Examining the Associations between Household Chaos and Child Diet Quality and Obesity Risk

By

Kira Jewell

A Thesis
presented to
The University of Guelph

In partial fulfillment of requirements
for the degree of
Master of Science
in
Family Relations and Applied Human Nutrition

Guelph, Ontario, Canada

© Kira Jewell, September 2019
ABSTRACT

EXAMINING THE ASSOCIATIONS BETWEEN HOUSEHOLD CHAOS AND CHILD DIET QUALITY AND OBESITY RISK

Kira Jewell
University of Guelph, 2019

Advisors:
Dr. Jess Haines and
Dr. Andrea Buchholz

The home environment is an influential framework for child health outcomes. The Confusion, Hubbub, and Order Scale (CHAOS) was developed by Matheny and colleagues to measure the level of disorganisation in the home. Families across all levels of socioeconomic status report moderate to high scores on the CHAOS. However, associations between the CHAOS and child diet and weight outcomes have not been extensively examined. This thesis examined associations between CHAOS scores and the diet quality (n=131), BMI-z score (n=90), and percent fat mass (n=72) of children between the ages of two and six years. Linear regression using generalized estimating equations was used to investigate associations between household chaos and children's diet quality, BMI-z score, and percent fat mass. In this sample, there were no significant associations between chaos and children's diet quality, BMI z-score, or percent fat mass. Researchers should continue to examine these relationships in diverse samples.
Acknowledgements

Thank you to my advisors, Jess and Andrea, for acting as the most amazing guides and role models I could have asked for through my graduate studies, to Nick for being a much needed HEI partner in crime, and to the rest of the wonderful people who make up the GFHS team for being such a special support network. Thank you, Kathryn for always being the most reassuring supporter I could ask for, from my first introduction to research, through graduate school, and even my DC application.

Thank you, thank you, thank you to my friends and family for being there for me through all the struggles (imposter syndrome, ESHA issues, writing frustrations, potato counting…) and more importantly, for much needed distraction from them. I love you all so very much.
Table of Contents

Abstract .............................................................................................................................................. ii
Acknowledgements ............................................................................................................................ iii
List of Tables ......................................................................................................................................... v
List of Figures ........................................................................................................................................ vi
List of Abbreviations .......................................................................................................................... vii
List of Appendices .............................................................................................................................. viii
1.0 Introduction ...................................................................................................................................... 1
2.0 Review of the Literature .................................................................................................................. 3
  2.1 The importance of dietary intake, diet quality, and diet quality assessment in children 3
    2.1.1 Dietary intake among Canadian Children ........................................................................... 3
    2.1.2 Defining and assessing diet quality .................................................................................... 5
    2.1.3 The relationship between diet quality and chronic disease risk ........................................ 8
  2.2 The role of parents and the family environment on child dietary intake and child-
    lifestyle associated health outcomes .............................................................................................. 11
    2.2.1 Parents’ role in the development of their children’s eating behaviours .............................. 11
    2.2.2 Impact of the family meal environment on child dietary intake and weight status ........ 13
    2.2.3 The impact of the general family environment on dietary intake and child weight
        status ............................................................................................................................................ 16
    2.2.4 The impact of household chaos on child dietary intake and weight outcomes .......... 18
3.0 Research Objectives, Rationale, and Hypothesis ......................................................................... 21
  3.1 Rationale ....................................................................................................................................... 21
  3.2 Research Objectives ....................................................................................................................... 23
  3.3 Hypotheses ..................................................................................................................................... 25
4.0 Methods ........................................................................................................................................... 25
  4.1 Recruitment and Eligibility ............................................................................................................ 26
  4.2 Measures ....................................................................................................................................... 27
    4.2.1 Household chaos ................................................................................................................. 27
    4.2.2 Child diet quality ................................................................................................................ 28
    4.2.3 Anthropometrics ................................................................................................................ 29
    4.2.4 Body composition .............................................................................................................. 31
    4.2.5 Family Food Behaviours ................................................................................................. 33
  4.3 Statistical Analysis ......................................................................................................................... 34
5.0 Manuscript ....................................................................................................................................... 36
  5.1 References ..................................................................................................................................... 52
6.0 Summary ......................................................................................................................................... 55
References .............................................................................................................................................. 57
Appendices ............................................................................................................................................. 66
List of Tables

Table 4.1 Survey questions used in the present study to capture food purchase, preparation, and consumption habits in the home ................................................................. 34

Table 5.1 Sample Characteristics .................................................................................................................. 51

Table 5.2 Results of linear regression modeling using generalized estimating equations examining the relationship between CHAOS and child diet quality and weight outcomes ........................................................................................................ 51
List of Figures

Figure 1: Main Effects and Mediation Models of Family Chaos on Child Diet Quality ...24

Figure 2: Main Effects and Mediation Models of Family Chaos on Child BMI Z-score and Child Adiposity.................................................................25
List of Abbreviations

AHEI – Alternate Healthy Eating Index
BMI – body mass index
CHAOS – Confusion, Hubbub, And Order Scale
CI – confidence interval
DQI-I – The Diet Quality Index-International
FFSS – Family Food Skills Study
GFHS – Guelph Family Health Study
HEI – Healthy Eating Index
HEI-C – Healthy Eating Index Canada
ONQI – The Overall Nutritional Quality Index
USDA – United States Department of Agriculture’s
WHO – World Health Organization
**List of Appendices**

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix A</td>
<td>Confusion, Hubbub, and Order Scale</td>
<td>66</td>
</tr>
<tr>
<td>Appendix B</td>
<td>Participant 3-Day Food Record Instructions</td>
<td>67</td>
</tr>
<tr>
<td>Appendix C</td>
<td>Food Record Data Entry Standard Operating Procedure</td>
<td>72</td>
</tr>
<tr>
<td>Appendix D</td>
<td>HEI Standard Operating Procedure</td>
<td>80</td>
</tr>
<tr>
<td>Appendix E</td>
<td>Standard Operating Procedure for Length/Height Measurement</td>
<td>85</td>
</tr>
<tr>
<td>Appendix F</td>
<td>Standard Operating Procedure for Weight Measurement</td>
<td>88</td>
</tr>
<tr>
<td>Appendix G</td>
<td>Standard Operating Procedure for BMI Z-Score Calculation</td>
<td>89</td>
</tr>
<tr>
<td>Appendix H</td>
<td>Standard Operating Procedure for Bioelectrical Impedance Analysis (BIA)</td>
<td>90</td>
</tr>
</tbody>
</table>
1.0 Introduction

Parents play an important role in the development of their children’s eating behaviours (Lazarou, Kalavana, & Matalas, 2008; Savage, Fisher, & Birch, 2007). Research has shown that parents’ use of more controlling feeding behaviours, and the availability and accessibility of less healthful foods in the home, have a negative impact on children’s food preferences, dietary intakes, and weight outcomes (Ventura & Birch, 2008). More recently, researchers have acknowledged the importance of examining the general family context within which parent feeding and child eating behaviours occur. Components of the family environment postulated to influence child eating behaviours, dietary intake, and obesity risk include parent stress, family functioning, and household chaos. Specifically, research has found greater parent stress and lower family functioning to be associated with increased risk of overweight and associated health behaviours (Parks et al., 2012; Halliday, Palma, Mellor, Green & Renzaho, 2014).

The Confusion, Hubbub, and Order Scale (CHAOS) was developed by Matheny and colleagues (1995) to measure the level of disorganisation and uncertainty in the home and has been associated with child eating behaviour (Lumeng et al., 2014), dietary intake, and household food availability (Martin-Biggers, Quick, Zhang, Jin, & Byrd-Bredbenner, 2018), but studies examining this relationship are sparse. It is postulated that chaos in the home environment could have implications on the ability of families to practice positive food behaviours (i.e., frequent participation in family meals), which in turn would impact the children’s dietary intake (Martin-Biggers et al., 2018) and weight status. To our knowledge, there are only three previous studies which have examined the relationship between the CHAOS and child eating behaviour and dietary intake. Of
the three existing studies, two found higher household CHAOS scores to be associated with undesirable nutrition outcomes (i.e., emotional overeating, higher consumption of sugar-sweetened beverages, and greater availability of salty and fatty snacks in the home) in children (Martin-Biggers et al., 2018; Lumeng et al., 2014), but none of these studies examined child overall diet quality as an outcome. Diet quality is an important indicator of chronic disease risk and a more comprehensive view of an individual’s diet than examining the intake of a specific food or nutrient (Golley, 2010; Atkins & Wannamethee, 2015).

Research examining the association between the CHAOS and obesity risk in children is more prominent in the literature, but has focused on weight status (i.e., BMI-z score) rather than body composition (i.e., percent fat mass and percent fat free mass) to evaluate obesity risk. In their review of existing studies examining associations between organization in the home and child weight, Bates and colleagues (2018) found 7 studies exploring associations between the CHAOS and child weight status, none of which reported a direct association. However, two studies found indirect associations through cortisol patterns (Lumeng et al., 2014) and eating behaviours (Leung et al., 2014).

The present study aims to extend the current body of literature examining the impact of the home environment on child nutrition risk by exploring how household chaos is associated with child diet quality and two measures of obesity risk (i.e., BMI-z score and percent fat mass) as well as how these relationships are mediated by:

1) parents’ time spent on meal preparation
2) family meal frequency
3) frequency of fast, and take-out food being served at meals
2.0 Review of the Literature

2.1 The importance of dietary intake, diet quality, and diet quality assessment in children

2.1.1 Dietary intake among Canadian Children

Current research suggests that the diets of most Canadian children do not align with the national recommendations for dietary intake (Tugault-Lafleur, Black, & Barr, 2017). Statistics suggest that Canadian children are not consuming an adequate amount of nutrient dense foods (e.g., fruits, vegetables, and whole grains). For example, one third of Canadian children aged four to eight are not meeting recommendations for milk and milk alternatives (Garriguet, 2007). This is of concern because milk and milk alternatives are the primary source of calcium and vitamin D in the diet, two nutrients that are critical for the development of strong bones, especially during childhood (USDA, 2015). Statistics also suggest that Canadian children are consuming less than 60% of the Adequate Intake of fibre for their age group (Health Canada, 2012). This is not surprising, considering 70% of this population is not reaching the recommended intake of fruits and vegetables and one quarter are not meeting recommendations for whole grain intake, all of which are important sources of fibre (Garriguet, 2007; USDA, 2015).

Meanwhile, Canadian children are consuming an excess of unhealthy foods which are recommended to be consumed in moderation, such as fast foods, high sodium foods, and sugar-sweetened beverages (Jessri, Nichi, & L’Abbé, 2016; Dubois, Farmer, Girard, Burnier, & Porcherie, 2011). In the 2004 Canadian Community Health Survey, 19% of parents with a child aged four to eight reported that their child had
consumed fast food in the past 24-hours, as assessed via 24-hr dietary recall (Garriguet, 2007). This statistic is concerning because fast food is often low in fibre and calcium (Woodruff & Hanning, 2009) and high in sodium and trans and saturated fats, nutrients associated with elevated risk for developing hypertension and cardiovascular disease (Bahadoran, Mirmiran, Golzarand, Hosseini-Esfahani, & Azizi, 2012). In a study examining the sodium intake of 190 children under the age of six living in British Columbia, two thirds of children were consuming more sodium than the Tolerable Upper Intake Level for this nutrient (Mulder, Zibrik, & Innis, 2011). Furthermore, according to the Canadian Community Health Survey data, Canadian children are consuming an average of 309 g of sugar-sweetened beverages each day (Danyliw, Vatanparast, Nikpartow, & Whiting, 2012).

Current statistics suggest that there is a substantial gap between Canadian children’s dietary intakes and current nutrient and food group consumption recommendations for this age group (Tugault-Lafleur, Black, & Barr, 2017; Garriguet, 2007; Danyliw et al., 2012). Although information about specific food and nutrient consumption is useful for capturing population intake, this technique has been criticized for failing to represent the effect of the entire diet on health outcomes (Nicklas, 2004). As a result, indices to assess an individual’s entire diet have emerged. These tools offer a multidimensional measure of overall diet quality, more reflective of the complexities of the human diet (Nicklas, 2004). Future research could benefit from using validated measures to assess children’s overall diet quality.
2.1.2 Defining and assessing diet quality

In the literature, diet quality is an umbrella term used to describe how closely an individual's entire diet aligns with dietary recommendations (Alkerwi, 2014). Although different sets of dietary guidelines exist (e.g., the guidelines described by the American government differ slightly from those described by the Canadian government), a high-quality diet is generally accepted as one that is balanced, nutritious, and that supplies the optimal amount (i.e., enough, but not an excess) of energy and nutrients to maintain health, promote optimal growth, and prevent disease (Alkerwi, 2014). Current research suggests that a high-quality diet is high in plant-based foods (i.e., whole grains, fruits and vegetables) and involves moderation of foods that are high in sodium and trans fatty acids, as well as foods such as sugar-sweetened beverages (Asghari, Mirmiran, Yuzbashian, & Azizi, 2017). Following these guiding principles, a number of diet quality indices have been developed (Nicklas, 2004).

In a review of published literature in this area, Wirt and Collins (2009) found a total of 25 diet quality indices. Existing diet quality indices have been classified according to the following three categories: 1) categories based on nutrient intake, 2) categories based on the consumption of specific foods or food groups, and 3) categories which combine both approaches (Arvaniti & Panagiotakos, 2008). Most of the existing indices fall into the third category, that is, diet quality scores are based on both nutrient and food group or specific food consumption. Examples of commonly used diet quality indices are described briefly below.

The Diet Quality Index-International (DQI-I) is a measure of diet quality that considers both nutrient and food group intakes. The tool measures variety, adequacy,
moderation, and balance. This index measures variety in the following food groups: meat/alternatives, dairy/alternatives, grains, fruits and vegetables. Variety within protein sources (meat, poultry, fish, eggs, dairy and beans) is also assessed. Adequacy of the following eight dietary components is measured: vegetables, fruits, grain, fibre, protein, iron, calcium, and vitamin C. The DQI-I measures moderation of the following components: total fat, saturated fat, cholesterol, sodium and “empty” calorie foods (i.e., solid fats, alcohol, and added sugars), and measures balance in macronutrient and fatty acid ratio (Kim, Haines, Siega-Riz, & Popkin, 2003).

The Overall Nutritional Quality Index (ONQI), is a scoring system, which ranks the overall nutritional quality of foods with an algorithm created using information from sources such as the Dietary Reference Intakes, and the Dietary Guidelines for Americans (USDA, 2015), comparing the nutrient composition of a food to recommendations. This index assigns higher scores for consumption of foods high in nutrients such as fibre, vitamins, and iron, assigning lower scores for consumption of foods high in nutrients like cholesterol and saturated fats (Chiuve, Sampson, & Willet, 2011).

The Healthy Eating Index (HEI) is a diet quality index commonly used in North America. It was first developed in 1995 by the United States Department of Agriculture’s (USDA) Center for Nutrition Policy and Promotion to measure how closely an individual’s dietary intake approximates the Dietary Guidelines for Americans (USDA, 2015). Because these guidelines evolve based on the most recent scientific evidence, three updated versions of the HEI have been developed since its original release: HEI-2005, HEI-2010, and HEI-2015 (Krebs-Smith, 2018). The most recent version, HEI-
2015, is considered a valid measure for examining diet quality relative to the 2015-2020 Dietary Guidelines for Americans, having been validated for reliability and for criterion and construct validity (Reedy, 2018). HEI measures adequacy of nutrients and food groups such as protein, whole fruits, and vegetables, as well as moderation of nutrients and foods such as sodium, refined grains, and added sugar. HEI scores range from 0 to 100, where 100 indicates the highest possible diet quality rating, and zero indicates the lowest possible diet quality rating. The HEI is commonly used in a variety of different health applications, including nutrition interventions, epidemiological research, and population monitoring (Guenther et al., 2014).

Adaptations of the HEI, such as the Alternate Healthy Eating Index (AHEI), HEI-Canada 2005 (HEI-C 2005), and HEI-Canada 2010 (HEI-C 2010), have also been developed. The AHEI is an adaptation of the original HEI tool which measures some of the same components of the HEI (e.g., fruits and vegetables), as well as compliance to dietary guidance (e.g., choose more fish and whole grains) and foods shown to be predictive of chronic disease risk (e.g., moderation of processed meats) to calculate a score for overall diet quality (Arvaniti & Panagiotakos, 2008). This tool considers intake of specific foods and nutrients to produce an overall score. The HEI-C 2005 and HEI-C 2010 are adaptations of the American HEI, which use the Canadian dietary guidelines instead of the Dietary Guidelines for Americans to determine dietary components and serving sizes used to calculate scores (Garriguet, 2009). The American and Canadian dietary guidelines used to guide these indices are similar, so the Canadian adaptations are comparable to the American versions. The major difference between the American HEI and the Canadian adaptations, is that the American HEI applies a proportional
approach (i.e., recommended intake of the component is expressed per 1,000 calories of total intake) for many components of the index; whereas, in the Canadian adaptations, recommended servings based on age and sex are used to score intakes (Garriguet, 2009).

Diet quality indices, such as the HEI-2015 are considered more reflective of overall dietary patterns than assessing intake of a single food, food group, or nutrient (Golley, 2010). Diet quality indices also offer a significant contribution towards understanding the impact of the entire diet on health outcomes, as diet quality scores are a known indicator of chronic disease risk (Atkins & Wannamethee, 2015).

2.1.3 The relationship between diet quality and chronic disease risk

Non-communicable diseases are recognized as a predominant global health issue, accounting for the majority of deaths globally (WHO, June 2018). These diseases are also referred to as chronic diseases and include cancer, cardiovascular disease, and type 2 diabetes (Willet et al., 2006). They result from a combination of genetic, physiological, environmental, and behavioural factors (WHO, June 2018). Diet is an important modifiable behavioural risk factor in developing chronic disease. In fact, in a recently published review of dietary risk factors globally, dietary risks were shown to be responsible for more deaths than any other risks and shown to affect individuals regardless of their age and sex (“Health effects of dietary risks,” 2019).

In a cohort study of over 25,000 adult participants conducted in Alberta, those in the highest diet quality score quartile (measured using HEI-C 2005), had a 20–30% lower risk of developing cancer over the 10-year follow-up, and 13% lower risk of chronic disease at the 4-year follow-up (Solbak et al., 2017). Moreover, these
associations were stronger for the total diet quality score than when considering any of the individual components of the score (e.g., moderate consumption of sodium, sufficient consumption of whole grains, etc.). These findings emphasize that measuring overall diet quality as opposed to individual component parts of the diet is an important strategy for assessing chronic disease and mortality risk.

This association between diet quality and chronic disease risk among adults is consistently supported in the literature, regardless of the index used to assess diet quality. For example, in a cohort study following over 60,000 healthy American women and over 42,000 healthy American men for 20 years, Chiuve and colleagues (2011) found that in both men and women, consumption of foods with a higher diet quality rating (measured using ONQI-I) was associated with a 9-12% reduced risk for developing a chronic disease. The researchers found that the association between diet quality and disease risk was especially strong for diabetes and cardiovascular disease risk. Additionally, the researchers found that participants consuming diets of higher nutritional quality, were also less likely to engage in unhealthy lifestyle behaviours, such as smoking. Similarly, in a longitudinal cohort study of over 3045 men aged 50-70 living in Italy, the Netherlands, and Finland, Huijbregts and colleagues (1997) found that the risk of mortality due to cancer and cardiovascular disease were 13% and 18% lower, respectively, in participants consuming the highest quality diets. In this study, diet quality was measured by assessing whether the intake of nutrients such as fibre, saturated fat and fruits and vegetables were within the recommended range developed by the World Health Organization. In a study using HEI-2015 to assess the diet quality of 422,928 older American adults, those individuals in the highest diet quality range had
a 13-23% reduced risk of cancer, cardiovascular disease, and all-cause mortality compared to individuals in the lowest diet quality range (Reedy, 2018).

Although research examining the association between chronic disease risk and diet quality in children is limited, diet quality has been associated with risk factors for chronic disease including excessive weight and weight gain. A prospective study conducted in Quebec which examined diet quality (assessed using the DQI-I) and weight gain in 500 children aged 8-10 years found that those with lower diet quality had a greater prospective weight gain than children consuming higher quality diets (Setayeshgar et al., 2016). This was especially true when examining dietary adequacy, that is the adequate consumption of the following nutrients: fruits, vegetables, grains, protein, fibre, iron, calcium, and vitamin C. Similar results were found in a study of over 1,000 children in the United Kingdom, which followed participants from age six months to six years. In this study, Okubo and colleagues (2015) found that over the study period, children’s continued consumption of a low-quality diet (assessed using the DQI-I) was linked to higher adiposity at the age of six years. Since overweight and obesity are risk factors for chronic disease, these results suggest that poor diet quality can begin increasing chronic disease risk as early as childhood. Research to better understand the influences on dietary intake and eating behaviours is critical to help support individuals in achieving a high-quality diet.
2.2 The role of parents and the family environment on child dietary intake and child-lifestyle associated health outcomes

2.2.1 Parents’ role in the development of their children’s eating behaviours

The first five years of an individual’s life are a period of rapid development. It is throughout this critical period that children begin to learn what, when, and how much to eat (Savage, Fisher, & Birch, 2007). These dietary intake patterns often persist into adulthood; studies suggest that a child who consistently consumes a diet high in energy-dense and low in nutrient-dense foods, is likely to continue consuming this type of diet as an adult (Duncanson, Burrows, & Collins, 2012). Parents are an important influence during this critical period (Lazarou, Kalavana, & Matalas, 2008) through their attitudes, beliefs, and practices surrounding food and eating (Savage, Fisher, and Birch, 2007).

Parents influence what their children eat through a number of mechanisms. One important mechanism is that of acting as food providers, selecting the food that is readily available to their children. This is an important mechanism, as the availability and accessibility of foods to children is known to impact children’s food preferences and intakes (Johnson, Van Jaarsveld, & Wardle, 2011). Specifically, this has been demonstrated in research examining children’s consumption of fruits and vegetables (Cullen et al., 2003; Spurrier, Magarey, Golley, Curnow, & Sawyer, 2008), milk (Fisher et al., 2004), fruit juice (Cullen et al., 2003; Spurrier et al., 2008), and carbonated drinks (Spurrier et al., 2008). In fact, in a cross-sectional study of 280 preschool-aged children, Spurrier and colleagues (2008) examined several nutritional variables associated with
children’s dietary habits and found that the types and amounts of foods present in the home were the most consistent variable associated with child dietary intake.

Serving as role models is another important mechanism by which parents influence the development of child eating behaviour. Children’s eating behaviours and preferences are influenced by observing their parents enjoying and avoiding certain foods. In a study examining acceptance of familiar fruits and vegetables in children aged one to three years old, Edelson and colleagues (2016) found that parent modeling was the most successful prompt to encourage consumption. Additionally, in a sample of 112 parent-child dyads, Brown and Ogden (2004) found a significant association between parents’ and children’s snack food consumption, suggesting that children’s dietary intake is influenced by their parents’ intakes. In addition, in a study examining milk consumption of mothers and their young girls, maternal intake of milk was positively associated with their daughters’ milk intake (Fisher, et al., 2004). Furthermore, in a study conducted by Wyse and colleagues (2011), higher fruit and vegetable consumption by parents was associated with higher intakes of these foods in their preschool-aged children, supporting the importance of parental modelling of healthful eating behaviours.

Parent feeding practices and interactions with children during feeding also have an important role in influencing child food intake and risk of obesity (Papaioannou et al., 2013). Examples of typical parent feeding practices include attempts to increase child intake of nutrient-dense foods (e.g., vegetables) and restricting children’s access to foods considered unhealthy by the parent (Savage, Fisher, and Birch, 2007). It has been suggested that overly controlling parental feeding practices (i.e., excessive
pressure and restriction) are disruptive to children’s eating autonomy and may unintentionally contribute to child overweight (Haycraft, & Blisset, 2008). In fact, in a study conducted by Orrell-Valente et al. (2007), the mealtime goal of the majority of parents participating was to encourage their children to eat more. The researchers found that many parents were successful in achieving this goal, with a third of the children in the study found to have consumed moderately more than they might have without prompts or pressure. Moreover, in their laboratory-based study, Fisher and Birch (1999) found that children consumed more foods high in sugar and fat, even in the absence of hunger, when parents restricted their children’s food intake. Ventura and Birch (2008) found similar results in a literature review of studies examining parents’ impact on children’s eating behaviours. Moreover, Ventura and Birch (2008) indicated that in most of the longitudinal studies reviewed, greater restriction of selected foods or food groups by parents was associated with greater child weight gain.

In this section, three important mechanisms by which parents impact child eating behaviours have been discussed; however, parents’ role in the development of these behaviours is complex and multi-faceted (Rhee, 2008). Continued research to better understand influences on child eating behaviour and dietary intake is critical.

2.2.2 Impact of the family meal environment on child dietary intake and weight status

Research examining the impact of mealtime interactions is extending beyond studying parent feeding practices and is considering more broadly the eating environment in the home and its impact on child dietary intake and weight status. Frequency of family dinners is one component of this environment which has been well-
examined in the literature over the past decade. Research indicates that higher frequency of family meals is associated with positive effects on child eating behaviour (i.e., increased fruit and vegetable intake, and decreased fried food and sugar-sweetened beverage intakes) and healthy weight status (Taveras et al., 2005; Anderson & Whitaker, 2010; Berge et al., 2014). In a review of 17 studies examining this association, Hammons and Fiese (2011) concluded that when compared to children and adolescents sharing fewer than 3 family meals per week, children and adolescents sharing 3 or more family meals per week were more likely to be within the normal weight range, and practice healthier eating behaviours.

Research suggests that not only the frequency of meals, but also the emotional atmosphere at meals, may influence dietary intake and weight status in children. In a study examining the relationship between interpersonal dynamics and child risk of overweight and obesity, Berge et al. (2014) found that positive mealtime interpersonal dynamics, such as warmth, group enjoyment, and parental positive reinforcement were associated with reduced risk of child overweight. Similarly, in a study by Saltzman and colleagues (2018), researchers observed mothers eating with their children and classified dyads as either “Positive Expressers” (characterized by relatively high positive emotions in mothers and children and relatively low negative emotions in mothers) or “All Expressers” (characterized by relatively equal amounts of negative and positive emotions in both mothers and children). The researchers considered Positive Expressers to have a more positive mealtime emotional climate than All Expressers. In this study, Positive Expresser mothers reported that their children ate significantly more healthy food compared to All Expresser dyads, suggesting that a more positive
mealtime emotional climate may promote consumption of more healthy foods by children.

Researchers have also examined how behaviours such as television viewing at meals impacts child dietary intake and weight status. In a review of studies examining the association between television viewing at meals and child and adolescent dietary intake, Avery, Anderson and McCullough (2016) reviewed 13 studies, representing over 60,000 children aged 1-18 years. Six of the studies reported overall food habits and all found a positive association between television viewing at meals and consumption of undersirable food choices (i.e., pizza, fried foods, sweets, and snacks). Seven of eight studies examining fruit and vegetable consumption identified a negative association with television viewing at meals and child fruit and vegetable intake. Finally, four of five studies examining sugar-sweetened beverage consumption identified a positive association between television viewing at meals and children’s intake of sugar-sweetened beverages. Furthermore, in a review of observational studies examining the association between child and adolescent television viewing at meals and child and adolescent overweight and obesity, Ghobaldi and colleagues (2018) concluded that 15 of the 20 studies reviewed (75%) found an association with obesity-related anthropometrics.

Characteristics of the family meal environment (e.g., television viewing, emotional atmosphere) have great potential for influencing children’s eating habits, and therefore obesity risk (Savage, Fisher, & Birch, 2007). Because the family meal environment and parent feeding behaviour occur within the overall home environment,
researchers have acknowledged the importance of considering the entire family system (Golan & Weizman, 2001).

2.2.3 The impact of the general family environment on dietary intake and child weight status

The household environment is an influential framework for child health outcomes because it provides the general context within which food parenting practices and family meals occur (Boles et al., 2017). Components of the general family context include parent stress, family functioning, and home level chaos. It has been postulated that greater parent stress and household chaos, and lower family functioning, may negatively impact children’s dietary intake, putting them at risk for overweight and obesity through the following mechanism: greater parent stress and household chaos and lower family functioning may interfere with parents’ abilities to model and support positive eating behaviours by contributing to a lack of time or ability to plan for family meals and food preparation, leading to an increased reliance on fast, pre-prepared, and take-out foods (O’Connor, 2017; Bauer et al., 2012; Brown, Broom, Nicholson, & Bittman, 2010).

Many studies in this area have examined only the impact of maternal stress on child dietary intake and child weight status. In a study of 214 families, Miriam and colleagues (2015) found that greater maternal perceived stress resulted in lower child consumption of healthful “core” foods, (i.e., foods from the food groups), and higher child consumption of “non-core” foods, (i.e., foods which do not belong in any food group categories and are recommended to be limited). This evidence suggests that higher maternal stress can put children at risk of poorer dietary intake. In a systematic
review examining the relationship between maternal stress and child weight status, Tate and colleagues (2015) concluded that greater maternal stress is associated with greater childhood obesity risk.

Similar results have been found in studies examining the influence of maternal and paternal stress. Bauer and colleagues (2012) found that higher maternal and paternal work-life stress was associated with less favourable family food behaviours (i.e., fewer family meals per week and less time spent on food preparation). Moreover, in a study of over 2,000 families, Parks and colleagues (2012) found a positive association between parent-perceived stress and children’s fast-food consumption; moreover, the number of stressors faced by parents was directly related to their children’s risk of obesity. Despite the greater research focus on maternal stress, studies including both parents are important because evidence has suggested that fathers play an important role in the development of their children’s eating behaviours (Johannsen, Johannsen, & Specker, 2006) and excluding fathers limits a study’s ability to capture the dynamic of the family unit as whole.

Family functioning is another dimension of the overall family environment which has been postulated to influence child weight status and child dietary intake (Rhee, 2008). This concept is defined by the interactions between family members (e.g., a parent with their child) and how those interactions influence the relationship and functioning of the entire family unit (Halliday et al., 2014). Low functioning families have been characterized by disorganization, poor communication, and either poorly defined or highly rigid roles. It has been hypothesized that this type of environment may be less supportive of healthy food related behaviours (e.g., planning healthy meals,
sharing meals together). Conversely, higher functioning families are characterized by lower conflict and higher cohesion (Martin-Biggers et al., 2018) which may be more supportive of healthy food-related behaviours (Rhee, 2008). In their study of 550 families, Martin-Biggers and colleagues (2018) found that children of families with low levels of conflict were less likely to engage in emotional and non-self-regulated eating. In a review of literature examining the association between family functioning and weight status, Halliday et al. (2014) concluded that reduced levels of family functioning were consistently associated with increased risk of child and adolescent obesity risk and that further research is necessary to better understand how family functioning influences child risk of overweight and obesity. The importance of the family setting in influencing child eating and weight-related behaviours is acknowledged, but not well understood (Kime, 2008). Further research in this area is critical to ensure that the family context within which family meals and eating behaviours occur is not overlooked.

### 2.2.4 The impact of household chaos on child dietary intake and weight outcomes

Household chaos is a concept appearing more recently in the literature examining the influence of the home environment on child dietary intake and child health outcomes. Household chaos is a term used to describe the level of organization, routine, crowding and noise within the home environment (Boles et al., 2017; Martin-Biggers et al., 2017). More chaotic households are described as hectic, noisy and unpredictable and are thought to contribute to a more stressful home environment (Matheny et al., 1995; Bates et al., 2018). Conversely, less chaotic home environments are characterized by more structure, organisation, and routines. Like parent stress, household chaos is hypothesized to influence child dietary intake and weight status
because it may be related to a lack of time for more positive eating behaviours such as family meals and food preparation and an increased reliance on pre-prepared, take-out, and fast foods. In the literature, the Confusion, Hubbub, and Order Scale (CHAOS) has been used to assess household chaos levels. The questionnaire consists of 15 questions and was developed and validated by Matheny and colleagues (1995). CHAOS has since been validated further for internal consistency and construct validity among families differing demographically in terms of their socioeconomic status, ethnicity, and age (Dumas et al., 2005). It is considered an appropriate and economical measure of household chaos, useful for clinical research with diverse samples (Dumas et al., 2005).

Current literature has shown the CHAOS to be predictive of children’s mental and physical health (Coley, Lynch, & Kull, 2015; Kamp Dush, Schmeer, & Taylor, 2013). However, studies examining the relationship between the CHAOS and child nutrition-related health outcomes (i.e., dietary intake and weight outcomes) are limited. Research by MacRae and colleagues (2017) has shown a positive association between household chaos and dietary fat intake of parents with preschool-aged children, suggesting there may be a relationship between the CHAOS and dietary intake in the homes of families with young children. Studies examining associations between CHAOS scores and children’s dietary intake and eating behaviour are limited and results have been inconsistent. In a study of 209 toddlers aged 21-33 months, Asta and colleagues (2016) did not find a significant association between CHAOS scores and eating in the absence of hunger. Meanwhile, in a study conducted among 331 low-income households, Lumeng and colleagues (2014) found a significant positive
association between an emotional CHAOS subscale and child emotional overeating. Similarly, Martin-Biggers and colleagues (2018) found that in high chaos homes, children aged 2-5 years consumed significantly more sugar-sweetened beverages and availability of salty and fatty snacks in the home was higher, where in low chaos homes there was greater availability of fruits and vegetables. Moreover, of the 550 mothers participating in the study, over one quarter reported their household as highly chaotic, suggesting that household chaos is prevalent among households with young children. Research also suggests that household chaos exists in families across socioeconomic status levels (MacRae et al., 2017).

In their review of existing literature examining associations between household chaos and child weight, Bates and colleagues (2018) found no direct associations between the CHAOS and weight in preschool children, but found that through path analysis, there is some evidence of indirect effect of the CHAOS on child weight status (Lumeng et al., 2014; Leung et al., 2014). In a sample of 331 low-income households, Lumeng and colleagues (2014) found indirect effects of CHAOS scores on child weight through cortisol patterns. Additionally, Leung and colleagues (2014) found CHAOS scores to be indirectly associated with child weight through food responsiveness and emotional overeating in a sample of 379 low-income pre-schoolers (Leung et al., 2014). In contrast, Appelhans and colleagues (2014) did not find an indirect association of the CHAOS on child weight status through sleep duration, though sleep duration was significantly associated with child weight. It remains unclear, how or if, the CHAOS is associated with child weight through mediating variables such as physiologic functions and child and family eating behaviour.
Few studies have examined associations between the CHAOS and children’s diets and none have examined associations with child overall diet quality. Further, most of this research has been in low-income populations. Studies examining associations between the CHAOS and child weight are more prominent and have suggested that though there may not be a direct association between CHAOS and child weight, there may be an indirect effect of CHAOS levels on weight, through mediating variables such as cortisol patterns and eating behaviour. Given that current evidence suggests that household chaos is prevalent in families with young children and that it does not discriminate by socioeconomic status, it is important to continue research examining this relationship in samples of diverse socioeconomic status. Moreover, no studies have examined the association between the CHAOS and child diet quality, which is an important predictor of chronic disease risk, making this an important next step for this area of research.

3.0 Research Objectives, Rationale, and Hypothesis

3.1 Rationale

Research suggests that there is substantial room for improvement in the diet quality of Canadian children. The lack of agreement between Canadian children’s diets and dietary guidance is of concern because: 1) childhood is a critical time for the development of eating behaviours, which tend to track into adulthood and 2) poor quality diets have been consistently associated with increased risk for the development of chronic disease. The essential role of parent feeding behaviours in shaping the development of these behaviours is well-established in the literature. More recently,
researchers have acknowledged the importance of the general family context within which eating and feeding behaviours occur because of the complex and multifaceted nature of influences on child dietary intake.

Household chaos, which describes the level of disorganization and uncertainty within the home, is an important component of the family environment. It is postulated that chaos in the home environment could have implications on family food behaviours (e.g., frequency of and emotional atmosphere at family meals), which in turn would impact the quality of children’s diets and obesity risk (Martin-Biggers et al., 2018). However, research examining the association between household chaos and child dietary intake is scarce and there are no studies examining the association between household chaos and child overall diet quality. It is important to measure overall diet quality because, unlike measuring the intake of a specific food or nutrient, it captures an individual’s entire diet. Moreover, diet quality is a known indicator of chronic disease risk.

The Guelph Family Health Study (GFHS) is a cohort study based in Guelph, Ontario that examines early life risk factors for chronic disease in families with preschool-aged children. This study expands on previous GFHS research which has shown a positive relationship between the CHAOS and parents’ dietary fat intake (MacRae et al., 2017) by examining the relationship between the CHAOS and child diet quality and child overweight and percent fat mass. The present study incorporates baseline data from families from the GFHS phase 1 and 2 pilot families (n=71) and data from a GFHS sub study, the Family Food Skills Study 2017 (n=41).
This research contributes to better understanding environmental influences on child diet quality, risk of overweight and obesity, and therefore, chronic disease risk. A more thorough understanding of the complex influence of the home environment on child diet and weight status strengthens the ability to develop effective interventions for families to improve nutrition and health outcomes of children.

3.2 Research Objectives

The present study aims to extend the current body of literature examining the impact of the home environment on child dietary intake by exploring the relationship between household chaos and child diet quality. The main objective is to explore the extent to which household chaos is associated with child diet quality. The secondary objective is to examine whether the association between household chaos and child diet quality is mediated by:

1) parents’ time spent on meal preparation
2) family meal frequency
3) fast and take-out food being served at family meals.

The main effects and mediation models are shown in Figure 1.
Figure 1: Main Effects and Mediation Models of Family Chaos on Child Diet Quality

The tertiary objective of the present study involves a sub-analysis of the GFHS Pilot Phase 1 and 2 data to examine the associations between household chaos and child weight status and adiposity, and whether these associations are mediated by:

1) parents’ time spent on meal preparation
2) family meal frequency
3) pre-prepared, fast, and take-out food being served at family meals.

These potential relationships are described in Figure 2.
3.3 Hypotheses

It is hypothesized that household chaos levels will be inversely associated with child diet quality and positively associated with child BMI z-score and percent fat mass and that these associations will be mediated by family meal frequency, time spent on meal preparation, and serving of fast, take-out and pre-prepared foods.

4.0 Methods

Data from three study samples: Guelph Family Health Study (GFHS) Phase 1, GFHS Phase 2, and Family Food Skills Study (FFSS) 2017 were used to address the research objectives of this study. GFHS Pilot Phase 1 and 2 were intervention studies, so only baseline data were analysed from these samples. Despite differences in some of the data collected in these studies, eligibility criteria were nearly identical and data required to investigate the main research question of the present study were collected.
from participating families in each study (i.e., 3-day food records from the target child and completion by one parent of the 15-item CHAOS survey). Survey data were collected from families participating in the FFSS 2017 over a four-week period through the months of August and September of 2017. Anthropometric and body composition data were collected from children participating in the GFHS Pilot Phase 1 and 2. A sub-analysis examining the association between family CHAOS and child weight outcomes was conducted with data collected from those families. Baseline survey and anthropometric data were collected from participants in pilot phase 1 between June 2014 and April 2015, and from participants in pilot phase 2 between December 2015 and April 2017.

4.1 Recruitment and Eligibility

Recruitment strategies for both the GFHS and FFSS included posting flyers locally and on social media using platforms such as Facebook and Twitter. In-person recruitment efforts occurred with the support of community partners such as Guelph Community Health Centre, local EarlyON Child and Family Centres, and the Guelph Family Heath Team.

Families were eligible for the GFHS pilot phase 1 and 2 if: 1) they were residing in Guelph, Ontario, Canada or its surrounding areas (i.e., Rockwood, Puslinch, Fergus, Elora, Erin, and Mount Forest) with no plans to move within the year, 2) they had at least one child aged 18 months to 5 years at the time of recruitment; and 3) at least 1 participating parent was comfortable reading and writing in English. Study data were collected at the University of Guelph Body Composition Lab as well as through online
surveys completed in the home. The GFHS was approved by the University of Guelph Research Ethics Board (RCT 02223234).

Families were eligible for the FFSS 2017 if: 1) they were residing in Guelph, Ontario, Canada or its surrounding areas, 2) they had at least one child aged 2-5 years at the time of recruitment, 3) at least 1 participating parent was comfortable reading and writing in English, and 4) neither parent had prior nutrition education at the time of recruitment (e.g., a degree in nutrition). Researchers performed home visits with participating families to explain the study protocol. Data were then collected through parents’ completion of an online survey and 3-day food records. The FFSS was approved by the University of Guelph Research Ethics Board (RCT 17-04-023).

4.2 Measures

4.2.1 Household chaos

The CHAOS was used to measure the level of household chaos in both the FFSS and the GFHS. The CHAOS was developed and validated to measure environmental confusion in the home by Matheny and colleagues (1995). The tool has since been validated further for internal consistency and construct validity among families differing demographically in terms of their socioeconomic status, ethnicity, and age (Dumas et al., 2005). One parent in each family rated the degree of household environmental chaos using 15 items on a 4-point scale, where 1 represents “Very much like your own home environment” and 4 represents “Not at all like your own home environment”. Responses were used to calculate a total score, where the highest possible score is 60 and represents a home environment characterized by more chaos,
disorganization, and pressure for time (Matheny et al., 1995). In this sample, Cronbach’s alpha for the scale was .87. The full survey can be found in Appendix A.

4.2.2 Child diet quality

3-day Food Records

Parents completed a handwritten 3-day food record on their children’s behalf, in which they recorded the amounts of all food and drink, including water, consumed for 2 weekdays and 1 weekend day. Parents were instructed to record all food and drink consumed in as much detail as possible (including brand name). They were provided written instructions about how to properly complete the food record, including a guide for estimating portion size (e.g., a two-tablespoon serving of peanut butter resembles a ping pong ball) and instructions to attach recipes for homemade items. After record collection, research staff reviewed the food records and followed-up with parents as needed to confirm missing details. The package is attached in Appendix B.

Nutrition Analysis

Trained research assistants entered all data collected through food records into Food Processor Nutrition Analysis Software version 11.5.226 (ESHA Research, Salem, Oregon). The data inputted into the program were double-checked for accuracy by another member of the research team. The full protocol can be found in Appendix C. The results were then exported into an Excel spreadsheet for diet quality calculation.

Healthy Eating Index

Child diet quality were calculated using the most recent version of the Healthy Eating Index (HEI), HEI-2015. In a validation study published in 2018, HEI-2015 was shown to have construct validity, criterion validity, and reliability (Reedy, 2018). HEI-
2015 scores the quality of an individual’s diet by examining the adequacy of nine dietary components, which should be consumed in sufficient amounts to promote optimal health, and moderation of four components, which should be limited to promote optimal health. Specifically, the index measures the following: 1) adequacy of fruit, whole fruit, greens and beans, whole grains, total protein, seafood and plant proteins, and fatty acids, and 2) moderation of refined grains, sodium, added sugars, and saturated fats (Krebs-Smith et al., 2018). Possible scores range from 0-100, where 100 indicates the highest quality diet score possible. Standard operating procedure for calculating an HEI score for each participant was developed by the research team. This protocol required that first, a trained researcher use the information from the participant food records to sum the number of servings of each category consumed per day using the serving sizes and categories presented in the USDA Dietary Guidelines for Americans (USDA, n.d.) as a standard. Next, a second researcher reviewed the work for accuracy and then calculated an overall HEI score for the participant’s three days of consumption using a standard Excel spreadsheet created for HEI-2015 scoring. The standard operating procedure for HEI calculations is attached in Appendix D.

4.2.3 Anthropometrics

*Height/Length*

For participants over 130 cm, height was measured in duplicate using a wall-mounted stadiometer (Medical Scales and Measuring Devices; Seca Corp., Ontario, CA), to the nearest 0.1 cm. A third measure was taken if the two differed by more than 0.5 cm. An average of the two closest measures was used as the final height measurement. Measurements were taken with participants in bare- or sock-feet without
hair accessories. Participants were measured with arms to the side, legs straight, shoulders relaxed, head in Frankfort horizontal plane, and mid-respiration, at the apex of inhalation. For participants shorter than 130 cm, a pediatric length board was used. For participants able to stand for measurement, the pediatric length board was used in standing position according to the above described height measurement protocol. For participants unable or unwilling to stand, measurements were taken in duplicate with the participant laying on the pediatric length board, right leg extended and right foot parallel with foot board, looking straight up at the ceiling. The complete protocol for both length and height measurements can be found in Appendix E.

**Body Weight**

Weight measurements were taken using the BOD POD™ digital scale (Cosmed Inc., Concord CA). Participants were instructed to remove all footwear and outer garments (e.g. jackets, hats, heavy sweaters, etc.) prior to measurement. For participants too young or uncomfortable to stand alone on the scale, a parent held the child for measurement, then the parent was measured alone, and the child’s weight was calculated as the difference between the two measurements. The high reliability of the BOD POD™ digital scale allows for a single weight measurement to suffice (Fields, Ganatilake, & Kalaitzoglou, 2015). The full protocol for weight measurement can be found in Appendix F.

**BMI z-scores**

Body mass index (BMI) is a measure of weight adjusted for height, calculated as weight in kilograms divided by the square of height in metres. It is the most commonly used measure for assessing obesity in adults and is considered a practical
measurement for clinical and research settings (Must & Anderson, 2006). For BMI to be meaningful in children, it must account for child age and sex by comparing to a reference standard. BMI z-scores are measures of relative weight adjusted for child age and sex using an appropriate reference standard. They are often used to assess weight status in children. This is the method used to calculate child weight status in the present study. The reference standards set out by the World Health Organization (WHO) were used for the calculation (WHO, 2006). A standard protocol to calculate BMI z-score was developed and can be found in Appendix G.

4.2.4 Body composition

Bioelectrical Impedence Analysis (BIA) was used to measure body composition for child participants in the GFHS Pilot Phase 1 and 2. Parents were previously instructed to ensure that their child did not consume any food or beverage 30 minutes prior to the BIA test and the research assistant asked parents whether their child had voided their bladder prior to measurement. The research assistant also confirmed that the participant was not wearing an artificial pacemaker, or implantable cardioverter-defibrillator. Participants were instructed to remove their right shoe and sock, any jewelry, and/or metal from the clavicle to the feet (including pants with metal zippers). Prior to BIA measurement, the BIA analyzer was tested against a 500-ohm test resistor. The participant was instructed to lay on a hospital bed, resting their head on a pillow, and to remain as still as possible, with arms and legs abducted about 30 degrees from midline. Participants’ right hand and foot were cleaned using alcohol prep pads prior to placement of electrodes. The BIA leads were attached to the electrodes per the diagram attached in Appendix H, and analyzer was turned on and left to stabilize for a few
seconds. The research assistant then recorded the resistance measurement and turned the BIA analyzer off, then back on to repeat the measurement. If there was a difference greater than 5% between two resistance results, a third BIA measurement was taken and the mean of the two closest values was used as the final measurement of resistance. The full protocol can be found in Appendix H. Raw output data were then entered in an equation by Kushner and colleagues (1992) to calculate % fat mass:

\[
TBW = 0.593H^2/R + 0.065W + 0.04,
\]

where TBW is total body water in litres, R is resistance in ohms and W is weight in kg. The above equation was chosen as the most appropriate equation for the GFHS pilot studies because it was validated using the reference standard isotope-dilution method in preschool-aged children of similar ethnicity. To determine percent fat mass from this equation, TBW was divided by an age- and sex-specific hydration factor to estimate percent fat and fat free mass (Fomon, Haschke, Ziegler & Nelson, 1982).

To test the reliability of the BIA, a sample of six adult participants were measured under the same conditions on two consecutive days. No significant differences were found between day one and day two of measurements. Inter- and intra-rater reliability of the BIA were tested in a sample of six child participants, whereby each child was measured twice by two trained research assistants, on the same day. The inter-rater coefficient of variation (CV) and reliability coefficient were 1.8 and 0.79, respectively. Intra-rater reliability coefficients were 0.96 and 0.99 for the first and second observer, respectively. Overall intra-rater CV for the first observer was 0.05 and for the second observer was 0.15.
4.2.5 Family Food Behaviours

Family food behaviours considered in this study as potential mediators (i.e., family meal frequency, time spent on meal preparation, and serving fast and take-out foods at meals) were captured using online surveys. The online surveys distributed to parents participating in FFSS 2017 and GFHS Pilot Phase 1 and 2 were not identical, but both contained questions related to food purchase, preparation, and consumption in the home, as well as questions pertaining to the general family environment (e.g., the CHAOS survey described above). For GFHS Pilot Phase 1 and 2, and for FFSS 2017, survey data from parent 1 (the first parent to reach out to the researchers expressing interest in the study) were used to investigate the present research objectives. Items from the FFSS 2017 and GFHS Pilot Phase 1 and 2 surveys which were used in the present study to capture family food behaviours are shown in Table 1 below. One question differed slightly in wording across the FFSS 2017 (see question 1a) and GFHS (see question 1b) surveys. Separate analyses were to be performed for the question that differed across surveys. One additional question was to be analysed for the sub-analysis examining effects of the CHAOS on child weight outcomes in the GFHS participants (see question 4). This question relates to serving pre-prepared foods (e.g., frozen lasagna, pre-made potato salad, etc.) at family meals. This information was not collected in the FFSS 2017 survey.
1. a) What is the average amount of time you spend preparing the evening meal (FFSS questionnaire)?
   b) What is the average time that your family spends preparing the evening meal (GFHS questionnaire)?

   • 0-15 minutes
   • 15-30 minutes
   • 30-60 minutes
   • More than 60 minutes

   **In FFSS survey, this question was only answered by respondents who do at least 25% of the cooking in the home

2. In the past week, how often did at least one adult in your house sit and eat with your child(ren)?

   • 1-2 times
   • 3-4 times
   • 5-6 times
   • 7 or more times

3. During the past week, how many times was a family meal purchased from a fast food or take out restaurant?

   • Never
   • Once
   • Twice
   • 3 or more times

4. GFHS families only
   During the past week, how many times were prepared foods that you heated up at home (for example frozen pizza, lasagna) served for family meal?

   • Never
   • Once
   • Twice
   • 3 or more times

<table>
<thead>
<tr>
<th>Question</th>
<th>Response Options</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. a) What is the average amount of time you spend preparing the evening meal (FFSS questionnaire)? b) What is the average time that your family spends preparing the evening meal (GFHS questionnaire)?</td>
<td>• 0-15 minutes • 15-30 minutes • 30-60 minutes • More than 60 minutes **In FFSS survey, this question was only answered by respondents who do at least 25% of the cooking in the home</td>
<td>Spurrier et al. 2008</td>
</tr>
<tr>
<td>2. In the past week, how often did at least one adult in your house sit and eat with your child(ren)?</td>
<td>• 1-2 times • 3-4 times • 5-6 times • 7 or more times</td>
<td>Spurrier et al. 2008</td>
</tr>
<tr>
<td>3. During the past week, how many times was a family meal purchased from a fast food or take out restaurant?</td>
<td>• Never • Once • Twice • 3 or more times</td>
<td>Project F-EAT Survey (Trofholz et al., 2017).</td>
</tr>
<tr>
<td>4. GFHS families only During the past week, how many times were prepared foods that you heated up at home (for example frozen pizza, lasagna) served for family meal?</td>
<td>• Never • Once • Twice • 3 or more times</td>
<td>Project F-EAT Survey (Trofholz et al., 2017).</td>
</tr>
</tbody>
</table>

Table 4.1 Survey questions used in the present study to capture food purchase, preparation, and consumption habits in the home

4.3 Statistical Analysis

All statistical analyses were performed using Statistical Analysis System (SAS Institute Inc., version 9.4, Cary, North Carolina). Because household environmental factors (e.g., chaos and maternal stress) have been shown to affect boys and girls differently in terms of weight outcomes and eating behaviour (Lumeng et al., 2014; Hernandez, Pressler, Dorius, & Mitchell, 2014; Leppert et al., 2018), exploratory analyses were performed to examine the interaction effect of child sex and CHAOS scores on each outcome (i.e., diet quality, BMI z-score, percent fat mass) to determine
the value in stratifying by child sex. Results showed that for all outcomes, there were no interaction effects of child sex and CHAOS scores, so analyses proceeded without stratification. Household income was coded as a quantitative variable and included in all models as a covariate. Child age and sex were both included as covariates in the analysis of the diet quality outcome, but not for the BMI z-score and percent fat mass outcomes because sex and age are accounted for already. Statistical significance was determined at p<.05. Multiple linear regression models were run separately for each outcome of interest (i.e., diet quality, BMI z-score and % fat mass). In all models, CHAOS scores were included as the independent variable and generalized estimating equations (GEE) were used to account for the potential correlation among siblings in the GFHS phase 1 and 2 cohorts. Further linear regression analyses to investigate potential mediators (Mackinnon et al., 2002) were not pursued because of a lack of significant association between CHAOS scores and the dependent variables.
5.0 Manuscript

**Title:** Associations between household chaos and preschool children’s diet quality and obesity risk

**Authors:** Kira Jewell¹, Lisa Tang¹, Valerie Hruska², Gerarda Darlington³, Genevieve Newton², David Ma², Andrea C. Buchholz¹, Jess Haines¹

¹ Department of Family Relations and Applied Nutrition, University of Guelph, Guelph, ON, Canada
² Department of Human Health and Nutritional Sciences, University of Guelph, Guelph, ON, Canada
³ Department of Mathematics and Statistics, University of Guelph, Guelph, ON, Canada

**Abstract:**

**Background:** The home environment is an influential framework for child health outcomes. Home environment factors such as, parent stress and family functioning are associated with children’s dietary intake and weight. Though household chaos is a component of the home environment which may also be associated with child diet and weight, this relationship has not been examined as extensively in the literature.

**Objective:** To examine cross-sectional associations between household chaos and diet quality, adiposity and BMI z-score in a sample of children aged 1.5 to 6 years.

**Methods:** This study used participant data from 112 families in the Guelph Family Heath Study pilot phases 1 and 2 and Family Food Skills Study 2017 (n=136). 2015- Healthy Eating Index scores were calculated from children’s 3-day food records to measure child diet quality and household chaos was evaluated using the 15-item Confusion, Hubbub and Order Scale (CHAOS) questionnaire. A sub-analysis was performed with those participants who had anthropometric and body composition data collected. Associations between the CHAOS and child diet quality, BMI-z score and %fat mass were examined using linear regression with generalized estimating equations. Household income was included in all models as a covariate. Analyses exploring associations with diet quality also included child age and sex as a covariate.

**Results:** The CHAOS was not significantly associated with children’s diet quality ($\beta = -0.12$, 95% CI= (-0.37, 0.13), p-value= 0.35), BMI z-score ($\beta=0.02$, 95% CI= (-0.01, 0.04), p-value= 0.18), or % fat mass ($\beta= 0.02$, 95% CI= (-0.20, 0.23), p-value= 0.88).

**Conclusion:** In this sample, there were no significant interactions between the CHAOS and child diet quality, BMI z-score or %fat mass. Researchers should continue to examine these relationships and in larger and more diverse samples.
Introduction

Preschool age is a critical period for the development of eating behaviours and as such, is an important point for establishing early weight trajectories (Shrempft, Jaarsveld, Fisher, & Wardle, 2015). The essential role of parents in the development of child eating behaviour and food preferences during this life stage is widely accepted (Lazarou, Kalavana, & Matalas, 2008; Savage, Fisher, and Birch, 2007; Ventura & Birch, 2008). More recently, researchers have acknowledged the importance of examining the general family context within which these behaviours occur to better target interventions promoting positive health behaviour and healthy weight in children (Bates et al., 2018; Rhee, 2008). Components of the family environment postulated to influence child eating behaviour and weight outcomes include stress, family functioning, and household chaos. Specifically, research has found greater parent and family stress and lower family functioning to be associated with poorer child eating behaviours and increased obesity risk (Garasky, Stewart, Gundersen, Lohman & Eisenmann, 2009; Parks et al., 2012; Halliday, Palma, Mellor, Green & Renzaho, 2014).

The Confusion, Hubbub, and Order Scale (CHAOS) was developed by Matheny and colleagues (1995) to measure the level of disorganisation and uncertainty in the home. It is postulated that chaos in the home environment could limit a family’s ability to participate in healthy food behaviours (e.g., frequent family meals), which in turn would impact the quality of children’s diets (Martin-Biggers et al., 2018) and obesity risk. While preliminary studies have found higher household CHAOS scores to be associated with greater levels of emotional overeating (Lumeng et al., 2014), higher consumption of sugar-sweetened beverages, and greater availability of salty and fatty snacks in the home.
home (Martin-Biggers et al., 2018), more evidence is needed to confirm these relationships. In particular, no studies have examined the relationship between CHAOS and child overall diet quality. Diet quality is a more comprehensive method for capturing overall dietary patterns than assessing intake of a single food, food group, or nutrient and contributes substantially towards understanding the impact of the entire diet on health outcomes, as diet quality scores are an indicator of chronic disease risk (Golley, 2010; Atkins & Wannamethee, 2015). Though no direct associations between CHAOS and weight status have been found in past research, indirect effects through mediators such as eating behaviour and cortisol patterns have been shown (Bates et al., 2018). None of the existing studies examining this relationship have used body composition data, instead studies have relied solely on proxy measures of obesity (e.g., BMI z-score) to evaluate child weight outcomes.

This study sought to investigate the influence of household chaos on health outcomes of preschool-aged children by exploring associations between household chaos and: 1) overall diet quality, 2) BMI z-score, and 3) % fat mass.

Materials and Methods

Recruitment and Eligibility

The study sample consisted of children in the Guelph Family Health Study (GFHS) pilot phases 1 and 2 and the Family Food Skills Study (FFSS) 2017. Recruitment strategies for the GFHS pilot phases 1 and 2 and the FFSS 2017 included in-person recruitment at agencies (e.g., child care centres) and events (e.g., library story times) focused on families with young children as well as posting flyers locally and on social media platforms.
Families were eligible for the GFHS pilot phase 1 and 2 if: 1) they were residing in Guelph, Ontario, Canada or its surrounding areas with no plans to move within the year, and 2) they had at least one child aged 18 months to 5 years at the time of recruitment. The GFHS was approved by the University of Guelph Research Ethics Board (RCT 02223234). Eligibility for the FFSS 2017 was similar, with the addition that neither parent had prior nutrition education at the time of recruitment (e.g., a degree in nutrition). The FFSS was approved by the University of Guelph Research Ethics Board (RCT 17-04-023).

Measures

Household Chaos

Parent report of the Confusion, Hubbub, and Order Scale (CHAOS) was used to measure the level of household chaos in both the FFSS and the GFHS. The CHAOS was developed and validated to measure environmental confusion in the home by Matheny and colleagues (1995). The tool has since been validated further for internal consistency and construct validity among families of differing socioeconomic status, ethnicity, and age (Dumas et al., 2005). One parent in each family rated the degree of household environmental chaos using 15 items on a 4-point scale, where 1 represents “Very much like your own home environment” and 4 represents “Not at all like your own home environment”. Responses were used to calculate a total score, where the highest possible score is 60 and represents a home environment characterized by more chaos, disorganization, and pressure for time (Matheny et al., 1995). The Cronbach’s alpha of the scale was calculated to be .87 in this sample.
Parents in the FFSS 2017 and GFHS Pilots 1 and 2 completed 3-day food records for their children, which were used to score the quality of children’s diets. Parents recorded the amounts of all food and drink consumed for 2 weekdays and 1 weekend day on their children’s behalf. Parents were provided written instructions outlining how to complete the food record in sufficient detail (e.g., provided a guide for estimating portion size). After record collection, research staff reviewed the food records and followed-up with parents as needed to confirm missing details. Trained research assistants entered all data collected through food records into Food Processor Nutrition Analysis Software version 11.5.226 (ESHA Research, Salem, Oregon). The data inputted into the program were double checked for accuracy by another member of the research team.

Child diet quality was then calculated using the 2015 Healthy Eating Index (HEI-2015) to score participant 3-day food records. HEI-2015 has been shown to have construct validity, criterion validity and reliability (Reedy, 2018). HEI-2015 scores the quality of an individual’s diet by examining the adequacy of nine dietary components (fruit, whole fruit, vegetables, greens and beans, dairy, whole grains, total protein, seafood and plant protein, and fatty acids) which should be consumed in sufficient amounts to promote optimal health, and the moderation of four components (refined grains, sodium, added sugars, and saturated fats), which should be limited to promote optimal health (Krebs-Smith et al., 2018). Possible scores range from 0-100, where 100 indicates the highest quality diet score possible.
A standard operating procedure for calculating HEI scores was developed and involved a trained researcher summing the number of servings from each HEI category consumed per day using the serving sizes presented in the USDA Dietary Guidelines for Americans as a reference standard (USDA, n.d.). The protocol also required a second researcher to review the work for accuracy and to then calculate an overall HEI score for the participant’s three days of consumption using a standard Excel spreadsheet created for HEI-2015 scoring.

**Percent Fat Mass**

Bioelectrical Impedance Analysis (BIA) was used to measure body composition for child participants in the GFHS Pilot Phase 1 and 2. Trained researchers used the Quantum IV – Body Composition Analyzer™ (RJL Systems, Clinton Township, MI) to measure participant BIA. Parents were instructed to ensure that their child did not consume any food or beverage 30 minutes prior to the test. The research assistant asked parents whether their child had voided their bladder prior to measurement and confirmed that the participant was not wearing any metal. The participant to lay on a hospital bed with arms and legs abducted about 30 degrees from midline. Participants’ right hand and foot were cleaned using alcohol prep pads prior to placement of electrodes. Resistance was measured in duplicate. If the difference between the two resistance values exceeded 5%, a third BIA measurement was taken and the mean of the two closest resistance values recorded. Raw output data were then entered in an equation by Kushner and colleagues (1992) to calculate % fat mass:

\[
\text{TBW} = 0.593H^2/R + 0.065W + 0.04,
\]

where TBW is total body water in litres, R is resistance in ohms and W is weight in kg.
To determine % fat mass from this equation, TBW was divided by an age- and sex-specific hydration factor (Fomon, Haschke, Ziegler & Nelson, 1982). Inter- and intra-rater reliability of the BIA were tested in a sample of six child participants. Each participant was measured twice by two trained research assistants on the same day. The inter-rater coefficient of variation (CV) and reliability coefficient were 1.8 and 0.79, respectively. Intra-rater reliability coefficients were 0.96 and 0.99 for the first and second observer, respectively. Overall intra-rater CV for the first observer was 0.05 and for the second observer was 0.15.

**BMI Z-score**

Body mass index (BMI) was calculated from height and weight measurements for participants of the GFHS pilots 1 and 2. A standard procedure for measuring height of children between 18 months and 5 years old was adapted (Frisancho, 2004). Depending on the child’s height, either a wall-mounted stadiometer (Medical Scales and Measuring Devices; Seca Corp., Ontario, CA) or pediatric length board in standing position were used. For participants unable or unwilling to stand, the measurement was taken with the participant supine on the pediatric length board. All measurements were taken in duplicate to the nearest 0.1 cm and an average of the two values was calculated as the final height measurement. Weight measurements were taken using the BOD POD™ digital scale (Cosmed Inc., Concord CA). The high reliability of the BOD POD™ digital scale allowed for a single weight measurement to suffice (Fields, Ganatilake, & Kalaitzoglou, 2015). For BMI to be meaningful in children, it must account for child age and sex by comparing to a reference standard. As such, BMI z-
scores were calculated as a measure of relative weight adjusted for child age and sex using the reference standards set out by the World Health Organization (WHO, 2006).

**Covariates**

Household income was included as a covariate in all statistical analyses. Child sex and age were also included as covariates in the analysis with diet quality as an outcome, but not in models with % fat mass and BMI-z score as outcomes, because these outcomes are already adjusted for child age and sex.

**Statistical Analysis**

Statistical analyses were performed using Statistical Analysis System (SAS Institute Inc., version 9.4, Cary, North Carolina). Because household environmental factors (e.g., chaos and maternal stress) have been shown to affect boys and girls differently in terms of weight outcomes and eating behaviour (Lumeng et al., 2014; Hernandez, Pressler, Dorius, & Mitchell, 2014; Leppert et al., 2018), exploratory analyses examined the interaction effect of child sex and CHAOS scores on each outcome to determine the value in stratifying by child sex. Results suggested that for all outcomes, there were no interaction effects of child sex and CHAOS scores. So, multiple linear regression models were performed without stratifying by sex for all outcomes. Generalized estimating equations (GEE) were applied to all models to account for the potential correlation among siblings in the GFHS phase 1 and 2 cohorts.

Five participants were excluded from analyses because they were missing predictor or outcome data, and five families were excluded because they did not disclose household income, which is a required covariate included in all models. Diet record data were collected from 132 participants, but one participant’s food record was
excluded because it lacked sufficient detail to score accurately; thus, 131 children were included in analysis of the diet quality outcome. Anthropometric and body composition data were only collected from GFHS participants and only from those children willing to participate in the collection of these measurements. Sample sizes for the BMI-z score and % fat mass outcomes were 90 and 72, respectively.

Results

Participant and Family-Level Characteristics

Participant and family level sample characteristics are presented in Table 5.1. Children had a mean age of 3.36 (SD=1.13) years and 52% were males. Of the 112, families, approximately 47% had an annual household income greater than $100,000 and average parent rating of household chaos was 31.18 (SD=7.87) of a possible 60. Participants’ mean fat mass was 29.21% (SD=5.66%) and mean BMI z-score was 0.47 (SD=0.89). Children had a mean HEI score of 68.66 (SD=9.90) of a possible 100, which is considered a “D” according to the graded approach for applying HEI scores to describe adherence to dietary guidelines (Krebs-Smith et al., 2018).

Exploration of CHAOS and child diet quality

Results of the linear regression models examining the relationship between CHAOS scores and child health outcomes are presented in Table 5.2. CHAOS scores were not significantly associated with children’s HEI score ($\beta = -0.12$, 95% CI= (-0.37, 0.13), p-value= 0.35).
Exploration of CHAOS and child weight outcomes

CHAOS scores were not significantly associated with either BMI z-score ($\beta$=0.02, 95% CI= (-0.01, 0.04), p-value= 0.18) or % fat mass ($\beta$= 0.02, 95% CI= (-0.20, 0.23), p-value= 0.88).

Discussion

The objective of this study was to examine associations between household chaos and preschool-aged children’s overall diet quality, BMI-z score and % fat mass. There were no significant associations found between CHAOS scores and child diet quality, BMI-z score or % fat mass. The CHAOS scores of participating families ranged from 16-53, with an average of 31. Children had an average HEI score of 68.66 and average BMI z-score and % fat mass of participants were 0.47 and 29.21%, respectively.

The present study builds on existing research which has focused primarily on low-income populations, often applied subscales of the CHAOS, and examined associations with dietary intake and eating behaviour, rather than diet quality. Though the present study fills a gap in this regard, it also makes it challenging to compare with existing research. The present study did not find CHAOS scores to be associated with child overall diet quality. Similarly, Asta and colleagues (2016) did not find an association between CHAOS scores and eating in the absence of hunger in a sample of 209 low-income preschool-aged children (Asta et al., 2016). In contrast, Lumeng and colleagues (2014) found, in a sample of 331 children from low-income homes, that an emotional CHAOS subscale was associated with greater food responsiveness and greater incidence of emotional over eating in girls. Martin-Biggers and colleagues
(2018) explored how a short (6-item) version of CHAOS was associated with dietary intake among a nationally representative sample of 550 American preschoolers and found that scores were not associated with emotional or uncontrolled eating. The researchers did, however, find that children living in less chaotic homes consumed significantly more fruits and vegetables and had more family meals, while families with high CHAOS levels had greater availability of high salt and fat snacks in the home. The inconsistency in findings across these studies is not surprising considering the high variability in measures used to assess evaluate the CHAOS (i.e., full version, short version, and emotional subscale) and diet (i.e., eating behaviour, dietary intake, and diet quality), as well as the variability in the samples studied (i.e., family income level). Researchers should continue to explore associations of the CHAOS and its subscales with child diet quality in samples of diverse socioeconomic status to gain a more comprehensive understanding of how household factors impact children’s dietary intake and diet quality in the population.

The present study did not find the CHAOS to be associated with BMI-z score or % fat mass. Similarly, in their systematic review of 32 studies which examined associations between measures of household organisation and routine and child weight, Bates and colleagues (2018) found seven studies that explored associations between the CHAOS and child weight and none of the studies reported a significant direct association. However, indirect effects of CHAOS scores on child weight status have been found via variables such as cortisol patterns (Lumeng et al., 2014) and eating behaviours (Leung et al., 2014). In their systematic review, Bates and colleagues did find that studies that investigated individual indicators of household chaos (e.g., routine
and limit setting), rather than an overall score of CHAOS, showed significant associations with child weight status. For instance, Anderson and Whitaker (2017) examined family routines in a sample of over 8,000 preschool-aged children and found that in families where three healthy routines were implemented, children were significantly less likely to be obese than children in families where less than three healthy routines were being implemented. Future research examining associations between household chaos and child weight outcomes could benefit from continued exploration of potentially mediating variables, such as physiologic responses to stress and eating behaviour, as well as examining individual indicators of household chaos as predictors.

Our finding that there were no significant interaction effects of sex on the association between household CHAOS scores and child diet quality, BMI-z score or % fat mass is in contrast with the findings of past researchers who have found gender differences in the effect of family-level stress on child and adolescent health outcomes. For instance, in a sample of more than 1,000 children aged 4 years old, Tremblay and Rinaldi (2010) found that more conflicts at family meal times predicted greater weight in boys, but not girls. In contrast, in a sample of more than 4,000 adolescents Hernandez and Pressler (2015) found that financial strain, family disruption and a cumulative family stress indicator were all positively associated with overweight in girls, but not in boys, while the only household stress indicator associated with overweight in boys was maternal risky behaviour, leading the authors to suggest that using a cumulative measure of family level stressors could limit the ability to detect gender differences related to the effect of family stress on weight outcomes among boys and girls. Thus, it
is possible that in the present research the use of the CHAOS as an overall measure of home organization and routine has masked differential effects of the individual components of this indicator on children of different sexes. Consistent with this idea, Lumeng and colleagues (2014) used an emotional CHAOS subscale consisting of 8 items taken from the CHAOS which are reflective of emotional stress and found an association with emotional overeating in girls, but not in boys. Further, Lumeng and colleagues (2014) also found gender differences when considering cortisol patterns and eating behaviours as mediators of the emotional CHAOS score and weight association, suggesting that the mechanisms by which emotional chaos in the home influences weight may differ for boys and girls. Future research should explore individual indicators of household chaos and CHAOS subscales (e.g., the emotional CHAOS subscale used by Lumeng et al.) as well as biochemical markers to help elucidate potential sex differences in the association between household chaos and diet and weight outcomes among young children.

The major strength of this study is the use of overall diet quality to assess children’s diets. This measure is a more comprehensive reflection of diet than are individual foods or food groups and is an important indicator of chronic disease risk (Golley, 2010; Atkins, 2015). The examination of child body composition data in addition to BMI to capture child obesity risk is a second important strength of this study. Another strength of this research is the use of objective anthropometric measurements as opposed to parent report, the latter which is subject to risk of misreport, as well as use of BIA to measure body composition rather than relying on proxy measures of obesity.
Although there are several strengths of this study, there are limitations to consider when interpreting the results of this research. First, household chaos and child diet were measured using parents’ self-report and therefore, could be subject to error due to social desirability, which could have biased our results towards the null. Second, while BIA is a more practical and cost-efficient body composition measurement method, it may be less accurate than other methods, such as the four-compartment model (Wells & Fewtrell, 2006; Talma et al., 2013). Lastly, though this study fills a gap in existing research by investigating associations in a sample of primarily moderate to high income households, this means that the results may not generalize to families of lower socioeconomic status.

**Conclusion**

This study extends the existing body of literature examining the association between household chaos and child health outcomes by examining associations of the CHAOS with child overall diet quality and multiple measures of obesity risk (i.e., adiposity and BMI z-score). There is limited research examining the association between CHAOS scores and child diet and the present study is the first to examine how CHAOS scores are associated with child overall diet quality, making it difficult to compare with the existing research. Rather, previous studies have explored the association between the CHAOS and children’s intake of certain foods (e.g., sugar-sweetened beverages) and eating behaviours (e.g., eating in the absence of hunger) as outcomes. Moreover, unlike the present study sample which was comprised of relatively high income families, much of the previous studies were performed with low income samples. The results of research examining associations between the CHAOS and child
diet have been inconsistent, which may be a consequence of the wide variability in the versions of the CHAOS used, and in the measures used to evaluate diet (i.e., eating behaviour, dietary intake, and diet quality), as well as the variability in the samples studied (i.e., family income level). In contrast, studies exploring associations between the CHAOS and weight outcomes are more prominent and results have been more consistent. The findings of the present study that CHAOS scores are not associated with BMI-z score or % fat mass are supported by previous research which suggests there is no direct association between CHAOS scores and child weight (Bates et al., 2018).

Research examining the effects of household chaos on child nutrition-related health outcomes is limited, especially with regards to the examination of child overall diet quality as an outcome. Considering that factors of the home environment (e.g., parent stress and family functioning) are known to be associated with poorer nutrition related health outcomes in children (Parks et al., 2012; Halliday et al., 2014) and that child diet quality is a predictor of chronic disease, it is important to continue research to understand the impact of household chaos on children’s diet quality among socioeconomically diverse populations.
Table 5.1 Sample Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Family-level Characteristics n=112</strong></td>
<td></td>
</tr>
<tr>
<td>CHAOS Score (15-60)</td>
<td>31.18 (7.87)</td>
</tr>
<tr>
<td>Household Income, n (%)</td>
<td></td>
</tr>
<tr>
<td>&lt;$ 30,000</td>
<td>6 (5.36)</td>
</tr>
<tr>
<td>$30,000-39,000</td>
<td>5 (4.46)</td>
</tr>
<tr>
<td>$40,000-49,000</td>
<td>2 (1.79)</td>
</tr>
<tr>
<td>$50,000-59,000</td>
<td>10 (8.93)</td>
</tr>
<tr>
<td>$60,000-69,000</td>
<td>6 (5.36)</td>
</tr>
<tr>
<td>$70,000-79,000</td>
<td>12 (10.71)</td>
</tr>
<tr>
<td>$80,000-89,000</td>
<td>13 (11.61)</td>
</tr>
<tr>
<td>$90,000-99,000</td>
<td>5 (4.46)</td>
</tr>
<tr>
<td>$100,000-149,000</td>
<td>36 (32.14)</td>
</tr>
<tr>
<td>&gt;$150,000</td>
<td>17 (15.18)</td>
</tr>
<tr>
<td><strong>Child-level Characteristics n=136</strong></td>
<td></td>
</tr>
<tr>
<td>Age in years</td>
<td>3.36 (1.13)</td>
</tr>
<tr>
<td>Sex, n (%)</td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>71 (52.21)</td>
</tr>
<tr>
<td>HEI Score (0-100) (n=131)</td>
<td>68.66 (9.90)</td>
</tr>
<tr>
<td>% Fat Mass (n=72)</td>
<td>29.21 (5.66)</td>
</tr>
<tr>
<td>BMI Z-score (n=90)</td>
<td>0.47 (0.89)</td>
</tr>
</tbody>
</table>

Note. Sample sizes for each outcome vary because anthropometric and body composition data were not collected from all participants

Table 5.2 Results of linear regression modeling using generalized estimating equations examining the relationship between CHAOS and child diet quality and weight outcomes

<table>
<thead>
<tr>
<th>Health Outcome</th>
<th>Adjusted Estimate* (95% CI)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEI Score (n=131)</td>
<td>-0.12 (-0.37, 0.13)</td>
<td>0.35</td>
</tr>
<tr>
<td>% Fat Mass (n=72)</td>
<td>0.02 (-0.20, 0.23)</td>
<td>0.88</td>
</tr>
<tr>
<td>BMI Z-Score (n=90)</td>
<td>0.02 (-0.01, 0.04)</td>
<td>0.18</td>
</tr>
</tbody>
</table>

*All models were adjusted for annual household income. The model examining the HEI outcome was also adjusted for child age and sex.

Note. Sample sizes vary because anthropometric and body composition data were not collected from all participants
5.1 References


maternal and child food-related behaviours. *Maternal & Child Nutrition, 14*(2), n/a-n/a. doi:10.1111/mcn.12540


6.0 Summary

Pre-school age is an important life stage for the development of eating behaviours, which have been shown to track into adulthood (Savage, Fisher, & Birch, 2007; Duncanson, Burrows, & Collins, 2012). Despite this, current statistics suggest that Canadian children are consuming suboptimal diets (Tugault-Lafleur, Black, & Barr, 2017; Garriguet, 2007). The results of the present study support current statistics, in that the average diet quality score of our participants was 68.66, which is considered a “D” per the graded system for interpreting HEI-2015 scores (Krebs-Smith et al., 2018). Considering that poor nutrition is a predictor of increased risk of obesity and many non-communicable diseases (e.g., diabetes, cancer) and that these conditions account for approximately 70% of deaths globally (WHO, June 2018), it is important to support the development of healthy eating behaviours and weight during this critical life stage.

The present study contributes to a better understanding of the effect of household chaos on child health outcomes by examining the association between the CHAOS and pre-school aged children’s overall diet quality in addition to two measures of child obesity risk (percent fat mass and BMI z-score). Previous research has investigated associations between the CHAOS and children’s intake of specific foods (e.g., sugar-sweetened beverages) and eating behaviours (e.g., emotional overeating), but not overall diet quality and has relied solely on proxy measures of obesity (e.g., BMI z-score) to evaluate child weight outcomes rather than body composition data. Furthermore, the present study builds on previous research which has focused on primarily low-income samples, by studying a sample comprised of families having primarily moderate to high annual household income. The present study did not find
CHAOS scores to be associated with child overall diet quality. Similarly, Asta et al. (2016) did not find an association between CHAOS scores and eating behaviour. Conversely, Lumeng et al. (2014) found an association between an emotional CHAOS subscale and children’s eating behavior and Martin-Biggers et al. (2018) found associations between a short (6-item) version of the CHAOS and fruit and vegetable intake, frequency of family meals, and availability of high salt and fat snacks in the home. The inconsistent findings among existing research could be a consequence of the variability in the versions of the CHAOS used (i.e., the full version, short version, and subscale), in the measures used to evaluate child diet (i.e., eating behaviour, dietary intake, diet quality), and in the samples studied (i.e., family income level). Future research should continue to explore associations of the CHAOS and its subscales with child diet quality in samples of diverse socioeconomic status to gain a more comprehensive understanding of how household chaos impacts children’s dietary intake and diet quality.

Research examining the effects of household chaos on child nutrition-related health outcomes is limited, especially with regards to the examination of child overall diet quality as an outcome. Considering that household environmental factors (e.g., parent stress and family functioning) are associated with poorer nutrition related health outcomes in children (Parks et al., 2012; Halliday et al., 2014), it is important to continue to explore associations of household chaos with children’s dietary intake, quality and obesity risk among socioeconomically diverse populations.
References


Kamp Dush, C. M., Schmeer, K. K., & Taylor, M. (2013). Chaos as a social determinant of child health: Reciprocal associations? Social Science Medicine, 95(Complete), 69-76. doi:10.1016/j.socscimed.2013.01.038


USDA. (2013). Diet quality of children age 2-17 years as measured by the Healthy Eating Index-2010. Center for Nutrition Policy and Promotion.


Appendix

Appendix A - Confusion, Hubbub, and Order Scale (CHAOS)

Source: Confusion, Hubbub, and Order Scale (CHAOS) (Matheny et al., 1995).

Please indicate how much you agree or disagree with each of the statements below using the following options:

1 = Very much like your own home environment
2 = Somewhat like your own home environment
3 = A little bit like your own home environment
4 = Not at all like your own home environment

1) There is very little commotion in our home.
   □ 1 □ 2 □ 3 □ 4

2) We can usually find things when we need them.
   □ 1 □ 2 □ 3 □ 4

3) We almost always seem to be rushed. *
   □ 1 □ 2 □ 3 □ 4

4) We are usually able to stay on top of things.
   □ 1 □ 2 □ 3 □ 4

5) No matter how hard we try, we always seem to be running late. *
   □ 1 □ 2 □ 3 □ 4

6) It's a real zoo in our home. *
   □ 1 □ 2 □ 3 □ 4

7) At home, we can talk to each other without being interrupted.
   □ 1 □ 2 □ 3 □ 4

8) There is often a fuss going on at our home. *
   □ 1 □ 2 □ 3 □ 4

9) No matter what our family plans, it usually doesn't seem to work out. *
   □ 1 □ 2 □ 3 □ 4

10) You can't hear yourself think in our home. *
    □ 1 □ 2 □ 3 □ 4

11) I often get drawn into other people's arguments at home. *
    □ 1 □ 2 □ 3 □ 4

12) Our home is a good place to relax.
    □ 1 □ 2 □ 3 □ 4

13) The telephone takes up a lot of our time at home. *
    □ 1 □ 2 □ 3 □ 4

14) The atmosphere in our home is calm.
    □ 1 □ 2 □ 3 □ 4

15) First thing in the day, we have a regular routine at home.
    □ 1 □ 2 □ 3 □ 4

* these questions are reverse scored.
Appendix B- Participant 3-Day Food Record Instructions

3-Day Food Record

Child's First Name _______________ Participant ID __________

Dates of Food Records ________________________

(2 weekdays and 1 weekend day)

Time Point ______________________

Instructions

- Please record all food and beverages (including water) that your child consumes on days that are representative of your child’s usual eating patterns. Please also include breastmilk and the approximate length of time during each feed. Record or attach recipes used to make food items and beverages.

- Please avoid choosing days that are atypical for your child, i.e. if they are sick. The 3 days do not need to be in consecutive order (for example, you could complete the food record on Wednesday, Friday, and Sunday) as long as 2 weekdays and 1 weekend day are included.

- You are provided with 2 pages for each of the 3 days of the 3-day food record, but if you need more space you can use another page and attach it to the food record.

Helpful Hint: Carry these sheets with you and record food and beverages as they are consumed.

Food Record Completion Guide
Time:
- Please record the time your child started eating.

Eating Occasion:
- Please identify whether you consider this eating occasion as breakfast, lunch, dinner or a snack.

Location:
- Please include where this eating occasion occurred, such as:

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home</td>
<td>Food consumed at your home</td>
</tr>
<tr>
<td>Daycare</td>
<td>Food consumed at daycare</td>
</tr>
<tr>
<td>Other</td>
<td>Food consumed at any other location that is not home or daycare (e.g. restaurant, elementary school, friend’s home)</td>
</tr>
</tbody>
</table>

Food Description and Preparation Method:
- Please describe the food or beverage and any preparation methods that were involved.
- Be as specific and detailed as possible, including brands and flavours of food items consumed, indicating variables such as reduced sodium, sugar and/or fat when applicable.
- If food is from a restaurant, please include as many identifying details as possible, including the name of the item on the menu, the size, sides and condiments.
- Record how any homemade food was prepared. For example, record if the food was baked, fried, broiled or BBQ’ed. Include the amount of any oil, margarine, butter or seasoning used during preparation and of course provide the details on those items (e.g. Becel Buttery Margarine).
- Include recipes (including serving size and number of servings) for any homemade meals or snacks that are consumed.

Amount Eaten:
- Please record how much of the food or beverage was consumed.
- Estimate amounts using weight (i.e. grams), volume (i.e. mL cups, teaspoons, tablespoons) or the number of items (1 slice of bread, 1 medium apple) whenever possible. Don’t be afraid to measure it yourself to determine these numbers.
- For more help, see the helpful serving size estimates on the next page. The more detail you provide, the more accurate our data!

THANK YOU FOR ALL YOUR WORK ON YOUR FOOD RECORDS!

Food Record Serving Size Guidelines
The following are some guidelines to help you estimate how much food your child is consuming so you can complete the “Amount Eaten” column with as much accuracy as possible.

<table>
<thead>
<tr>
<th>Handy Measure</th>
<th>Good for measuring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fist = 1 cup</td>
<td>Fresh leafy greens</td>
</tr>
<tr>
<td></td>
<td>Yogurt, cooked legumes (e.g. peas, beans, lentils, chickpeas), tofu</td>
</tr>
<tr>
<td></td>
<td>Drinks like milk and soy beverage</td>
</tr>
<tr>
<td>Half fist = ½ cup</td>
<td>Pasta, rice, quinoa, oatmeal, barley</td>
</tr>
<tr>
<td></td>
<td>Cereal</td>
</tr>
<tr>
<td></td>
<td>Fresh, frozen and canned fruit and vegetables</td>
</tr>
<tr>
<td></td>
<td>Canned evaporated milk</td>
</tr>
<tr>
<td></td>
<td>100% juice</td>
</tr>
<tr>
<td>Cupped hand = ¼ cup</td>
<td>Nuts</td>
</tr>
<tr>
<td></td>
<td>Dried fruit (e.g. raisins, dates, figs, apricots)</td>
</tr>
<tr>
<td></td>
<td>Seeds (e.g. flax and hemp)</td>
</tr>
<tr>
<td>Palm = 2 ½ oz</td>
<td>Protein-rich foods like chicken, beef, fish, pork and turkey (the thickness of your pinky finger)</td>
</tr>
<tr>
<td>Flat hand</td>
<td>1 slice of bread</td>
</tr>
<tr>
<td></td>
<td>½ a bagel, pita or tortilla</td>
</tr>
<tr>
<td>Thumb = 1 Tbsp</td>
<td>Oil and spreads like margarine, butter, peanut butter, mayonnaise and sauces</td>
</tr>
<tr>
<td>Thumb tip = 1 tsp</td>
<td>Cheese (2 thumbs)</td>
</tr>
</tbody>
</table>

Source: Eatright Ontario
**Food Record Example**

Here is an example of how to complete a food record form. Remember, the more detail you provide the better as it will allow us to more accurately quantify your nutrient intake.

<table>
<thead>
<tr>
<th>Time (Start Time)</th>
<th>Eating Occasion (Breakfast, Lunch, Dinner, Snack)</th>
<th>Location (Home, Daycare, or Other)</th>
<th>Food Description and Preparation Method (Please include brands, cooking method, and any condiments, oils and/or seasonings used)</th>
<th>Amount Eaten (Weight, volume, number)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Meal</th>
<th>Location</th>
<th>Meal Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 am</td>
<td>Breakfast</td>
<td>Home</td>
<td>Scrambled eggs: Naturegg omega-3 eggs: Combined with 2% milk Cooked in salted butter Salt and pepper</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Orange Juice, Tropicana Grovestand, with Calcium + Vitamin D and Pulp</td>
</tr>
<tr>
<td>10:15 am</td>
<td>Snack</td>
<td>Daycare</td>
<td>Granny Smith apple, medium, sliced</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kraft, crunchy peanut butter</td>
</tr>
<tr>
<td>12:30 pm</td>
<td>Lunch</td>
<td>Daycare</td>
<td>Milk, 2%, small carton</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Grilled Cheese Sandwich, pan-fried: Dempster's whole grain bread Salted Butter Cracker Barrel, mild marble cheese</td>
</tr>
<tr>
<td>3:30 pm</td>
<td>Snack</td>
<td>Other</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pepperidge Farm Goldfish Crackers, coloured</td>
</tr>
<tr>
<td>6:00 pm</td>
<td>Dinner</td>
<td>Home</td>
<td>Cucumber, sliced into rounds</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cheeseburger: PC Blue Menu Thick and Lean Beef Burgers, BBQ'ed Dempster's Deluxe 100% whole wheat hamburger bun Kraft Singles processed cheese slice Heinz ketchup, French’s mustard, &amp; Heinz relish Raw slice of medium tomato, thick</td>
</tr>
</tbody>
</table>

Remember to provide as much detail as you can, include recipes used, and amount of water consumed.

THANK YOU for your work in completing this food record!
Appendix C- Food Record Data Entry Standard Operating Procedure

*** Save your work often! ESHA is known to crash! ***

DE#1 (Data Entry #1):

1. Getting Started

Creating a New Person/Food Record:

1. Open the program “The Food Processor” on the Desktop

2. To start a new participant’s food records, click New >> Person or Ctrl+Shift+P

   ➔ This window will pop up:

3. Enter a file name in the following format into the First Name field.

   **First Name: ID#-FR-TimePoint-FirstDateofFoodRecord-YourInitials**

   For example: A0011-FR-Month0-Jan12_16-JM (Month0 food records)
   or A0011-FR-6Month-Jan12_16-JM (6Month and 18Month food records)

   - Notice the different arrangement of the number in Month0 and 6Month/18Month food records

4. Enter ‘GFHS’ in the Last Name field.

5. Enter a placeholder number into the age, height and current weight fields. ESHA requires these fields to be filled, but our analysis does not require this information. Do not add anything to the user code field.

6. Click Next and then Finish

   ➔ You will now see the main screen.
2. Entering the Food Record Content:
1. Double-click on Day 1 to change the date to the first day of the 3-day food record.
2. Right-click within the white field and select Add item to input the first food (or beverage) item on the food record.
3. In the search field, enter a short description of the food item and select the most appropriate option. For specific brands, enter the fewest number of words as possible as ESHA recognizes exact spelling. Play around with spelling to find your food item. Specific brands should only be chosen if specified in the food record. If the brand is not provided, choose generic food items. If available, always choose generic food items listed under the Canadian Nutrient File. If the appropriate food item is not listed under the Canadian Nutrient File, select the most appropriate file under the USDA, or under another generic brand if USDA is not available. The brand name, Canadian Nutrient File or USDA distinction will be visible to the right of the food item name.

4. Once the appropriate food item is chosen, enter the reported amount, select the unit and eating occasion, as reported on the food record.
   *If the unit recorded in the food record is not listed in the units of measure drop-down menu, enter a random amount and unit to enter the food item into your record. Then, open the “Canadian Nutrient File – Search by Food” webpage (webprod2.hc-sc.gc.ca/cnf-fce/index-eng.jsp or google “Canadian Nutrient File”) and look up the food item. If the food item in ESHA is only available in mL and you were given the amount in grams, look for this conversion in the list of available serving sizes for that food item in the Canadian Nutrient File. For example, for banana, raw: 100 mL = 63.4 g.
In ESHA, right-click on the food item and select Open Item.
Click Yields/Measures >> Edit Measures >> Add. Enter the conversion here. Click the save button in the upper right corner of the screen. Double-click on the food-item (or right-click, select Modify item) and correct the amount and unit. The required unit should now be visible in the drop-down menu.

5. Continue to enter each food and drink that the participant consumed that day of the food record. To move on to the second and third day, right-click in the window and select Add Day. The date of the food record should automatically follow day 1, given that you changed the date of day 1 to reflect the first day of the food record.

**Choosing a Comparable Food Item When Your Food Item in Not in the Database:**
If you cannot find your food item in the database, choose a comparable food item, in terms of nutritional composition. See below for examples.

**Banana muffin**—not available in database, so choose **bread mix, banana, with real bananas (Betty Crocker)** (this is a comparable item with a generic brand).

**Boom Chicka Pop, Lightly Sweet Popcorn**—not available in database, so choose **popcorn, sweet & salty (Pret A Manger)** (this is a comparable item, no generic brand was available so a specific brand was chosen to best represent the food item).

---

**Indicate directly on the food record which comparable item you have added to ESHA, your initials and the date using a differently coloured pen or highlight.**

**Creating a New Ingredient (NOT recommended if possible)**
Only use this option as a last resort when you cannot find a comparable food item in the database! It is preferable to use a food item already in the database since it provides a
Look up the nutrition facts table online.

1. Click **File >> New >> Ingredient** or Ctrl+Shift+I

   → This window will pop up:

   ![Ingredient Information](image)

2. Name the ingredient: GFHS-PartID-Food Name (i.e. GFHS-A0020-McDonald’s Hash Browns) and enter the serving size in grams.

3. Click **Nutrients** from the left menu and enter all nutrition information provided in your nutrition facts table or list (found online).

4. Click **Yields/Measures >> Edit Measures >> Add** to enter the most appropriate serving/slice/piece, etc. and its weight in grams (for example, if there are 50 g of cookies in a pouch, enter this conversion using the most appropriate terms found in the drop-down menu).

5. Click **Ok >> Save >> Finish >> Close** to get back to your food record.

6. You can now search for the ingredient by right clicking and selecting **Add item**. Enter the amount, unit and at which meal it was consumed.

**Creating a New Recipe**

Use this option when you have been provided with a recipe for a dish or snack or if you have been given a complex food item, i.e. home made chicken soup, and need to input an equivalent recipe found online. You should have all ingredients listed in volumes or weights, and then the serving size that the participant consumed. For example, you may be given a lasagna recipe, and you will need to know if they ate approx. 1 cup of the recipe or if it was 1/8th of the pan.

Note: It helps to know how they report their serving size before you enter the recipe!

1. Click **File >> New >> Recipe** or Ctrl+Shift+R
2. Name the recipe starting with GFHS and the ID number. For example, GFHS-A00111-Chicken Noodle Soup.
3. Enter the recipe yield (or serving weight, if available) below the recipe name and click **Finish**.
4. A recipe window should open. Enter one ingredient into this field at a time by right-clicking in the window field and selecting **Add item**.
5. Save the recipe by selecting the save button in the upper left corner. Then close the window.
6. You have now created a recipe that any ESHA user on this computer can use, but it has not been entered into the food record yet. Search the recipe file in the search field or by right-clicking then select **Add item**. Enter the recorded amount or serving size of the food item. If you cannot find the correct unit, use Canada’s Nutrient File to find the correct conversion factor and add to the recipe by right-clicking on item, select **Open Item** >> **Measures** >> **Edit Measures** >> **Add**.

**Saving Data:**
1. Save the ESHA Data File by clicking **File** >> **Save to File**. From the Desktop, select **GFHS ESHA** >> **Food Records** >> **Month0** or **6Month** depending on the food record.
2. From the home screen (you should be able to see each day’s items), ensure that all days are checked (the small white box should have a black check in it).

<table>
<thead>
<tr>
<th>Am I Finished Checklist?</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ check all food items and amounts</td>
</tr>
<tr>
<td>✓ check the file name</td>
</tr>
<tr>
<td>✓ check that file is saved in appropriate folder</td>
</tr>
</tbody>
</table>
DE #2 (Data Entry #2):

Double-Checking Procedure:

1. Ensure the name is encoded correctly:

   **FIRST NAME: ID#-FR-#Month-Day1of Food Record-Your Initials**
   Example: For baseline data: A0123-FR-Month0-Mar5_15-JM
   For 6-month data: A0123-FR-6Month-Sept22_15-JM
   *notice baseline data is written as “Month0” and 6-month/18-month data is written as “6Month” or “18Month”

   **LAST NAME: GFHS**

2. Ensure file name is the same. For example, “A0123-FR-Month0-Mar5_15-JM GFHS”.

3. Ensure day 1, 2, and 3 dates reflect those of the food record.

4. Go through every food item and amount, including those in recipes, and ensure accuracy with each day of the food record. If you think a more specific food item is available in the database, check for it and replace if available. If a broad food choice has been selected for a specialty item not found in the database, create a new ingredient (follow instructions on page 4) and replace the item.

5. Document the double check manually on the post-it note with your initials and the date. Also document the double-check on the GFHS Food Record Tracking Sheet located on the GFHS Students dropbox folder.

Export Procedure:

**Once you have checked over the food record, export the spreadsheet data:**

1. Click **HOME >> Nutrients to View**. Ensure **GFHS** is selected.
2. Click **REPORTS >> Spreadsheet**.
3. Expand days 1, 2, and 3 by clicking the plus icon beside the day numbers.
4. Click “Export as Text” and select “To Clipboard”
5. Open a new file in excel.
6. Click paste.
7. Save the file to **Desktop >> GFHS ESHA >> Export Data >> Month0 or 6Month** as “PartID-Month0/6Month-SpreadsheetData”.
   For example, “A0123-6Month-SpreadsheetData”.

    ***Save your work often! ESHA is known to crash! ***

Standards:

<table>
<thead>
<tr>
<th>Food Item/Measurement</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Always select “water, municipal tap” unless a brand of bottled water is specified. If an amount of water was consumed throughout the day, but not during a specific mealtime, add this ingredient and the amount, but do not add a meal time.</td>
</tr>
<tr>
<td>Breast feeding</td>
<td>Use <strong>12.5mL/minute</strong></td>
</tr>
<tr>
<td>Bread</td>
<td>If a type is not specified, select <strong>white</strong></td>
</tr>
</tbody>
</table>
Milk | If a type is not specified, select milk, **2%, with vitamins A and D**
--- | ---
Milk (%) | Always select specified percentage with added **vitamins A and D**
Pasta/Flour | Always select **enriched** unless otherwise noted
Honey | Select strained
Soy Sauce | Select **soy and wheat** unless otherwise noted
Butter | Select **salted** unless otherwise noted
Dry measurements | Should be in dry servings, i.e. ounce, gram
Wet measurements | Should be in wet servings, i.e. fluid ounces, mL
*Go to Canadian Nutrient File for correct conversions if required.

<table>
<thead>
<tr>
<th>Pasta</th>
<th>Dry-to-Cooked Ratio (weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Tbsp</td>
<td>15 g (14.785) = 3 Tsp</td>
</tr>
<tr>
<td>1 Tsp</td>
<td>5 g</td>
</tr>
<tr>
<td>1 Dash/Pinch</td>
<td>0.4 g</td>
</tr>
</tbody>
</table>

**Fruit** | Assume medium size unless otherwise specified
--- | ---
1 lb raw ground beef | ~1 cup
1 tsp cooked ground beef | ~14 g
Handfuls | Assume ½ cup
1 apple slice | ~3 oz.
1 cup spinach | ~30 g
1 cup diced cheddar cheese | ~132 g
1 cup diced watermelon | ~5.4 oz.
20-25 fries | ~76 g
1 cucumber slice | ~5 g
1 bite | ~5 g
Few sips of water/beverage | ¼ cup

**ESHA Data Management (added Oct 2017)**

1. **Data Manipulation in Excel**
   * Note for AA to add file location where files are stored and name of sample file – will this be One Drive?
   * Note for AA to add why we have to manipulate the data ie. for use in SAS and DB

   a. Open the file to be manipulated and save as a new file by adding ‘_SAS’ to the end of the file name.
   b. Copy columns A-F from sample file and insert copied cells to left of column A in the new file.
   c. Use the title in the new file to update PID, Study Wave, Study Phase and Month in the new file.
   d. Copy bottom rows with the average calculations from the sample file (J26-J32 to CE26-CE32).
   e. Adjust the first “average total” (row 25) with appropriate average formulas. IE =AVERAGE(J4,J11,J18) and drag the formula across the entire row J – CE.
f. Repeat step above for columns 26 – 32. Remember to also drag this formula across to CE.
g. Confirm the formulas entered yield the appropriate values for all averages on all 3 days (B/L/D/MS/AS/ES). Note – some participants may not have 3 meals and snacks on each of the 3 days.
h. Center justify the cells in rows 3-32.
i. Bold the cells in rows 25-32.
j. Select cells J4-J24 to CE4-CE24 and replace ‘--’ with ‘0’.
k. Click save.
Appendix D - HEI Standard Operating Procedure

- The Healthy Eating Index (HEI-2015) is used to assess the diet quality of participants on a scale out of 100. Foods/nutrients are divided into two components:
  - Adequacy: Fruit, whole fruit, vegetables, greens and beans, whole grains, dairy, total protein, seafood and plant proteins and fatty acids
  - Moderation: refined grains, sodium, added sugars and saturated fats

- For details regarding the definition of each category, please see *Table 1*.

- **Note:** HEI-2015 is based on the USDA MyPlate serving sizes and deviates slightly from EWCFG – refer to [https://www.choosemyplate.gov](https://www.choosemyplate.gov) for USDA serving sizes.

- The data for each category will be collected using the following steps:

**Data Enterer #1**
These steps will be completed by the person who does the first pass through the food record output.

1. **ESHA food record exports are assessed by a trained research assistant:**
   - Open the exported ESHA file on OneDrive. Food Records -> ESHA Export Files
   - Copy and paste the teal scoring columns from the “HEI_FR_Sample Scoring” document *make sure you are in editing mode to enable copy/paste
   - Calculate servings of each category of the food record by going through the electronic food record and recording beside each food. Please see *Table 1* for serving sizes of each category or [https://www.choosemyplate.gov](https://www.choosemyplate.gov)
   - For mixed prepared foods (i.e. canned chilli, soups stews), look the item up in the on the product website to estimate amounts of each ingredient. Use these amounts to estimate HEI category.
   - Recipes will be titled “GFHS-PID-Name of Food” and the ingredient list will follow in the output. Use the output for each individual component to estimate the HEI servings.
   - Check Documents:
     - Categories for common foods/servings: This document has been created to document agreed upon servings for common foods consumed by preschoolers (i.e. goldfish crackers and pizza)
     - Categories for (un)common foods/servings: This document was created to establish agreed upon servings for less common foods
   - Note any added sugars by entering “kcal” in the HEI Serving cell and highlighting it in yellow
   - For GB servings: in capitals on the right side of the HEI serving column, detail whether it was a “GREEN” or “BEAN”
     - This will help DE#2 perform the bean/legume calculation for the final HEI score
   - Record initials, date and notes in the HEI Score Tracking Sheet
NOTE: If you find errors in the food record (i.e. odd serving sizes, missing information, inappropriate items – 437 mL of dry iced tea powder vs. 437 mL of liquid iced tea) highlight them in red in the food record output and make a note in the tracking sheet, also highlighted in red.

Data Enterer #2:
*must be different than data enterer #1
These steps will be completed by the person who does the second pass through the food record output.

NOTE: If the food record you are double checking is highlighted in red, you must go back to the original paper copy of the 3-day food record to find the correct item/quantity/etc., re-enter it in ESHA, and change it in the HEI scoring export file on OneDrive prior to moving forward with scoring.

1. **Added Sugar Kcals are determined and calculated**:
   - If the exact brand is available: Use the product label (from the brand’s website) to find grams of sugars and these values are multiplied by 4 to calculate calories.
   - If the exact brand is not available (e.g, a generic pecan pie): Find the participant’s file in ESHA to determine the grams of sugar in the item. Use the grams multiplied by 4 to calculate the number of sugar kcals.

2. **ESHA Analysis of 3-day food records**:
   - Open ESHA outputs (located in the one drive) and obtain the following information for each participant.
   - Obtain the following information from the ESHA reports (bottom row of the 3-day report) and enter it into the GFHS HEI paper chart and then the spreadsheet:
     - Average total kcals
     - Average Sodium
     - Average Saturated Fat
     - Average Saturated Fat kcals
     - Average Mono-unsaturated Fat
     - Average Poly-unsaturated Fat
     - The HEI spreadsheet will calculate the ratio of MUFA+PUFA/SFA

3. **HEI Excel Export Component Scoring**
   - Review the amounts entered in the “HEI Serving” column of the food record output
   - Double check against Table 1 and the USDA MyPlate if necessary
   - Calculate total HEI servings for each component and day and enter into the summary table in the food record output spreadsheet

4. **Final HEI Scoring in Master Spreadsheet**
   - Enter participant’s information into the HEI Spreadsheet. Go through each 3-day food record output separately and record intake in the appropriate column for each participant (i.e. Fruit Day 1). Intake for each category will be averaged over the 3
days to calculate a consumption score for the HEI.

- Enter added sugar kcals into HEI spreadsheet for each day (i.e. AddedSugarKcalDay1). The HEI spreadsheet will calculate the % of total kcals that added sugar kcals account for (Variable: %AddedSugarKcals)
- Enter average saturated fat kcals (this information is available in the ESHA export file) into HEI spreadsheet. The HEI spreadsheet will calculate the % of total kcals that SFA kcals accounts for (Variable: %SFAKcals)

5. **For Participants who have consumed beans/legumes (i.e., chickpeas, hummus, green beans, etc.)**
   a. These will be inputted in the ‘Greens and Beans’ category during the initial scoring
   b. Per HEI-2015 protocol, all greens and beans (incl. leafy greens) also count towards vegetables, this is done automatically by the scoring spreadsheet.
   c. Legumes also count towards SPP and so, are added to the SPP columns of the scoring spreadsheet. This is done by hand, as they must be separated from leafy greens in the GB category.

6. **For participants who consume alcohol**
   - Alcohol is not considered as part of the moderation or adequacy components and so, is not counted as part of scoring.
   - Added sugar kcals added, if participant consumed a mixed drink (e.g., gin and tonic-> kcal from sugar in tonic is counted)

Table 1: Calculation Methods for HEI-2015

<table>
<thead>
<tr>
<th>HEI-2015 Component</th>
<th>Component Details</th>
<th>USDA Serving Size</th>
<th>Method for Calculating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adequacy Components</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Fruit (F) | Includes 100% fruit juice, dried fruit and **ALL WHOLE FRUIT is also counted towards the Fruit Component** *(The HEI Master Spreadsheet will add WF into F automatically)* | 1 cup fruit juice, ½ cup dried fruit | Determine how many servings of each the person consumed on the food record  
1) Juice  
2) Whole Fruit Category |
<p>| Whole Fruit (WF) | Includes fresh, frozen and canned whole fruit | 1 full fruit, 1 cup fresh or cooked or frozen = 1 cup from Fruit Group (1 cup= 1serving) | Determine the number of servings of whole fruit consumed on the food record. |
| Vegetables (V) | Includes all veggies <strong>All leafy greens are counted in V and GB (done automatically by the spreadsheet)</strong> | 1 cup raw or cooked, 1 cup juice = 1 cup from Vegetables Group (1 cup= 1serving) | Determine the number of vegetables consumed on the food record (i.e. cucumbers, carrots, broccoli). |</p>
<table>
<thead>
<tr>
<th><strong>Greens &amp; Beans (GB)</strong></th>
<th>Includes leafy greens and beans (canned, dried, fresh) <strong>beans count towards SPP and must be added to these columns of the scoring spreadsheet</strong> Beans and Greens are also counted towards vegetables (this will be done automatically by the scoring spreadsheet)</th>
<th>1 cup cooked, 2 cups raw leafy greens 1/4 cup beans cooked</th>
<th>Determine the number of servings of: 1) Leafy greens 2) Beans (i.e. chickpeas, green beans, kidney beans)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Whole Grains (WG)</strong></td>
<td>Includes all whole grains 1 slice bread, 1 cup cereal, 1/2 cup cooked, quinoa, pasta or oatmeal = 1 oz from Grains Group (1 oz= 1serving)</td>
<td>Determine the number of servings of whole grains (i.e. whole wheat bread, tortillas or bagels, quinoa, oatmeal, whole wheat pasta) indicated on the food record.</td>
<td></td>
</tr>
<tr>
<td><strong>Dairy (D)</strong></td>
<td>Includes all dairy 1 cup milk, yogurt or soy milk 1.5 oz natural cheese, 2 oz processed cheese</td>
<td>Determine the number of servings of the following on the food record: 1) Cow’s milk 2) <strong>Fortified</strong> dairy alternatives (must have Ca and Vitamin D to count) 3) Yogurt 4) Cheese</td>
<td></td>
</tr>
<tr>
<td><strong>Total Protein Foods (TP)</strong></td>
<td>Includes animal sources of protein (red meats, poultry, eggs) and any beans if intake is low in this group 1 oz meat or poultry, 1 egg = 1 oz from Protein Group (1 oz = 1serving)</td>
<td>Determine the number of servings of the following on the food record: 1) Meat (red meat, poultry) 2) Eggs</td>
<td></td>
</tr>
<tr>
<td><strong>Seafood and Plant Proteins (SPP)</strong></td>
<td>Includes seafood (fish, shellfish) and plant proteins including nuts, seeds, nut butters <strong>HEI-2015 update: legumes are counted here AND in GB</strong> <em>This is done by hand in the final scoring sheet</em></td>
<td>Determine the number of servings of: 1) Fish or shellfish 2) Nuts 3) Nut butters 4) Tofu</td>
<td></td>
</tr>
<tr>
<td><strong>Fatty Acids</strong></td>
<td>Ratio of unsaturated/saturated fats</td>
<td>Ratio &gt;2.5</td>
<td></td>
</tr>
</tbody>
</table>
**Moderation Components**

<table>
<thead>
<tr>
<th>Refined Grains (RG)</th>
<th>All grains that are not whole grain</th>
<th>See WG Anything that isn’t whole grain 1 oz = 1 serving</th>
<th>Determine the number of servings of grains (not whole wheat) (i.e. white or multigrain bread, tortillas, bagels, pasta, rice, crackers) consumed each day.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>Captured by ESHA</td>
<td>&lt;1100mg</td>
<td></td>
</tr>
<tr>
<td>Added Sugars</td>
<td>Foods that are high in sugar Most snack foods i.e. cookies, cakes, packaged snack foods, honey, jam</td>
<td>&lt;6.5% of energy</td>
<td></td>
</tr>
<tr>
<td>Saturated Fats</td>
<td>Captured by ESHA</td>
<td>≤8% of energy (≥16% of energy)</td>
<td></td>
</tr>
</tbody>
</table>

**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


**Standard Operating Procedure for Pediatric Length Measurement**

Participants shorter than 130 cm, will be too small for the wall-mounted stadiometer.

In this case, and if the participant can stand, use the pediatric length board in a standing position, shown below.

Follow the GFHS Height Measurement Protocol.
If Participant is Unable/Unwilling to Stand
- Ask participant to lie on the bed, on pediatric length board.
- Ensure participant’s right leg is extended and right foot is parallel with foot board, and that s/he is looking up at the ceiling.
- Measure in duplicate.

If participant is unable/unwilling to lie on the length board:
Run the measuring along the mattress on the right side of the participant’s body, from the right heel to the crown.

*Don't forget to calculate Inter and Intra-Rater Reliability Coefficients of Variation for your study. You can find the steps for these calculations in the SOP for calculating CV's.
Appendix F - Standard Operating Procedure for Weight Measurement

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
   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 G- Standard Operating Procedure for BMI Z-Score Calculation

Use WHO Anthro for children <5 years of age at time of assessment.
Use WHO AnthroPlus for children 5-19 years of age at time of assessment.

1. **Open program (WHO Anthro or Who AnthroPlus).**
2. **Click “Anthropometric calculator” option.** Window will open.
3. **Enter date of visit** (health assessment).
4. **Select sex.**
5. **Enter date of birth.** If you do not know the day of birth (only month and year), input correct month of year and year, then select “Approximate date” field.
6. **Enter weight in kg to two decimal places.**
   Round up or down PRIOR to input into program, i.e. if weight is 14.456kg, enter 14.46kg into program. If you type in 14.456, it will not round up for you and will instead remove the last digit so that you receive the wrong number (14.45).
7. **Enter height in cm to two decimal places.**
   This should be the average of the TWO CLOSEST HEIGHT VALUES and NOT the average of all three (or four) height values.
8. **Select “Standing” under the Measured option, this is the GFHS default for height measurements. The program’s default is “Recumbent”; remember to change this option to “Standing” every time you calculate the score. Use “Recumbent” if measure was taken while child was laying down (should be reported in the height notes).**
9. **Once all of these fields have been inputted/options selected, you will receive the results. You do not need to select anything further. Record the BMI-for-age value.** This is the BMI z-score.

**Helpful Hints:**
- If switching between WHO AnthroPlus and WHO Anthro, remember to select “Standing” under the Measured option, unless height was measured in recumbent position (this information is available in the height notes). Each time you switch between programs, the default option “Recumbent” will be selected.
- If no values are visible in the Results section, it is likely that the age is not appropriate for the selected program. You will need to switch to the appropriate program.
Appendix H- Standard Operating Procedure for Bioelectrical Impedance Analysis (BIA)

Instructions for Bioelectrical Impedance Analysis (BIA)

The body composition of children will be measured using bioelectrical impedance (BIA).

Tell the parent/participant:

“BIA is a method that measures the resistance of our body tissues (like body water and body fat) to a weak electrical current. The current is less than what is in a dying 9V battery. The test is quick and painless. To do the test, we will put sticky pads on your hands and feet, and ask you to lie still.”

Tell the child:
“‘I am going to measure your body. I am going to put some stickers on your hand and on your foot and attach these special cables. All you need to do is lie still (like a star) and count to 10.’

The GFHS uses the Quantum IV BIA Analyzer System. Disposable foil electrodes are required for BIA. The GFHS uses Stay Fresh Electrodes Packs (or similar) from RJL Systems. Ordering information is included at the end of this document. The BIA analyzer must be tested once each study day using the test resistor and BIA test instructions.
1. Ask child/participant if they need to void their bladder (ie. ‘go pee’) prior to the BIA test.

2. Confirm that the participant does not have an artificial pacemaker or an implantable cardioverter-defibrillator (ICD). If so, do not proceed with the BIA test.

3. Confirm that the participant has not consumed any food or beverage for 30 minutes prior to the BIA. If so, make a note in the Comment section of the Health Assessment Form.

4. Have the participant remove their right shoe and sock, and any jewelry (small earrings are fine) and/or metal from their pockets. There should be no metal on the participant from the neck/clavicle down to their feet. This includes taking off pants with metal zippers/snaps.

5. Ask the participant to lie down on the bed (ideally flat, no pillow). Ask the participant to be as still as possible. Ensure that the participant’s arms and legs are abducted about 30° from their torso. If required, a rolled-up towel can be used to separate legs.

   **Note:** If necessary, one parent can stand at the head of the bed and put a hand on the child’s forehead to comfort the child during the test. The medical bed can also be lowered or raised for convenience.

6. Clean the electrode sites with an alcohol swab. See the diagram on the BIA Instruction Sheet for electrode locations.

7. Prepare the gel electrodes by cutting them in half. You will need 4 half electrodes for each participant (2 for the right foot and 2 for the right hand).

8. Attach the electrodes and cables as shown in the diagram on the BIA Instruction Sheet. Remember, for the electrode placement “red to head”.
Note: For the children in the GFHS, place the electrode at the base of the middle finger on the right hand, instead of wrapping the electrode about the finger.

9. Turn on the BIA analyzer, let the measurements stabilize for a few seconds and then record the Reactance, Resistance, Impedance and Phase Angle measurements on the Health Assessment Form.

10. Turn off the BIA analyzer.
11. Turn on the BIA analyzer and repeat the measurements for a second reading.

   **Note:** If there is a greater than 5% difference between the two resistance results, a third BIA measurement should be taken.

12. Remove the cables and the electrodes. Dispose of the electrodes in the garbage.

*Don't forget to calculate *Inter and Intra-Rater Reliability Coefficients of Variation* for your study. You can find the steps for these calculations in the SOP for calculating CV's.

**BIA Supplies – Ordering Information**

Additional electrodes for the BIA can be ordered online from RJL Systems at [www.rjlsystems.com](http://www.rjlsystems.com).

Go to the Order tab in the menu and scroll down the list to *Purchase Additional Accessories & Supplies* and select the electrodes you wish to purchase.

For GFHS, we typically order the Stay-Fresh Pack of 200 electrodes (Item #92500S).