Part 2: Agreeing to the study
Check the box next to each statement that you agree with.

By completing this consent form, I declare that:

☐ I understand the Guelph Family Health Study – Pilot Study, what’s required of my family if I participate, and the benefits and risks. I have had the opportunity to ask questions about the study and have received adequate answers. **I am making an informed decision to participate in this study.**

☐ I understand that my spouse/partner has provided consent for my children listed below and that they will be taking part in this study.

Please provide us with the names of your children:

Child #1 __________________ Child #2 ____________________ Child #3 ________________________

☐ I understand that participation in this study is voluntary. I know I can refuse to participate, refuse to answer questions, or withdraw myself or my children from the study at any time with no effect on our future healthcare or relationship with the University of Guelph. I understand that any information I do not ask to be destroyed will remain with the study for future research.

☐ I understand that the study team may withdraw me from this research at their discretion.

☐ I understand that the program my family receives is not an established therapy shown to improve health and there may be no clinical benefit to me or to my children for participating in this study.

☐ I understand that our family will be chosen by chance to receive one of the following 6-month programs:

4) 1 e-mail each month that provides general health information, or
5) 1 e-mail each week that provides specific health information for my family, plus 2 home visits with a health educator, or
6) 1 e-mail each week that provides specific health information for my family, plus 4 home visits with a health educator.

☐ I understand that each home visit will take approximately 1 hour and will be completed at a convenient time.

☐ I understand that I may be contacted after the completion of this study to participate in future assessments. I understand that I will receive a new form that describes these future assessments, including possible risk and benefits, and I will be able to decide at that time whether I would like to participate.
Parent #2 Name ______________________________

Parent #2 Signature________________________________ Date

________________________

Study Coordinator Signature ____________________ Date

________________________
APPENDIX B – REB Information for BOD POD Body Composition Measurement

The BOD POD™ is an enclosed, seated chamber in which participants are able sit comfortably. The BOD POD™ uses the displacement of air inside the chamber to determine body volume. From these measurements, whole-body density is determined and body fat and lean mass (muscle) are calculated. This procedure is non-invasive, simple and painless and results are obtained in minutes.

All participants will be asked about claustrophobia prior to the test. While the risk of claustrophobia is very low as there is a large, clear Plexiglas window at the front of the instrument, there is “stop test” button located under the participants’ left knee. S/he can press this button at any time during the test; this automatically stops the test and disengages the magnets that keep the chamber door closed. Alternatively, the participant can merely state to the researcher through the Plexiglas window that s/he would like the test stopped.

Participants are asked to wear a bathing suit and bathing cap for this test to minimize the trapping of air between clothing, hair and the skin (as this causes measurement artifact). Participants provide their own bathing suits; they can either bring their own bathing caps, or we can provide a disposable bathing cap. For those who wish it, we can provide a hospital gown for modesty directly prior to and following the test. The hospital gown will be worn by each participant until he/she is seated in the BOD POD™ and then it will be handed to the Operator before the test. After the test, the Operator will hand the hospital gown back to the participant to put on prior to exiting the BOD POD™. At no time will participants be viewed in their bathing suits by anyone other than the personnel performing the health assessment. After use, the hospital gown is placed in a laundry cart, the contents of which are laundered by the study personnel.

Accurate measurement of body density using the BOD POD™ also requires measurement of thoracic gas volume. This is achieved by having the participant provide three, short light breaths into a single-use tube connected to the rear of the test chamber, while the participant is seated in the chamber. For this additional step, participants are required to briefly plug their nose while simultaneously exhaling through their mouth into the tube. Most participants undertake this measurement twice, as they typically blow too hard during their three breaths.

The entire BOD POD™ test takes approximately 15 minutes. Of these 15 minutes, participants are in the chamber for perhaps a total of 5 minutes. There is additional calibration time (approx. 5 to 10 minutes), but for this the participant is standing outside the chamber.
The door to the lab must remain closed during the test to avoid pressure fluctuations in the room; this will also serve to prevent passers-by from entering the lab from the hallway. There is a plastic film on the window of the door such that; when the light above the BOD POD™ is turned off, passers-by cannot see into the lab, thus further protecting participants’ privacy.

At the end of the test, the participant receives a printout with their body composition results. This printout includes an explanation and interpretation of the participant’s values.

**BOD POD™ Warm-up Protocol for Guelph Family Health Study**

1) Turn on the BOD POD™ upon arrival to the lab
2) Run an ANALYZE HARDWARE test from the QC menu
   If anything fails, call the BOD POD™ technicians
3) Run a CHECK SCALE test from the QC menu
   Calibrate the scale if it has been greater than two weeks since last calibration
4) Run one AUTO RUN tests from the QC menu
   Passing Standard deviations are lower than 60
5) Run a VOLUME CHECK test from the QC menu

The BOD POD™ is ready for a body composition test.
APPENDIX C – Standard Operating Procedure for Height and Weight collection from participants who have moved away

Dear XXX Family,
Thank you for your continued participation in the Guelph Family Health Study! Please measure weight and height for each family member enrolled in the study return this form by email to coordinator@guelphfamilyhealthstudy.com. This form is two pages and contains instructions for how to accurately complete each measurement. If you have any questions, please contact the Study Coordinator at coordinator@guelphfamilyhealthstudy.com or 519-824-4120 ext. 56168.

Weight Measurement:
Parents and Children - Please use your own scale to measure weight and record the measurement in kilograms or pounds (be sure to indicate kg vs. lb) in chart below. If you do not have a scale at home, please indicate “no scale”. Please remove footwear and outer garments (e.g. jackets, hats, heavy sweaters, etc). You can encourage children to remain “still as a statue” to ensure the measurement is accurate. Record the weight values including all decimals (if applicable).

<table>
<thead>
<tr>
<th>Name</th>
<th>Weight 1st time:</th>
<th>Weight 2nd time:</th>
<th>Date Recorded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


**Height Measurement:**

**Parents** – Please record your height as it looks on your driver’s license in the chart below.

**Children** – Please use the measuring tape provided to record your child’s height. Secure the measuring tape to the wall. For further instructions on how to set up your measuring tape please watch this video [http://www.healthyhomestyle.com/height/](http://www.healthyhomestyle.com/height/). Your child should be barefoot or in sock feet, and be wearing minimal clothing to facilitate the correct position during measurement. Any hair ornaments (barrettes, hair ties etc.) should be removed. The child should stand with heels together (the toes can be pointed outward slightly), arms to the side, legs straight, shoulders relaxed, head looking straight ahead. Please measure your child’s height two times and record in the chart below.

![Incorrect measurement]

Tape the measuring tape to the wall and measure each child’s height against the wall like the pose on the left.

<table>
<thead>
<tr>
<th>Name</th>
<th>Height 1st time: cm</th>
<th>Height 2nd time: cm</th>
<th>Date Recorded cm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D – Standard Operating Procedure for BODPOD Body Composition Measurement

BODPOD Measurement Protocol

BOD POD™ Warm-up Protocol for Guelph Family Health Study
1. Turn on the BOD POD™ upon arrival to the lab
2. Wait 30 minutes after turning on BOD POD before running QC
3. Run an ANALYZE HARDWARE test from the QC menu
   a. If anything fails, call the BOD POD™ technicians (techsupport@bodpod.com)
4. Run a CHECK SCALE test from the QC menu
   a. Calibrate the scale if it has been more than two weeks since last calibration. If in doubt as to when calibration was last done, proceed to calibration.
5. Run one AUTO RUN tests from the QC menu
   a. Passing Standard deviations are lower than 60
6. Run a VOLUME CHECK test from the QC menu

The BOD POD™ is ready for a body composition test.

BOD POD™ Body Composition Test Protocol for Guelph Family Health Study
1. Begin a new body composition test and enter the information for the participant. Participant ID is entered for the first name (PXXXX) and GFHS for the last name
2. Confirm birthdate (dd/mm/yyyy) with data sheet and participant and enter into the computer
3. Enter gender for the participant
4. Enter average height from two measurements following GFHS height measurement SOP, including units (cm).
5. Select the appropriate ethnicity classification (general population vs. African American)

*NOTE: If prompted, choose an existing participant from within the BODPOD software – this is only applicable for follow-up visits

6. Continue to the next screen
7. Select the Siri equation to use as the density model and measured thoracic gas volume
8. Continue to the next screen and follow the prompts to begin the body composition test
9. Install breathing tube and perform calibration, as prompted by the BODPOD software. Ensure participant is wearing cap and has removed glasses, jewellery. Check to see if participant has anything to eat or drink or exercised in the past 2 hours. 

10. Weigh participant on BOD POD scale following on screen prompts 

11. BOD POD is now ready for volume measurements 

12. Two volume measurements will be taken (a third measurement may be needed if these two measurements are significantly different – the computer will instruct you if a third measurement is needed) 

13. Instruct participant to sit still and breath normally for the duration of the 30 second measurement. Inform the participant that they may hear clicking or feel pressure but it is all a normal part of the test. Instruct the participant about the emergency stop button behind their left knee. 

**BOD POD Thoracic Gas Volume Measurement Protocol for Guelph Family Health Study**

*NOTE:* Participants can wear glasses for this portion of the test if needed. 

1. We will now begin the lung volume measurement part of the test. This measurement is used to determine how much air is within your lungs. 

2. The screen will instruct you when to breathe by moving bars up and down. The bars read “breath in” and “breath out”. The test will begin with a short calibration period where you will hold the tube in your hand and breath normally before putting the tube in your mouth. Then the screen will prompt you to “prepare to put the tube in your mouth and plug your nose”, and then will say “put the tube in your mouth and plug your nose”. You will then breathe in and out normally through the tube with your lips sealed all the way around the tube. 

3. Near the end of the breathing test, the screen will prompt you to “prepare to huff” and then “huff, huff, huff”. When you are instructed to “huff, huff, huff” pant into the tube as if you were fogging your glasses or gently blowing a feather off the palm of your hand. Do not try to blow hard while doing this, it is a gentle huff. 

4. There will be clicking heard during the test but this is a normal part of the test. You may feel resistance when breathing into the tube, but do not try to blow harder to overcome this resistance, just continue to breathe normally. 

**Completing the Test**

1. Upon completion of the volume measurements, ask the participant to exit the BOD POD. 

2. Enter participant’s activity level as “Active” on BOD POD software. 

3. Follow the prompts on screen to print the data sheet in kg/cm. 

4. Attach BOD POD results to data collection form.
Note to Operator

Please note the following instructions:

- Operator will leave the room and participants can get changed. Be sure to offer the participant a hospital gown to wear on top of their bathing suit.
- Instruct the participant not to take off the hospital gown until just before stepping into the BOD POD™. This will minimize the participant’s exposure while wearing a bathing suit.
- *Above all, remember that research participants are volunteers. Treat them respectfully, in the same manner as you would want to be treated if you were in their shoes.*

The entire BOD POD™ test takes approximately 15 minutes. Of these 15 minutes, participants are in the chamber for perhaps a total of 5 minutes. There is additional calibration time (approx. 5 to 10 minutes), but for this the participant is standing outside the chamber.
APPENDIX E – Standard Operating Procedure for Weight Measurement

Weight Measurement Protocol

To measure weight using the BODPOD:

1. Instruct the participant to remove his/her footwear and outer garments (e.g. jackets, hats, heavy sweaters, etc).

2. Turn on POD (green button on white box and computer).

3. Login to the BODPOD software
   Username = bodycomp
   Password = bodycomp

4. Be sure the scale has been calibrated in the last 2 weeks.

5. Click on PRACTISE>MASS. The scale will tare and then prompt you to ask participant to stand on the scale for measurement.

If a child participant is too young or too nervous to stand on the scale, measure the mass of one parent holding the child and then measure the parent alone. The child’s mass can be calculated from these two measurements.

Weight only needs to be measured once as reliability testing has been done and is very high.

If the BODPOD scale is unavailable, use the Seca scale in the back room to take a manual weight measurement.
APPENDIX F – Standard Operating Procedure for Waist Circumference Measurement

Waist Circumference Measurement Protocol

Measuring waist circumference at the top of the iliac crest:

1. Participant should clear abdomen of all clothing.
2. Participant should stand with feet shoulder-width apart and arms crossed over chest.
3. On the **RIGHT** side of the participant, on **BENDED KNEE**, palpate the **TOP** of the right iliac crest (think of the crest of a wave). You are aiming for the uppermost lateral border of the right hipbone.

Requires **TWO** technicians:

- One to do the landmarking and measurement
- The other to ensure measuring tape is parallel with the floor, and to record the values
4. Draw a horizontal line at this landmark, using eyeliner.

5. Wrap a Gulick II measuring tape around the abdomen. The bottom of the measuring tape should be level with the line. It should be horizontal all the way around.

6. Apply tension to the tape to make sure the tape is snug, but not so tight as to compress tissue. One of the two red balls of the spring mechanism should be visible. See “How to take a measurement” in the Gulick II Instruction Manual.

7. At the end of normal expiration (after expiration, before inspiration), take the measurement to the nearest 0.1 cm.

8. Repeat steps 5 to 7 for a second measurement.
   - If the two values are within 0.5 cm, take the mean.
   - If the two values diverge by more than 0.5 cm, take a third measurement, and GFHS will use the mean of the two closest values.

References
Measuring Height Using a Stadiometer

1. The participant should be barefoot or in sock feet, and be wearing minimal clothing to facilitate the correct position during measurement. Any hair ornaments (barrettes, etc.) should be removed.
2. The participant should stand with heels together (the toes can be pointed outward slightly), arms to the side, legs straight, shoulders relaxed, head in Frankfort horizontal plane (“look straight ahead”).

3. There should be four points of contact between the participant and stadiometer/wall: heels, buttocks, scapulae, back of head.

4. Just prior to measurement, instruct the participant to inhale deeply & hold their breath with shoulders up, back and down to maintain an erect posture (“stand up tall”), while the headboard is lowered on the highest point of the head with enough pressure to compress the hair.

5. Measure to the nearest 0.1 cm. Read the measurement at the red line in the center of the ruler. Participant can exhale.

6. Reposition the participant and repeat steps 2 to 5 for a second measurement.
   - If the two values are within 0.5 cm, take the mean.
   - If the two values diverge by more than 0.5 cm, take a third measurement, and GFHS will use the mean of the two closest values.

References