THE ASSOCIATION BETWEEN MEAL REGULARITY AND MENTAL HEALTH IN NOVA SCOTIAN CHILDREN

by

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I dedicate this work to my mom and dad.

Thank you for teaching me to ask questions,
to strive for excellence,
and for your support through the good and the bad.

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Abstract

Background: Few studies have examined the association between childhood meal regularity and mental health.

Objectives: To determine whether a cross-sectional relationship exists between meal regularity and both self-esteem and mental health-related physician visits in Nova Scotian children.

Methods: Data from the CLASS-II study (4,009 grade five children, Nova Scotia, 2011) and HDNS were used to examine whether meal regularity predicts both self-esteem and mental health related physician visits. Mixed effects logistic regression and zero-inflated Poisson regression were used to predict odds of lower self-esteem and risk of mental health-related physician visits, respectively.

Results: Supper alone, supper in front of the television, breakfast skipping (boys) and family supper were significantly associated with lower self-esteem. Supper in front of the television (boys) and skipping lunch (girls) were associated with increased mental health-related physician visits.

Conclusion: Some aspects of meal regularity are associated with childhood self-esteem and mental health-related physician visits.

List of abbreviations used

BMI: Body Mass Index

CI: Confidence Interval

CIHI: Canadian Institute for Health Information

CLASS-II: Children's Lifestyle and School-performance Study

DQI: Diet Quality Index

ED: Emergency department

HDNS: Health Data Nova Scotia

ICD: International Classification of Disease

IRR: Incidence Rate Ratio

MSI: Medical Services Insurance

OR: Odds Ratio

PAQ-C: Physical Activity Questionnaire for Children

REB: Research Ethics Board

SES: Socioeconomic Status

WHO: World Health Organization

YAQ: Harvard Youth/Adolescent Food Frequency Questionnaire

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Chapter I: Introduction

1.0 The prevalence and costs of mental illness in Canada

In Canada, an estimated 12.6% of children aged 4-17 years are living with mental illness at any given time (1). Mental illness often begins before adulthood, with 50-75% of mental illness starting in childhood and adolescence (1,2). As a substantial proportion of mental illness develops during childhood and adolescence, early interventions are vital to help lessen the considerable burden of mental illness on individuals and society (1–3).

Mental illness is a major cause of morbidity and mortality, and suicide is the second leading cause of death for Canadian youth aged 15-24 (4–6). Individuals with mental illness often face stigma and socio-economic exclusion (7–9), and childhood mental illness may impact development and interfere with education (10). In Canada, the economic burden of mental illness represents an estimated 50 billion dollars each year (5).

1.1 Self-esteem as an indicator of mental health in children

Self-esteem has been shown to be associated with mental health in children (11,12). Having low self-esteem may contribute to the development of mental health problems including depression, anxiety, eating disorders, violence, aggressive behaviours, and high-risk behaviours (12). A prospective study investigating the impact of self-esteem on the development of mental health problems in youth observed that higher initial self-esteem predicted fewer mental health problems over three years in

terms of symptoms of anxiety and depression, and attention problems (11). Covariates controlled for in the model included prior mental health symptom levels, medication use, therapy, and gender (11). Other studies have described an association between low self-esteem and a variety of mental health disorders such as social phobia (13), depression (14), and obsessive-compulsive disorder (15). Although lower self-esteem has been shown to be associated with mental health problems in youth, it is important to note that very high self-esteem is also associated with some forms of psychopathology such as narcissism (16) and the manic phase of bipolar disorder (17). As demonstrated by the literature, self-esteem is an important aspect of mental health in children and youth.

1.2 Mental health service use in Canadian children

Mental health service use is a term which defines interactions with the healthcare system for mental health-related purposes. Mental health service use captured by administrative health databases may include interactions such as physician visits, hospital admissions, and emergency department (ED) visits (18). It is important to note that psychologist visits are not captured in administrative health data. In the province of Ontario, a repeated cross-sectional study investigated trends in mental health service use including visits to the ED related to mental health/addictions, psychiatric hospitalizations, and outpatient visits related to mental health among 10-24 year olds (19). Overall, anxiety disorders were the most frequent reason for ED visits, while mood and affective disorders represented the greatest proportion of mental illness for hospitalizations (19). Over the course of the study, an overall trend of increasing mental

health service use among young people was observed (19). Similarly, a 2015 report by the Canadian Institute for Health Information (CIHI) demonstrated that among young people ages 5-24 with a mental disorder, between 2006-2007 and 2013-2014, mental health-related ED visits increased by 45% and hospitalizations for mental health disorders increased by 37% relative to stable rates for non-mental health reasons (20). In this report, ED visit data are from Alberta and Ontario only (20). In summary, results from both provincial and national level data suggest that mental health service use is increasing among young Canadians (19,20).

1.3 Non-nutrition predictors of mental health in children

A cohort study from New Zealand identified childhood risk factors for mental health outcomes including: parental separation and divorce (associated with socioeconomic disadvantage, elevated rates of adverse life events and higher levels of conflict between parents), childhood abuse (associated with family dysfunction, impaired parenting and parental psychopathology), and sexual orientation (gay, lesbian, bisexual orientations) (21). In a German cohort study, results demonstrated that adverse family climate was particularly predictive of mental health problems (22). Specifically, significant risk factors included conflicts in family, single and/or step parent households, parental strain, parental psychiatric symptoms, and poor self-rated physical and psychological health (22). Factors associated with better mental health included individual resources (self-efficacy, self-concept, optimism), family resources (family climate, parental support), and social resources (social support, peer competence) (22). Self-esteem has also been

shown to be strongly associated with mental health in children (23). In Nova Scotia, the *Together We Can* project outlines five priority areas for improving mental health, which include early intervention and timely access to appropriate care (including offering supports and services in schools and those to strengthen families), with a focus on youth and children (24). On a national level, *Advancing the Mental Health Strategy for Canada,* a report from the Mental Health Commission of Canada, describes additional factors that may increase a one's risk of developing mental health problems (25). Factors identified that may increase risk of mental illness include experiencing racism or poverty, identifying as First Nations, Inuit, or Metis, children whose parents have a mental illness or substance abuse problems, and those experiencing family violence (25).

1.4 Meal regularity and mental health

The term 'meal regularity' refers to *when* and *how* people eat. Meal regularity is a different concept than diet quality, which refers to *what* people eat. Although meal regularity and diet quality are associated, they are distinct concepts related to overall nutritional status (26). Meal regularity can be defined as meal skipping (for example, breakfast skipping) and eating environment (eating in front of the television, eating alone, and eating family meals). Previous research suggests that meal regularity is a factor associated with childhood mental health (27–30), as described in the following sections.

1.4.1 Meal skipping and mental health

Previous studies have shown that meal skipping is a common practice among children and adolescents (31–33). The prevalence of breakfast skipping among children and adolescents is reported to be between 10-30 percent (31–33). Meal skipping may have adverse mental health consequences at a population level if skipping meals and mental health are associated. In children and adolescents, skipping breakfast is associated with numerous adverse outcomes such as decreased cognition, physical activity, and nutrient intake and an increased BMI (31,34–36). To date, skipping meals has been associated with the long-term development of several other outcomes in adults, such as hypertension, dyslipidemia, insulin sensitivity, colon cancer, diabetes, and myocardial infarction (37–42).

To the best of our knowledge, there are no systematic reviews investigating meal skipping and mental health of youth, accentuating the need for additional research regarding this association. However, there are two cross-sectional studies investigating this association for middle and high school-aged children in Britain and Korea (28,29). A large (n=10,645) cross-sectional survey in Britain examined the association between irregular eating and mental health of 12-16 year olds (29). In this study, "never eating regular meals" refers to meal skipping (29). Those who never ate regular meals had a greater odds of mental health difficulties as measured by the Strengths and Difficulties Questionnaire, compared to those who always ate regular meals (OR=3.10; 95% CI: 2.24-4.32) (29). Covariates included were junk food consumption, gender, age, ethnicity, living environment, free school meal, special educational needs, smoking, and physical health (29). Findings from a smaller (n=1,413), cross-sectional, community-based study

in Korea examining the association between frequency of meal skipping and stress, depressive mood, and suicidal ideation echoed these results, suggesting adolescents aged 13-18 years who skipped breakfast were at greater risk of reporting depressive mood (OR=1.77; 95% CI: 1.07,2.92) (28). Variables adjusted for in the analysis included age, sex, BMI, smoking, alcohol use, physical activity, SES, and family structure (28). As these studies are both cross-sectional, causation cannot be inferred (28,29). Mental health problems may affect meal regularity, meal regularity may impact mental health, or mechanistic pathways may co-exist and work simultaneously. Possible mechanisms will be discussed in-depth in section 1.6.

1.4.2 Eating environment and mental health

In this study, the term "eating environment" refers to *where* and *with whom* a meal is eaten. The literature regarding eating environment is primarily focused on family meals (eating with other family members) specifically (27,30). No studies were identified that examined the association between eating in front of the television or eating alone and childhood mental health. Frequent family meals may result in decreased opportunity for eating alone or in front of the television. Canadian children in grades six, seven, and eight in the provinces of Ontario and Nova Scotia reported a high frequency of family meals, with 70% of children reporting a high family meal frequency (6-7 days/week) (43). The frequency of family meals decreased as children got older (43). Two systematic reviews examining the relationship between family meals and mental health in youth have been conducted (27,30). These reviews included both cross-

sectional and longitudinal research, suggesting a causal mechanism may exist in the association between meal regularity and mental health (27,30). One review of fourteen studies found that habitual family meals are inversely associated with various mental health problems such as disordered eating, alcohol and substance use, violent behaviour, depressive symptoms, and suicidal thoughts in adolescents (30). Another review including eighteen studies identified a significant inverse association between family meals and depressive symptoms, suicidal ideation, antisocial behavior, and perceived stress (27). Results of these reviews suggest that eating environment may play an important role in mental health for children and youth (27,30).

1.5 Predictors of meal regularity in children

Factors affecting nutrition and eating behaviours are complex. There are numerous factors associated with meal regularity that may impact the relationship between meal regularity and mental health. Predictors of meal regularity for children may include SES, ethnicity, family structure, caretaker's concern regarding child's diet, BMI, sex, physical activity, residence, and diet quality (44,45). Results from a study in the Netherlands suggested that schoolchildren of lower socioeconomic position, as well as those part of an ethnic minority group are at greater risk of skipping meals (44). Another study examining predictors of meal skipping in Korean children found that age, region, family structure, job of caretaker, and caretaker's concern about the child's diet were associated with meal skipping (45). Moreover, previous studies examining meal regularity and mental health have included many of these factors when examining the

relationship between meal regularity and mental health suggesting they may be important to consider (27–30).

1.6 Mechanisms connecting meal regularity to mental health in children

Meal regularity and mental health are likely linked through a complex, bidirectional relationship that exists within the context of socioeconomic, socioenvironmental, and physiological factors (See figure 1.1). Mental health problems may affect meal regularity, meal regularity may impact mental health, or mechanistic pathways may co-exist and work simultaneously. Studies examining the mechanisms between nutrition and mental health in children are limited. However, this field of research is evolving and there are many proposed mechanisms that could explain the link between nutrition and mental health. The following sections provide a description of several potential mechanisms for the association between meal regularity and mental health in children (26,46–53). The specific roles of major nutrients in brain function are outlined in Table 1.1 of Appendix A.

1.6.1 An overview of the potential influence of mental health on meal regularity in children

There are many pathways whereby mental health may affect childhood meal regularity. Children with mental health problems may experience symptoms that may disrupt mealtimes and reduce meal regularity such as trouble concentrating and controlling emotions (54,55). Families experiencing dysfunction or who have children with mental health problems may find that difficulties often arise during mealtimes,

causing stress and disrupting meals (56). Further, as mental health problems often present somatically in children (57), physical ailments such as stomach pains and headaches may reduce a child's appetite or make mealtimes a negative experience. In summary, there is strong potential for mental health problems to affect meal regularity in children. In this study, we propose that a complex, bidirectional relationship exists between meal regularity and mental health in children.

1.6.2 Socioenvironmental factors

Meal regularity and mental health are connected by various socioenvironmental factors. Family meals are important for the mental health of children and youth as they may provide an opportunity for open communication among family members, enhance trust within the family, and allow caregivers an opportunity to identify issues of concern (27). When children eat in front of the television, they may be losing the benefits of family meals. A Canadian study of family meals and mental health problems in 11-15 year olds observed an inverse association between family meal frequency and both internalizing and externalizing symptoms (58). This association was partially mediated (30% and 13% for internalizing and externalizing symptoms, respectively) by family communication (58). These results suggest that family communication plays an important role in the meal regularity and mental health of children (58). However, families with dysfunction or who have children with mental illness may experience stress and difficulties during mealtimes, leading to negative experiences and reduced family meals (56). Exposure to lower family function (less cohesion, structure, and beliefs) may

also facilitate the development of mental health problems in children (59). Lower mental health can cause often manifest somatically in children causing symptoms such as stomach aches, headaches, and reduced appetite (57) which may reduce meal regularity. Lastly, consumption of meals in front of the television is negatively associated with diet quality in children (49,60). As diet quality is associated with mental health in this population, this may be a pathway whereby meal regularity and mental health are linked (46–48,61–65).

1.6.3 Socioeconomic factors

Socioeconomic status (SES) may be another mechanism by which mental health and meal regularity are related. Families of higher SES may have more time, be able to afford more frequent family meals, and may have less overall stress, thus promoting better mental health of children (66). Food insecurity is a function of lower SES (67). In a community-based report from Nova Scotia, food security is defined as "enough affordable, healthy, and culturally appropriate food, produced in socially, economically, and environmentally sustainable ways that promote self-reliance and social justice" (67). Families experiencing food insecurity likely experience added stress and may be more vulnerable to mental health problems (68). In turn, this could negatively impact the experience of family meals and reduce meal regularity. Additionally, those experiencing food insecurity often cannot afford to buy healthy foods, potentially leading to a lower intake of vitamins and minerals (67). This may affect mental health due to the many important functions of vitamins and minerals, as will be described in the following

section. Previous studies have demonstrated the negative effect of food insecurity on childhood mental health (69,70). In a prospective birth cohort study of children aged 1.5-4.5 years, food insecurity was found to predict future hyperactive/inattention symptoms (OR=2.65; 95%CI: 1.16,6.06) after adjusting for confounders (69). This same study examined anxiety/depression as well as aggression in the context of family food insecurity. Results of these associations were not significant after adjustment for the following covariates: sex, immigrant status, family structure, maternal age at child's birth, family income, maternal education, paternal education, prenatal tobacco exposure, maternal and paternal depression score, family functioning score, and negative parenting score (69). Another study examined the association between food insecurity and mental health of adolescents aged 13-17 years (70). In the fully adjusted model, food insecurity was significantly associated with increased odds of any mental disorder (OR=1.1; 95% CI: 1.1,1.2) in the past year as well as mood, anxiety, and behavior and substance use disorders (70).

1.6.4 Physiological factors: Vitamins, minerals, neurotransmitters, and brain proteins

Physiological mechanisms connected to diet quality are important as meal regularity and diet quality are related in several manners. For example, studies have shown that compared to children who eat breakfast, children who skip breakfast may consume lower quality diets, including fewer important nutrients (fibre, folate, iron, calcium) and food groups (fruit, whole grains, dairy) (26). As meal skipping is associated with poorer diet quality in children this may result in lower intake of vitamins and

minerals (26). Vitamins and minerals are important to brain function as they contribute to optimization of neurotransmitters, which affect mood (53). The intakes of various nutrients are associated with mental illness (46,71,72). For example, folate, magnesium, and zinc intakes are inversely related with depressive disorders while Omega-3 intake is inversely correlated with anxiety disorders (46,71,72). Neurological impairment would result from only severe deficits in neurotransmitters; however, subtle changes may occur day-to-day due to diet (53). For example, the release of neurotransmitters is affected by calcium and tryptophan (53). These nutrients act as biological precursors for neurotransmitters critical to mental health such as serotonin (53). Thiamin and pyridoxine are B vitamins that contribute to the creation of neurotransmitters in addition to carbohydrate metabolism, important for healthy blood glucose levels (53). The B vitamins are water soluble, and are therefore sensitive to changes in the diet as they are not stored in the body in large amounts (53). Rigorous studies have demonstrated that composure, mood, and clarity of thought are improved by thiamin supplementation (53). Folate and iron are also involved in the production of serotonin and other neurotransmitters in the brain (53).Younger individuals with developing brains may be affected by high-fat, high-sugar diets (46). This type of diet can affect the signaling molecule, brain-derived neurotrophic factor, which plays an important role in brain development (46). Patients with depression often present with lower levels of this brain protein (46). Conversely, by augmenting brain-derived neurotrophic factor, indicators of depression can ameliorate (46).

1.6.5 Physiological factors: Stress and hormones

There are many forms of stress which may negatively impact the mental health of children. While the previous sections discussed how socioenvironmental and socioeconomic forms of stress are associated with meal regularity and mental health, the physiological effects of hunger may also cause stress and contribute to increased vulnerability to childhood mental health problems (53,73–75). There are many reasons hunger may occur in children, such as food insecurity or family dysfunction. However, the physiological effects of childhood hunger are likely similar regardless of the cause. When someone skips a meal, their body may enter a state of fasting (50). In a state of fasting, blood sugar levels decrease (50). To maintain these levels, the body will rely on other sources to supply energy including glycogen stored in the liver, muscle tissue, or fatty tissue (50). Prolonged periods of fasting can deplete muscle and fatty tissues (50). Blood glucose levels have been shown to affect mood, and glucose is metabolically required for brain functioning (53). When blood glucose concentrations are decreased, a stress response occurs, and stress hormones (cortisol and adrenaline) are released in the body (53). Low blood glucose can cause irritability, difficulty concentrating, and difficulty controlling emotions, all symptoms related to mental health (53,73–75). By consuming regular meals, adequate blood glucose levels can be maintained and stress related to fasting can be minimized (53).

1.6.6 Physiological factors: Inflammation and immune function

People with depression often demonstrate significantly higher levels of inflammation compared to controls, indicating an issue with immune function (46).

Inflammatory markers are also associated with dietary intake (46). Malnourishment, defined as under-nutrition, is associated with immune function (76). A recent systematic review demonstrated an association between malnourishment and the dysfunction of various immune markers in children such as decreased function of the gut-barrier and reduced plasma complement levels (76). Both depression and/or habitual meal skipping may result in chronic under-nutrition and lead to decreased immune function (46,76).

1.7 Research gap

With the exception of family meals (77), studies of the association between meal regularity and mental health in children have primarily focused on diet quality (46–48,61–65) and middle and high school-aged children (28,29,78–80). While preliminary evidence suggests a positive relationship exists between meal regularity and mental health in middle and high school-aged children (28,29,78–80), a gap in knowledge exists about the relationship between meal regularity and mental health in elementary school-aged children. As Sarris and colleagues describe, "there is much to be done to advance this nascent field. There is a clear need to now refine, replicate and scale-up dietary interventions aimed at both preventing and treating common mental disorders" (81).

1.8 Thesis objectives

The purpose of this study is to investigate the following research question: "What are the cross-sectional associations between five aspects of meal regularity (breakfast skipping, lunch skipping, eating in supper in front of the television, eating supper alone, and eating family supper) and two domains of mental health (self-esteem

and mental health-related physician visits) for children in Nova Scotia?”

To answer this research question, we have identified two objectives:

(1) To determine whether a cross-sectional association exists between meal regularity and self-esteem in grade five Nova Scotian children.

(2) To determine whether a cross-sectional association exists between meal regularity and mental health-related physician visits from 1998-2011 in Nova Scotian children.

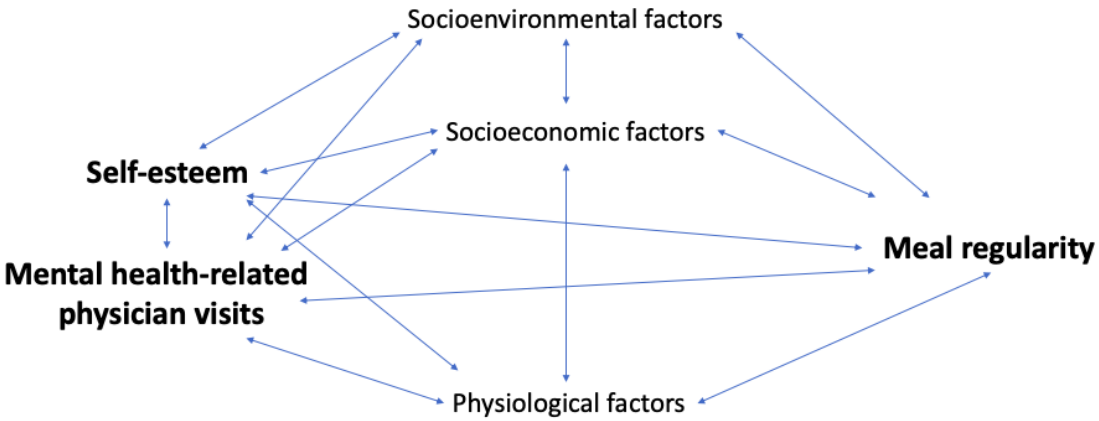

Figure 1.1: Directed Acyclic Graph of the potential mechanistic pathways between self-esteem, mental health-related physician visits, and meal regularity

Chapter II: The association between meal regularity and self-esteem in grade five children

2.0 Abstract

Background: Meal regularity is associated with many aspects of mental health. However, few previous studies have examined whether a relationship exists between meal regularity and self-esteem in children.

Objective: To determine whether an association exists between meal regularity and self-esteem in children.

Methods: In 4,009 grade five students from the 2011 CLASS-II study (Nova Scotia, Canada) meal regularity (breakfast skipping, lunch skipping, family supper, supper in front of the television, and supper alone) was examined in relation to self-esteem. Multilevel mixed effects logistic regression was used to determine the odds ratios (OR) and 95% confidence intervals (CI) predicting lower self-esteem. The analysis was stratified by sex and adjusted for demographics and lifestyle covariates.

Results: Compared to children who ate supper in front of the television or alone either never or less than once/week, children who ate supper in front of the television or alone five or more times/week had greater odds of lower self-esteem (OR= 1.82; 95% CI:1.44, 2.31 and OR= 3.46; 95% CI:1.88,6.38), respectively. Compared to children who ate family supper five or more times/week, children who ate family supper never or less than once/week had greater odds of lower self-esteem (OR: 1.97; 95% CI: 1.54,2.52). Lunch skipping was not significantly associated with lower self-esteem. Breakfast skipping was significantly associated with self-esteem in boys (OR=2.46; 95% CI: 1.14,5.25), but not girls (OR=1.21; 95% CI: 0.62,2.38).

Conclusion: Meal regularity is significantly associated with self-esteem in grade five children. The relationship between eating supper alone and low self-esteem is particularly pronounced.

2.1 Introduction

Childhood mental illness is prevalent in Canada, with an estimated 12.6% of children and youth ages 4-17 affected by a mental illness at any given time (1). The onset of mental illness often occurs in childhood and adolescence, and is a serious population health concern (5,82,83). Self-esteem has been shown to be associated with mental health in children (11,12,23). Poor self-esteem may facilitate the development of mental health problems such as depression, anxiety, eating disorders, violence, aggressive behaviours, and high-risk behaviours (12). A recent prospective study of youth ages 13-18 reported that higher initial self-esteem predicted fewer psychiatric issues including fewer symptoms of anxiety and depression, and attention problems (11). Therefore, it is imperative to identify risk factors as early as possible to reduce the burden of low self-esteem and mental illness on Canadians of all ages (3). Meal regularity may be a factor influencing childhood self-esteem and mental health (27–30,79,84).

The term 'meal regularity' refers to *when* and *how* people eat, and includes meal skipping and the eating environment. Meal regularity is a different concept than diet quality, which refers to *what* people eat. Although meal regularity and diet quality are associated, they are distinct concepts (26). To date, the majority of research connecting nutrition to self-esteem and mental health in children has focused on diet quality, studying the presence or absence of specific foods/nutrients and overall nutrient intake (46–48,61–65), or has focused solely on disordered eating (84–86). The result is a gap in the literature concerning how meal regularity is associated with self-esteem and mental

health in children. There are several socioenvironmental, socioeconomic, and physiological mechanisms that could link meal regularity to self-esteem in children, including the biological and hormonal effects of low blood sugar on a child's mood (53,73,75), and the influence of family function on a child's diet (87). A recent study of family meals demonstrated that even having the television on during family meals is associated with a poorer emotional atmosphere during family mealtimes (88). Meal regularity may be a proxy for the child's home environment and the quality of their parental relationships (88). For example, children who eat alone or in front of the TV likely have weaker parental relationships, less parental supervision and interaction, or may experience more family dysfunction (88).

To the best of our knowledge, no studies to date have tested for an association between family meals and self-esteem in elementary school-aged children. Two previous studies in middle-school and high-school aged participants have investigated family meals and self-esteem (78,79). One study of family meal frequency and adolescent development within 99,462 participants from grades six to twelve across the United States reported significantly higher self-esteem in youth who reported eating 5-7 family meals per week compared to those who reported eating 0-1 family meals per week (79). The only other study of this topic reported no significant association between family meals and self-esteem in n=4,734 American girls and boys aged 11-18 years (78). Previous studies have examined the association between meal skipping and self-esteem; however, all but one have been in the context of disordered eating (84–86). As far as we know, no studies to-date have examined the association between eating supper alone or

eating supper in front of the television and self-esteem. The objective of the present study is to determine whether an association exists between two domains of meal regularity: (1) meal skipping (breakfast and lunch) and (2) eating environment (family supper, eating supper alone, and eating supper in front of the television) and self-esteem in children.

2.2 Methods

2.2.1 Participants & sample size

The present study used survey data from the Children's Lifestyle and School-performance Study (CLASS-II). The CLASS-II survey was completed in 2011 and sampled grade five Nova Scotian children and their parents (89). In Nova Scotia, the majority of students (approximately 97%) attend public schools (90). There were 286 public schools with grade five children at the time of this study, and 269 participated (94.1% participation rate) (90,91). Consent was obtained from parents of children attending participating schools and the completion rate was 67.4 percent (90). The final sample size was n=4,009.

2.2.2 Data collection and study design

Data for CLASS-II were collected in Nova Scotia from February-June 2011 using a population-based, cross-sectional design, and questionnaires (89). Questionnaires included a student survey and food frequency questionnaire completed by students, and a home survey completed by parents/guardians. Consent was obtained by distribution

of a consent form for parents/guardians to complete (89). There were two trained assistants who led students during administration of the surveys and measured the students' growth (89).

2.2.3 Ethics

A submission to the Dalhousie University Research Ethics Board (REB) was accepted on November 22, 2018.

2.2.4 Instruments used

Before use in the CLASS-II study, all surveys were piloted to target populations. Once consent was obtained, a 147 question Canadian-adapted Harvard Youth/Adolescent Food Frequency Questionnaire (YAQ) and a survey were administered to the students (63,89,90). The YAQ has been independently assessed and validated for youth/adolescents (92). Rockett et al investigated the validity of YAQ by examining the correlation of responses to this measure of dietary intake to a gold standard measure of 24-hour recall (92). Although 24-hour recall is not a perfect measure of diet quality, this method has been more extensively studied and found to be mostly representative of dietary intake (92). The use of biochemical methods to measure intake were not feasible due to the large sample size in this study; therefore, 24-hour recall was used as the gold standard measure (92). The Pearson correlation coefficient was 0.54, similar to findings from studies of adult populations (92). Further, comparable mean nutrient intakes were found for YAQ and 24-hour recall methods, supporting the use of the YAQ as an

acceptable measure of dietary intake (92). The student survey consisted of items pertaining to lifestyle factors as well as health and self-esteem (89,90). Most survey questions were adapted from published and validated instruments (90). A home survey was administered to parents, containing questions about socio-demographics, health, and lifestyle (89,90).

2.2.5 Exposure assessment

To assess meal regularity, responses from the YAQ regarding meal skipping (breakfast and lunch) and eating environment (eating supper in front of the television, eating supper alone, and eating family supper) were examined. Skipping breakfast was assessed using the question '*Where do you usually eat breakfast? (At home, at school, don't eat breakfast, other*)'. Skipping lunch was assessed using the question '*Which of the following best describes your lunch on a school day? (Bring a prepared lunch, buy lunch at school, eat lunch at home, don't eat lunch, other)*'. Frequency of eating supper alone was derived from the question '*How many times a week (including weekdays and weekends) do you eat supper alone? (Never/<once, 1-2 times, 3-4 times, 5 or more times)*'. Frequency of eating supper in front of the television was assessed using the question '*How many times each week (including weekdays and weekends) do you usually eat supper in front of the TV?' (Never/<once, 1-2 times, 3-4 times, 5 or more times).* Finally, family meal frequency was derived by the question *'How many times each week (including weekdays and weekends) do you usually eat supper at the table with other people? (Never/<once, 1-2 times, 3-4 times, 5 or more times).*

2.2.6 Outcome assessment

To measure self-esteem, ten items from the CLASS-II student survey (Table 2.1) were combined to create an aggregate outcome variable (93). Taking into account the age of participants, various items from pre-existing instruments were used in the CLASS-II survey to assess self-esteem (93). Specifically, these items were chosen to examine appearance, abilities, emotions, peer acceptance, future hopes and overall life satisfaction (93). Reponses were scored as 1, 2 and 3, with higher score indicating higher self-esteem (93). Scores were then totaled so that the overall score ranged between 10 to 30 (93). The Cronbach Alpha for this composite scale is 0.70, suggesting internal consistency (94).

2.2.7 Statistical analysis

Data were analyzed using multilevel mixed effects logistic regression. Breakfast and lunch skipping variables were binary while eating environment variables were categorical with four levels. The outcome variable of self-esteem was originally measured on a scale from 10-30. However, this variable did not achieve normality after transformation and was therefore categorized into a binary variable, divided at the median value. We categorized self-esteem into a binary variable with the median value as the cut-point for the following reasons: (1) we were unable to determine clinically relevant cut-points from the instrument used for our composite self-esteem variable, (2) the distribution of self-esteem was extremely skewed, (3) for ease of interpretation.

Further, a recent study by Maximova et al using the same CLASS-II data categorized the outcome of self-esteem in this manner (94).

Although the amount of missing data in the sample was low, ranging from 0-10.4% among variables, missing data were analyzed to identify the potential for bias. We compared results from four different specifications of univariate logistic regression to investigate whether results changed depending on specifications used and to determine whether multiple imputation (MI) was necessary: (1) MI and mixed effects models, (2) MI and survey weights, (2) MI, survey weights, and mixed effects models, and (4) mixed effects models and survey weights, but not MI. The use of MI did not impact the results, and the results from all models were very similar. (See Table 2.5 in Appendix C). Therefore, the mixed effects models with survey weights option was selected and list wise deletion was used for missing data.

Covariates, defined a priori, were added to the model simultaneously. Covariates included: physical activity, rurality, food insecurity, stressful life event, parental education, total parental income, obesity, family structure, and diet quality. A composite physical activity variable was created from a subset of questions from the Physical Activity Questionnaire for Children (PAQ-C) (95). Rurality was assessed using postal code from the CLASS-II home survey and classified as rural/urban through postal code second digit identification (96). Food insecurity was assessed by the home survey item: *'The food we bought just didn't last and we didn't have the money to get more (Often true, sometimes true, never true, prefer not to answer)'.* Stressful life event was assessed by the home survey item '*Has your grade 5 child experienced any event or situation in the*

past year that has caused him or her a great amount of worry or unhappiness? (Yes, no, unsure or prefer not to answer)'. Parental education and household income were used as measures of socioeconomic status. Sex of the child was reported by parents as either male or female. Body Mass Index (BMI) was measured by first obtaining the children's height (no shoes to the closest 0.1 cm) and weight (on a calibrated scale to the closest 0.1 kg) during the data collection process (89,91). Obesity was defined by the World Health Organization (WHO), which provides specific BMI cut-off points for age and sex (97). Lastly, diet quality was measured by responses to the YAQ, a validated measure of dietary intake for older children/adolescents, as discussed above. Based on responses to the YAQ, a diet quality score (0-100, 100= highest quality diet) was assigned as assessed by the Diet Quality Index (98).

Mixed effects modelling was used to account for the possible effects of clustering within each school. Survey weights were used to ensure the results were applicable to the population. Models were stratified by sex, as mental health outcomes are often distinct for boys and girls (99). A significance level of p=0.05 was used for all analyses. Analyses were conducted using Stata 15.0.

2.3 Results

2.3.1 Baseline characteristics

A total of 4,009 participants were included in the analysis. Baseline characteristics were examined by calculating the frequency and proportion for each variable (see Table 2.2). Sex was evenly distributed in the sample, and 65.4% of girls and

64.8% of boys reported living in an urban centre. The median value for self-esteem (measured on a scale from 10-30) was 26. More than half of girls and boys (55.4% and 60.9%, respectively) reported having self-esteem lower than the median value. The vast majority of girls and boys reported eating breakfast (96.2% and 97.4%, respectively) and lunch (99.1 and 99.0, respectively). Most girls and boys reported eating supper alone as '*never or less than once a week*', and only 2.4% of girls and 3.1% of boys reporting eating supper alone five or more times a week. Many girls and boys (59.6% and 57.8%, respectively) reported eating supper with their family five or more times a week, while eating supper in front of the television was more evenly distributed across response categories.

2.3.2 Univariate analysis

Compared to girls and boys who ate supper with their families five or more times a week, girls and boys who reported eating supper with their families never or less than once a week had greater odds of lower self-esteem (OR=2.02; 95% CI: 1.39,2.93 and OR=2.33; 95% CI: 1.73,3.14, respectively). Compared to girls and boys who reported eating supper in front of the television never or less than once a week, girls and boys who reported eating supper in front of the television five or more times a week had greater odds of lower self-esteem (OR=2.15; 95% CI: 1.59,2.90 and OR=2.08; 95% CI: 1.53,2.83 respectively). The univariate relationship between eating supper alone and self-esteem was 5.24 (95% CI: 2.26,12.16) among girls and 2.98 (95% CI: 1.57,5.66) among boys. Skipping breakfast was significantly associated with lower self-esteem

among boys at the univariate level (OR=2.19; 95% CI: 1.06,4.55), but not among girls (OR=1.76; 95% CI: 0.97,3.22). The univariate relationship between lunch skipping and self-esteem was 2.27 (95% CI: 0.59,8.63) among girls and 2.78 (95% CI: 1.00,7.76) among boys.

2.3.3 Multivariable analysis

Both girls and boys who reported eating supper in front of the television five or more times a week had greater odds of lower self-esteem compared to girls and boys who ate front of the television never or less than once a week (OR=1.80; 95% CI: 1.30,2.50 and OR=1.76; 95% CI: 1.27,2.44, respectively). Girls and boys who reported eating supper alone five or more times a week had greater odds of lower self-esteem compared to girls and boys who reported eating supper alone never or less than once a week (OR=5.11; 95% CI: 1.89,13.86 and OR=2.80; 95% CI: 1.35,5.81, respectively). Girls and boys who reported eating family supper never or less than once a week had greater odds of lower self-esteem compared to girls and boys who reported eating family supper five or more times a week (OR=1.78; 95% CI: 1.21,2.61 and OR=2.03; 95% CI: 1.48,2.79, respectively). Meal skipping variables (both breakfast and lunch) were not significant in the overall adjusted analysis. However, a significant association was observed for the association between breakfast skipping and lower self-esteem in boys (OR=2.46; 95% CI: 1.14,5.25), but not girls (OR=1.21; 95% CI: 0.62,2.38).

2.4 Discussion

In our multivariable-adjusted analysis, we observed strong, significant associations between eating environment (eating family meals, eating alone, and eating in front of the television) and self-esteem in grade five children. Results were most pronounced for the relationship between eating supper alone and odds of low self-esteem, with children who reported eating supper alone five or more times a week having close to three and a half greater odds of lower self-esteem as compared to those who reported eating supper alone never or less than once a week. Results for breakfast and lunch skipping were not significant overall; however, a strong, significant association between breakfast skipping and low self-esteem was observed in boys but not in girls.

To the best of our knowledge, the present study is the first to assess the relationship between meal regularity and self-esteem in elementary school age children. However, the present study's findings are in line with the results of previous research of meal regularity and mental health (77). In a recent study of 1,492 children participating in the Quebec Longitudinal Study of Child Development, the quality of the family meal environment at age 6 was longitudinally associated with lower amounts of oppositional behaviour, reactive aggression, physical aggression, and nonaggressive delinquency in children at age 10 after adjustment for sex, temperament problems and cognitive abilities, BMI, family configuration and functioning, maternal education, depression, and BMI (77).

In terms of self-esteem, in of a study in 99,462 American youth from grade six to twelve, Fulkerson et al reported that compared to participants who ate 0-1 family meals per week, participants who ate family meals 5-7 times per week had a greater odds of

better self-esteem (multivariable-adjusted OR=1.40, 95% CI: 1.27,1.49) (79). The only other study of this topic by Eisenberg et al observed no significant association between family meals and self-esteem in 4,734 American girls and boys aged 11-18 years (78). This discrepancy may be due to the differences in family meal comparison groups used in these studies. In the first and larger study, Fulkerson et al compared self-esteem among children reporting 0-1 family meals per week with children reporting 5-7 family meals per week (79). In contrast, Eisenberg et al examined the outcome of self-esteem among children using a one-unit difference in family meal frequency, which may not have been a large enough difference to observe a significant effect (78). The present study, which used comparison groups akin to Fulkerson et al, observed results that were similar to Fulkerson et al in direction, strength, and significance.

To the best of our knowledge, only one previous study has examined meal skipping and self-esteem outside of the context of disordered eating (80). This study, conducted within 692 Korean children ages 13-15 by Park et al, reported no significant correlation between the frequency of eating breakfast and self-esteem (80). Similarly, our findings for the overall association between lunch skipping and self-esteem were not significant in the present study. As only 0.98% of students reported skipping lunch in our sample, this finding is not surprising. After stratification by sex, we observed a significant association between breakfast skipping and lower self-esteem in boys, but not in girls. Results for the correlation between breakfast and self-esteem in the study by Park et al were not stratified by sex (80). The relationship between family meals, another aspect of meal regularity, and a variety of factors associated with self-esteem have also differed

by sex in past studies (27). Further, previous studies have demonstrated that mental health patterns are often distinct for children, differing by sex (99). Skeer & Ballard hypothesize that boys and girls are affected differently by their family environment, with girls being more vulnerable to the effects of family instability/disconnect (27).

Family meals and childhood self-esteem are likely to be linked through a complex, bidirectional relationship situated within the context of socioenvironmental, socioeconomic, and physiological factors. Children who have better self-esteem may have better family function and better parental relationships and thus be more likely to eat more family meals (88). Family meals may also facilitate better self-esteem in children through multiple social and physiological mechanisms that may occur simultaneously. Family meals may foster better self-esteem in youth through indicators of family function such as increased family communication, cohesion, relationship building, and enhanced trust (27,100). A longitudinal study of 2,379 children ages 9-19 in the United States found that greater frequency of family meals over the first three years of the study facilitated better coping skills and family cohesion after 7-8 years. Children who eat alone or in front of the television may miss out on the potential benefits of family meals. Eating alone or in front of the television may also contribute to feelings of loneliness, which could influence self-esteem (101,102). Other factors associated with family meals that may also affect a child's self-esteem and could be influencing the observed association are academic performance (78), diet quality (49,60,103), and weight status (103). Although the present study included diet quality and weight status in the analysis, academic performance was not examined, and we cannot rule out that

our findings were due to confounding by an unmeasured variable. However, there are plausible social and physiological mechanisms where meal regularity may influence self-esteem. Past studies have certainly demonstrated an association between family meals and numerous factors associated with mental health in youth including depressive symptoms (78,103) and disordered eating (104,105).

Findings from the present study were not always consistent between boys and girls, suggesting that sex and/or gender may play a role in the association between meal regularity and self-esteem. A Norwegian study with 7,343 participants ages 15-16 investigating breakfast skipping in relation to both mental distress and academic performance identified stronger associations for boys compared to girls (30). This may represent a pathway whereby breakfast skipping affects self-esteem more strongly for boys compared to girls through associations with mental distress and academic performance. Other unmeasured social factors (such as potential sex differences related to the impact of family cohesion on mental health) and/or unmeasured biological factors (such as potential sex differences in metabolic effects of fasting on mental health) could also account for the differences observed by sex. Further research is necessary to elucidate mechanisms for sex differences in the associations between meal regularity and self-esteem.

2.5 Strengths and limitations

This study is novel for the contribution of knowledge of the association between meal regularity and self-esteem in grade five children. This study had a robust sample

size and collected data using validated assessment tools and methods (89,91). Further, many important factors were incorporated into the analysis including socioeconomic status, food insecurity, diet quality, and physical activity. Data were analyzed overall as well as by sex, facilitating the ability to observe the association between meal regularity and self-esteem in boys and girls separately.

There are several limitations of the present research to acknowledge. Given the sample size (4,009) and the low proportion of participants who reported two of the exposures, skipping breakfast (3.2%) and skipping lunch (0.98%), this study is underpowered to detect an association between these exposures with self-esteem employing a cross-sectional study design. As this study is cross-sectional, we cannot infer a causal relationship between meal regularity and self-esteem. The use of non-validated composite scores to measure the outcome of self-esteem and the covariate physical activity are other limitations of this study. Although items from the CLASS-II survey were developed from validated tools, all items from the validated tools were not used; therefore, we cannot determine the resulting validity. For the outcome of self-esteem, categorization into a binary variable caused the loss of information regarding whether a dose-response relationship exists for the association with meal regularity. Additionally, as the median value for self-esteem was quite high (26 on a scale from 10-30), we are likely including participants with healthy self-esteem in the 'lower self-esteem' category which may reduce the magnitude of any observed associations with meal regularity and bias results towards the null. Future studies of self-esteem should use validated instruments with clinically relevant cut-points to measure self-esteem. If

self-esteem was categorized into levels based on instruments that indicated abnormal or unhealthy self-esteem, this may produce more meaningful results for clinicians and policy-makers. Different methods of measuring self-esteem in children are described by Hosogi et al. (107). The use of a binary variable to report the child's sex which does not capture intersex children, no variable to capture gender, and lack of information about academic performance, parental mental health, and family function are other limitations of this research. Further, meal regularity, as it is defined and captured by this study, is not distinguishable from social functioning/appetite, limiting our ability to make any conclusions about mechanisms. The present study relied heavily on retrospective and self-reported data in terms of the food frequency questionnaire administered to students. This may introduce recall bias, which could over or underestimate the true value. Although the surveys were anonymous, due to the personal nature of the survey questions, social desirability bias may have differentially influenced the results. For example, those with lower incomes, less physical activity, poorer nutrition, and worse mental health may have altered their responses to be more socially desirable, biasing the results towards the null. The overall response rate for the CLASS-II study was 67.4 percent, therefore non-response bias is another limitation (91). Those who did not complete the survey may have been systematically different than those who did, introducing bias to the results. For example, participants who were in poor health and not present on survey day would not have had the opportunity to complete the survey. This would bias results towards the null. Only public schools took part in the study, which may have limited the external validity of the results by excluding students

attending private schools or those who are home-schooled; however, risk of bias would likely be low due to the high proportion of public school attendance.

2.6 Future directions and implications

This study provides novel information about the relationship between meal regularity and self-esteem in grade five children. Replication in additional studies, especially those with longitudinal designs, is necessary to confirm directions of the association, identify a causal relationship, and explore potential mechanisms of the association between meal regularity and self-esteem. However, regardless of whether a causal relationship exists, because the relationship between meal regularity and self-esteem is likely bidirectional and complex, policies that address both meal regularity and mental health problems together are likely optimal for promoting both meal regularity and mental health of children. The association between meal regularity and mental health exists within the context of socioenvironmental, socioeconomic, and physiological factors; therefore, multipronged strategies that address modifiable mediating factors as well as mental health and meal regularity are likely to be most beneficial. Strategies may include school-based interventions such as school breakfast programs and eating together programs and community-based interventions such as mental health programs where meals are shared together. Interdisciplinary intervention programs for families of children with mental health problems that incorporate aspects of both meal regularity and mental health may be helpful for increasing family function and ensuring children are well-nourished.

2.7 Conclusion

In summary, we conducted the first study of meal regularity and self-esteem among a large sample of elementary-school aged children and found a significant association between meal regularity (family supper, eating supper alone, eating supper in front of the television, and breakfast skipping) and self-esteem. Our findings provide novel evidence for the potential role of meal regularity in childhood self-esteem and which, if replicated, may represent a target of intervention used to support both childhood meal regularity and self-esteem.

Table 2.1: Self-esteem outcome variables

Variable	Question on Student Survey
Child's future looks good	My future looks good to me (never or almost never, sometimes, often or almost always)
Child likes the way they look	I like the way I look (never or almost never, sometimes, often or almost always)
Child likes themselves	I like myself (never or almost never, sometimes, often or almost always)
Child feels like they do not have friends	I feel like I do not have any friends (never or almost never, sometimes, often or almost always)
Child feels unhappy/sad	I feel unhappy or sad (never or almost never, sometimes, often or almost always)
Child worries a lot	I worry a lot (never or almost never, sometimes, often or almost always)
Child is in trouble	I am in trouble with my teachers (never or almost never, sometimes, often or almost always)
Child has trouble paying attention	I have trouble paying attention (never or almost never, sometimes, often or almost always)
Child has trouble enjoying themselves	I have trouble enjoying myself (never or almost never, sometimes, often or almost always)

Table 2.2: Participant characteristics of grade five children overall and by sex from the 2011 Children's Lifestyle and School-performance Study (CLASS-II) in Nova Scotia, Canada

Variable	**Overall** Frequency (%)	**Girls** Frequency (%)	**Boys** Frequency (%)
Sex	4,009	2008 (50.93)	1935 (49.07)
Family Income N=3886			
<$20,000/year	248 (6.38)	116 (5.96)	123 (6.54)
$20-40,000/year	541 (13.92)	284 (14.96)	249 (13.24)
$40-60,000/year	568 (14.62)	292 (15.01)	269 (14.30)
>60,000/year (REF[A])	1920 (49.41)	949 (48.79)	944 (50.19)
Prefer not to answer	609 (15.67)	304 (15.63)	296 (15.74)
Parental education N=3891			
Secondary school or lower	703 (18.07)	365 (18.75)	324 (17.2)
Community college/technical school	1545 (39.71)	754 (38.73)	766 (40.66)
University	1021 (26.24)	497 (25.53)	507 (26.91)
Graduate university (REF)	529 (13.59)	277 (14.23)	249 (13.22)
Prefer not to answer	93 (2.39)	54 (2.77)	38 (2.02)
Rurality N=4009			
Rural	1411 (35.20)	695 (34.61)	682 (35.25)
Urban (REF)	2598 (64.80)	1313 (65.39)	1253 (64.75)
Family Structure N=3899			
2 members	141 (3.62)	65 (3.33)	72 (3.82)
3 members	670 (17.18)	337 (17.25)	323 (17.14)
4 members (REF)	1758 (45.09)	891 (45.60)	845 (44.83)
5 members	879 (22.54)	430 (22.01)	437 (23.18)
>5 members	451 (11.57)	231 (11.82)	208 (11.03)
Food insecurity N=3903			
Often	144 (3.69)	68 (3.48)	71 (3.76)
Sometimes	517 (13.25)	271 (13.87)	234 (12.39)
Never (REF)	3188 (81.68)	1586 (81.17)	1559 (82.53)
Prefer not to answer	54 (1.38)	29 (1.48)	25 (1.32)
Physical activity score N=4009			
<= median score	2004 (49.99)	1080 (53.78)	858 (44.34)
>median score (REF)	2005 (50.01)	928 (46.22)	1077 (55.66)

Table 2.2: Participant characteristics of grade five children overall and by sex from the 2011 Children's Lifestyle and School-performance Study (CLASS-II) in Nova Scotia, Canada

Variable	**Overall** Frequency (%)	**Girls** Frequency (%)	**Boys** Frequency (%)
Obesity N=3591			
No obesity (REF)	2894 (80.59)	1527 (84.27)	1367 (76.84)
Obesity	697 (19.41)	285 (15.73)	412 (23.16)
Diet Quality Index (DQI) score N=3793			
<= median score	1898 (50.04)	946 (48.91)	952 (51.21)
>median score (REF)	1895 (49.96)	988 (51.09)	907 (48.79)
Stressful life event N=3901			
Yes	1164 (29.84)	611 (31.25)	537 (28.47)
No (REF)	2604 (66.75)	1278 (65.37)	1283 (68.03)
Prefer not to answer	133 (3.41)	66 (3.38)	66 (3.50)
Self-esteem score N=3675			
>= median score (REF)	1539 (41.88)	837 (44.57)	702 (39.07)
<median score	2136 (58.12)	1041 (55.43)	1095 (60.93)
Supper with family N=3760			
Never-<1/week	457 (12.15)	203 (10.59)	254 (13.78)
1-2 times/week	523 (13.91)	256 (13.35)	267 (14.49)
3-4 times/week	571 (15.19)	315 (16.43)	256 (13.89)
5+ times/week (REF)	2209 (58.75)	1143 (59.62)	1066 (57.84)
Supper alone N=3776			
Never-<1/week (REF)	2956 (78.28)	1552 (80.62)	1404 (75.85)
1-2 times/week	601 (15.92)	266 (13.82)	355 (18.10)
3-4 times/week	114 (3.02)	60 (3.12)	54 (2.92)
5+ times/week	105 (2.78)	47 (2.44)	58 (3.13)
Supper in front of the television N=3764			
Never-<1/week (REF)	1509 (40.09)	785 (40.80)	724 (39.35)
1-2 times/week	1183 (31.43)	620 (32.22)	563 (30.60)
3-4 times/week	479 (12.73)	248 (12.89)	231 (12.55)
5+ times/week	593 (15.75)	271 (14.09)	322 (17.50)
Breakfast			

Table 2.2: Participant characteristics of grade five children overall and by sex from the 2011 Children's Lifestyle and School-performance Study (CLASS-II) in Nova Scotia, Canada

Variable	**Overall** Frequency (%)	**Girls** Frequency (%)	**Boys** Frequency (%)
N=3781			
Eats breakfast at home/school, or other (REF)	3659 (96.77)	1851 (96.16)	1808 (97.41)
Does not eat breakfast	122 (3.23)	74 (3.84)	48 (2.59)
Lunch			
N=3793			
Eats lunch (REF)	3756 (99.02)	1916 (99.07)	1840 (98.98)
Does not eat lunch	37 (0.98)	18 (0.93)	19 (1.02)

A. Ref is the reference group.

Table 2.3: Univariate mixed effects logistic regression analysis predicting the odds of lower self-esteem[A] a by sex and overall for grade five children of the 2011 Children's Lifestyle and School-performance Study (CLASS-II) in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Variable	%	OR	95%CI	p	OR	95%CI	p	OR	95% CI	p
Supper with family										
N=3760										
Never-<1 /week	12.15	2.22	1.76,2.80	<0.001	2.02	1.39,2.93	<0.001	2.33	1.73,3.14	<0.001
1-2 times/week	13.91	2.30	1.74,2.76	<0.001	1.99	1.42,2.79	<0.001	2.43	1.84,3.22	<0.001
3-4 times/week	15.19	1.30	1.08,1.58	0.006	1.04	0.80,1.36	0.76	1.75	1.29,2.38	<0.001
5+ times/week	58.75	1.00			1.00			1.00		
Supper alone										
N=3776										
Never-<1 /week	78.28	1.00			1.00			1.00		
1-2 times/week	15.92	1.86	1.52,2.27	<0.001	1.70	1.30,2.23	<0.001	1.93	1.45,2.58	<0.001
3-4 times/week	3.02	2.01	1.24,3.25	0.005	2.09	1.18,3.70	0.011	2.08	1.04,4.18	0.039
5+ times/week	2.78	3.84	2.29,6.45	<0.001	5.24	2.26,12.16	<0.001	2.98	1.57,5.66	0.001
Supper in front of the tv										
N=3764										
Never-<1 /week	40.09	1.00			1.00			1.00		

Table 2.3: Univariate mixed effects logistic regression analysis predicting the odds of lower self-esteem[A] a by sex and overall for grade five children of the 2011 Children's Lifestyle and School-performance Study (CLASS-II) in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Variable	%	OR	95%CI	p	OR	95%CI	p	OR	95% CI	p
1-2 times/week	31.43	1.28	1.09,1.50	0.002	1.21	0.97,1.51	0.099	1.39	1.10,1.74	0.005
3-4 times/week	12.73	1.74	1.39,2.18	<0.001	1.56	1.12,2.17	0.008	1.99	1.42,2.77	<0.001
5+ times/week	15.75	2.15	1.70,2.73	<0.001	2.15	1.59,2.90	<0.001	2.08	1.53,2.83	<0.001
Breakfast										
N=3781										
Eats breakfast at home/ school, or other	96.77	1.00			1.00			1.00		
Does not eat breakfast	3.23	1.84	1.15,2.94	0.011	1.76	0.97,3.22	0.065	2.19	1.06,4.55	0.035
Lunch										
N=4009										
Eats lunch	99.02	1.00			1.00					
Does not eat lunch	0.98	2.45	0.97,6.19	0.059	2.27	0.59,8.63	0.23	2.78	1.00,7.76	0.050
Family income										
N=3886										
<$20,000/year	6.38	2.27	1.60,3.23	<0.001	2.79	1.69,4.63	<0.001	1.91	1.24,2.93	0.003
$20-40,000/year	13.92	2.06	1.65,2.57	<0.001	2.23	1.61,3.09	<0.001	1.92	1.35,2.74	<0.001
$40-60,000/year	14.62	1.37	1.13,1.66	0.002	1.46	1.09,1.97	0.012	1.32	0.97,1.79	0.076

Table 2.3: Univariate mixed effects logistic regression analysis predicting the odds of lower self-esteem[A] a by sex and overall for grade five children of the 2011 Children's Lifestyle and School-performance Study (CLASS-II) in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Variable	%	OR	95%CI	p	OR	95%CI	p	OR	95% CI	p
>$60,000/year	49.41	1.00			1.00			1.00		
Prefer not to answer	15.67	1.21	0.99,1.47	0.059	1.07	0.80,1.43	0.66	1.39	1.06,1.83	0.017
Parental education N=3891										
Secondary school or lower	18.07	1.66	1.26,2.19	<0.001	1.79	1.26,2.53	0.001	1.62	1.08,2.41	0.018
Community college/ technical school	39.71	1.35	1.07,1.69	0.010	1.14	0.84,1.55	0.41	1.64	1.21,2.24	0.002
University	26.24	1.05	0.83,1.33	0.694	1.03	0.76,1.40	0.84	1.08	0.77,1.51	0.66
Graduate university	13.59	1.00			1.00			1.00		
Prefer not to answer	2.39	1.70	1.05,2.76	0.031	1.72	0.91,3.24	0.096	1.78	0.88,3.61	0.11
Stressful life event N=3901										
Yes	29.84	1.56	1.32,1.84	<0.001	1.64	1.31,2.04	<0.001	1.51	1.20,1.90	<0.001
No	66.75	1.00			1.00			1.00		
Prefer not to answer	3.41	1.97	1.32,2.93	0.001	2.60	1.29,5.26	0.008	1.46	0.84,2.56	0.182

Table 2.3: Univariate mixed effects logistic regression analysis predicting the odds of lower self-esteem[A] a by sex and overall for grade five children of the 2011 Children's Lifestyle and School-performance Study (CLASS-II) in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Variable	%	OR	95%CI	p	OR	95%CI	p	OR	95% CI	p
Obesity N=3591										
No obesity	80.59	1.00			1.00			1.00		
Obesity	19.41	1.49	1.24,1.79	<0.001	1.42	1.08,1.88	0.013	1.48	1.18,1.86	0.001
Diet Quality Index (DQI) score N=3793										
<= median score	50.04	1.37	1.19,1.57	<0.001	1.31	1.09,1.57	0.004	1.43	1.16,1.76	0.001
>median score	49.96	1.00			1.00					
Physical activity score N=4009										
<= median score	49.99	1.89	1.62,2.21	<0.001	1.69	1.38,2.08	<0.001	2.31	1.84,2.88	<0.001
>median score	50.01	1.00			1.00			1.00		
Rurality N=4009										
Rural	35.20	1.52	1.27,1.81	<0.001	1.60	1.24,2.06	<0.001	1.47	1.18,1.82	0.001
Urban	64.80	1.00			1.00			1.00		
Family structure N=3899										
2 members	3.62	1.35	0.92,1.98	0.12	1.17	0.72,1.90	0.52	1.54	0.83,2.86	0.17

Table 2.3: Univariate mixed effects logistic regression analysis predicting the odds of lower self-esteem[A] a by sex and overall for grade five children of the 2011 Children's Lifestyle and School-performance Study (CLASS-II) in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Variable	%	OR	95%CI	p	OR	95%CI	p	OR	95% CI	p
3 members	17.18	1.38	1.12,1.69	0.002	1.46	1.11,1.91	0.007	1.31	0.96,1.78	0.089
4 members	45.09	1.00			1.00			1.00		
5 members	22.54	1.13	0.92,1.40	0.243	1.15	0.87,1.50	0.33	1.12	0.84,1.49	0.44
>5 members	11.57	1.23	0.97,1.56	0.086	1.07	0.76,1.49	0.701	1.48	1.06,2.06	0.022
Food insecurity N=3903										
Often	3.69	2.18	1.42,3.35	<0.001	2.15	1.24,3.72	0.006	2.43	1.29,4.57	0.006
Sometimes	13.25	1.63	1.32,2.03	<0.001	1.81	1.34,2.44	<0.001	1.49	1.07,2.07	0.020
Never	81.68	1.00			1.00			1.00		
Prefer not to answer	1.38	1.09	0.54,2.18	0.809	1.06	0.42,2.65	0.90	1.19	0.41,3.47	0.74

A. Self-esteem originally measured as a score from 10-30. Self-esteem was categorized into a binary outcome by dividing self-esteem score at the median value (26).

Table 2.4: Multivariable mixed effects logistic regression analysis[A] predicting the odds of lower self-esteem[B] by sex and overall for grade five children of the 2011 Children's Lifestyle & School performance Study (CLASS-II) in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Exposure	%	OR	95%CI	p	OR	95%CI	p	OR	95% CI	p
Supper with family										
n=3760										
Never-<1 /week	12.15	1.97	1.54,2.52	<0.001	1.78	1.21,2.61	0.003	2.03	1.48,2.79	<0.001
1-2 times/week	13.91	1.97	1.55,2.50	<0.001	1.78	1.23,2.58	0.002	2.12	1.57,2.87	<0.001
3-4 times/week	15.19	1.19	0.96,1.48	0.11	0.95	0.71,1.27	0.73	1.63	1.16,2.28	0.005
5+ times/week	58.75	1.00			1.00			1.00		
Supper alone										
n=3776										
Never-<1 /week	78.28	1.00			1.00			1.00		
1-2 times/week	15.92	1.76	1.42,2.19	<0.001	1.52	1.13,2.05	0.005	1.89	1.38,2.59	<0.001
3-4 times/week	3.02	1.82	1.10,3.02	0.020	1.91	1.03,3.56	0.041	1.91	0.96,3.78	0.065
5+ times/week	2.78	3.46	1.88,6.38	<0.001	5.11	1.89,13.86	0.001	2.80	1.35,5.81	0.0060
Supper in front of the tv										
n=3764										
Never-<1 /week	40.09	1.00			1.00			1.00		
1-2 times/week	31.43	1.22	1.03,1.45	0.022	1.16	0.90,1.51	0.26	1.29	1.01,1.64	0.040
3-4 times/week	12.73	1.60	1.26,2.04	<0.001	1.29	0.88,1.84	0.20	2.02	1.40,2.91	<0.001
5+ times/week	15.75	1.82	1.44,2.31	<0.001	1.80	1.30,2.50	<0.001	1.76	1.27,2.44	0.001
Breakfast										

Table 2.4: Multivariable mixed effects logistic regression analysis[A] predicting the odds of lower self-esteem[B] by sex and overall for grade five children of the 2011 Children's Lifestyle & School performance Study (CLASS-II) in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Exposure	%	OR	95%CI	p	OR	95%CI	p	OR	95% CI	p
n=3781										
Eats breakfast at home/ school, or other	96.77	1.00			1.00			1.00		
Does not eat breakfast	3.23	1.52	0.91,2.52	0.11	1.21	0.62,2.38	0.58	2.46	1.14,5.25	0.021
Lunch										
n=4009										
Eats lunch	99.02	1.00			1.00					
Does not eat lunch	0.98	2.14	0.82,5.57	0.12	1.84	0.49,6.89	0.37	2.99	0.87,10.26	0.082

A. Model adjusted for rurality, family structure, food insecurity, stressful life event, physical activity questionnaire score, Diet Quality Index score, obesity, highest parental education, and family income
B. Self-esteem originally measured as a score from 10-30. Self-esteem was categorized into a binary outcome by dividing self-esteem score at the median value (26).

Chapter III: The association between meal regularity and mental health-related physician visits in Nova Scotian children

3.0 Abstract

Background: Meal regularity is associated with many self-reported mental health outcomes. However, no previous studies have examined whether an association exists between meal regularity and mental health-related physician visits in children.

Objective: To determine whether an association exists between meal regularity and mental health-related physician visits in children.

Methods: Meal regularity data from 3,907 grade five students in the 2011 Children's Lifestyle and School-performance Study (CLASS-II) (Nova Scotia, Canada) were linked to physician billing data from Health Data Nova Scotia to determine number of mental health-related physician visits per child from 1998-2011. Zero-inflated Poisson regression was used to determine the incidence rate ratios (IRR) and 95% confidence intervals (CI) predicting mental health-related physician visits and controlling for demographics and lifestyle covariates.

Results: Compared to girls who ate lunch, girls who reported skipping lunch had a significantly increased risk of mental health-related physician visits (IRR=2.71; 95% CI:1.21,6.09). Compared to boys who ate supper in front of the television never or less than once/week, boys who ate in front of the television five or more times/week had a significantly increased risk of mental health-related physician visits (IRR=1.66; 95% CI:1.24,2.21). Eating supper alone, eating family supper, and skipping breakfast were not significantly associated with mental health-related physician visits.

Conclusion: Skipping lunch is positively associated with mental health-related physician visits in girls. Eating in front of the television is significantly associated with mental health-related physician visits in boys.

3.1 Introduction

Mental illness affects an estimated 12.6% of children and youth in Canada, with considerable costs to their quality of life and the healthcare system (1). Longitudinal research in adults with mental illness suggests that 50-75% of mental disorders begin during childhood or adolescence (1,2). As a considerable portion of mental illness develops before adulthood, it is critical to address these health issues as early as possible to reduce impacts on both an individual and societal level (1–3). The costs of mental illness to individuals include self-stigma, socio-economic exclusion, and social isolation (7–9). In children and youth, mental illness can affect development and disrupt education (10). The economic burden of mental illness in Canada is estimated to be approximately 50 billion dollars annually (5).

Meal regularity is an aspect of overall nutritional status defined as *when* and *how* people eat and encompasses meal skipping and eating environment. Although related, diet quality is a different aspect of overall nutritional status which refers to *what* people eat. In previous studies of the association between nutrition and mental health, the focus has been on diet quality (46–48,61–65). Other than family meals, previous studies of meal regularity and mental health have primarily focused on middle and high school-aged children (28,29,78–80). The result is a gap in knowledge of the association between meal regularity and mental health in elementary school aged children.

To the best of our knowledge, only two studies investigating the association between meal skipping and mental health in youth have been conducted (28,29). A large study of British youth ages 12-16 years observed that those who reported always

skipping meals had a greater odds of mental health difficulties compared to those who never skipped meals (29). Similarly, findings from a smaller community-based study in Korea suggested that adolescents aged 13-18 years who skipped breakfast were at greater risk of reporting depressive mood (28).

To the best of our knowledge, no previous studies have examined the association between eating in front of the television or eating alone and childhood mental health. Regular family meals may result in decreased opportunity for eating alone or in front of the television. Two systematic reviews examining the relationship between family meals and mental health in youth have reported that habitual family meals are inversely associated with various mental health problems such as disordered eating, alcohol and substance use, violent behaviour, depressive symptoms, antisocial behavior, perceived stress, and suicidal thoughts (27,30) suggesting that family meals may be a protective factor for youth's mental health.

Mental health service use is a term used to describe interactions with the healthcare system such as physician visits, hospital admissions, and ED visits (18). These interactions are recorded and information is stored in administrative health databases. Trends observed over time suggest that mental health service use, including visits to the ED related to mental health/addictions, psychiatric hospitalizations, and outpatient mental health-related physician visits, is increasing in Canada among 10-24 year olds (19). Similarly, a 2015 CIHI report demonstrated that among young people ages 5-24 with a mental disorder, between 2006-2007 and 2013-2014, mental health-related ED visits increased by 45% and hospitalizations for mental health disorders increased by

37% relative to stable rates for non-mental health reasons (20). Data for ED visits in this report are from Alberta and Ontario only (20).

Current studies examining the relationship between meal regularity and mental health focus on middle and high school aged populations have used self-reported mental health data (27–30). To the best of our knowledge, no previous studies have examined the association between meal regularity (meal skipping and eating environment) and mental health-related physician visits (a component of mental health service use) in children. The objective of this study is to determine whether a cross-sectional association exists between meal regularity and all mental health-related physician visits (including general practitioners, psychiatrists, pediatricians, etc.) in Nova Scotian children from 1998-2011 using administrative health data.

3.2 Methods

3.2.1 Participants

Participants in the present study are from the 2011 Children's Lifestyle and School-performance Study (CLASS-II). As 97% of grade five students in Nova Scotia attended public schools in 2011, this survey sampled the majority of children (29). When the study was conducted there were 286 public schools with grade five children, and 269 consented to participate (94.1% participation rate) (90,91).

3.2.2 Data collection

Survey data for the CLASS-II study were collected using a cross-sectional, population-based design from February to June, 2011 (89). Trained personnel administered a student survey and food frequency questionnaire to students and collected the students' anthropometric measurements (height and weight) (89). Administrative health data were collected from Medical Services Insurance (MSI) physician billings and linked to CLASS-II survey data by Health Data Nova Scotia (HDNS). Figure 3.1 provides details of the data linkage process. Only health data existing before the CLASS-II survey in 2011 were examined to identify mental health-related physician visits for consenting participants.

3.2.3 Inclusion/exclusion criteria and sample size

The present study includes mental health service use data between 1998 and 2011. Participants from the CLASS-II survey whose parents/guardians did not consent to linkage of CLASS-II survey data with their child's existing administrative health data were excluded from the analysis. In total, 102 participants (2.5% of the sample) were excluded from the analysis. The final sample size was n=3,907.

3.2.4 Ethics & data access

A Dalhousie University Research Ethics Board (REB) submission was approved on November 22, 2018. A request to HDNS for permission to link existing health data to CLASS-II data was accepted on July 18, 2018.

3.2.5 Instruments used

The CLASS-II study used three questionnaires for data collection: (1) a student survey, (2) a home survey, and (3) a Canadian-adapted, 147-item Harvard Youth/Adolescent Food Frequency Questionnaire (YAQ). Before data collection, all surveys were piloted to relevant populations. The student survey consisted of health and lifestyle items while the home survey, administered to parents/guardians, containing questions about socio-demographics, health, and lifestyle (89,90). The YAQ is a validated method of dietary assessment for youth. Please refer to Rockett et al for validation details (92).

3.2.6 Exposure assessment

Exposure variables in this study include: (1) breakfast skipping, (2) lunch skipping, (3) eating supper in front of the television, (4) eating supper alone, and (5) eating family supper. Each of these five variables were examined separately in relation to the outcome. Exposure variables were captured by the following items from the YAQ. Breakfast skipping data was collected by the item '*Where do you usually eat breakfast? (At home, at school, don't eat breakfast, other*)'. Lunch skipping data was collected by the item '*Which of the following best describes your lunch on a school day? (Bring a prepared lunch, buy lunch at school, eat lunch at home, don't eat lunch, other)*'. Eating supper alone was assessed by the item '*How many times a week (including weekdays and weekends) do you eat supper alone? (Never/<once, 1-2 times, 3-4 times, 5 or more times)*'. Eating supper in front of the television was assessed by the item '*How many times each week (including weekdays and weekends) do you usually eat supper in front*

of the TV?' (Never/<once, 1-2 times, 3-4 times, 5 or more times). Lastly, family supper data were collected using the item *'How many times each week (including weekdays and weekends) do you usually eat supper at the table with other people? (Never/<once, 1-2 times, 3-4 times, 5 or more times).*

3.2.7 Outcome assessment

In Canada, there is a publicly funded healthcare system for all medically necessary health services with regard to hospital and physician access (108). MSI physician billing data were used to identify all mental health-related physician visits (including general practitioners, pediatricians, and psychiatrists, etc.) from 1998-2011 (18). International Classification of Disease (ICD) codes ICD-9-CM 290-319 codes were used to identify mental health-related physician visits from physician billing data (109). ICD codes identifying included disorders are found in Table 3.1. The outcome of mental health-related physician visits was measured as a count variable indicating number of physician encounters with the public healthcare system.

3.2.8 Statistical analysis

Zero-inflated Poisson regression was used to determine the association between each meal regularity variable and mental health-related physician visits from 1998-2011. Models were specified using a standard error that accounts for intragroup correlation due to the potential effects of clustering within schools. Survey weights were used so

that results are applicable to the general population. Analysis was stratified by sex as outcomes related to mental health are often different for boys and girls (99).

Covariates were added to the model simultaneously and selected based on a review of the literature. The multivariate analysis was adjusted for: physical activity, rurality, food insecurity, stressful life event, parental education, total parental income, obesity, family structure, and diet quality. Physical activity was evaluated by the student survey which contained a subset of items from the Physical Activity Questionnaire for Children (PAQ-C) (95). Postal code second digit identification was used to determine rurality (96). The home survey item *'The food we bought just didn't last and we didn't have the money to get more (Often true, sometimes true, never true, prefer not to answer)'* was used to evaluate food insecurity. The home survey item '*Has your grade 5 child experienced any event or situation in the past year that has caused him or her a great amount of worry or unhappiness? (Yes, no, unsure or prefer not to answer)'* was used to evaluate previous stressful life events in children. Socioeconomic status variables included in the analysis were total parental income and parental education. Body Mass Index (BMI) was calculated from anthropometrically measured height and weight data for each child (89,91). Obesity was classified according to standards by the World Health Organization (WHO) (97). The YAQ was used to collect information about the children's diets and a diet quality score was calculated (0-100, 100= highest quality diet) as per the Diet Quality Index (98).

3.3 Results

3.3.1 Baseline characteristics

There were a total of n=3,907 children included in the analysis. Sex was evenly divided among participants, with 51% males and 49% females in the sample. Almost half (49.4%) of families earned a total income of greater than $60,000 per year, and 65% of children resided in an urban centre. Food insecurity was reported by 13.2% of the sample, and 3.7% of families reported always being food insecure. The proportion of children who reported eating family supper five or more times a week was 59%. Most (78.5%) children reported that they ate supper alone never or less than once a week, and 5.8% reported eating suppers alone more than twice a week. Among participants, 40.3% reported eating supper in front of the television never or less than once a week. The proportion of children who reported eating breakfast and lunch was 96.7% and 99.1%, respectively. From 1998-2011, the total number of mental health-related physician visits per child ranged from 0-69. More than two thirds of children (2,665 participants or 68.2% of the sample) had no mental health-related physician visits during this period and 91.4% of the sample had three visits or less.

3.3.2 Univariate analysis

Overall, compared to children who reported eating supper in front of the television never or less than once a week, children who reported eating supper in front of the television five or more times a week had a greater risk of mental health-related physician visits (IRR=1.64; 95%CI: 1.32,2.04). This relationship was significant for boys (IRR=1.69; 95% CI: 1.30,2.18) but not girls (IRR=1.36; 95% CI: 0.86,2.14). Overall, skipping lunch was not significantly associated with mental health-related physician visits

(IRR=1.59; 95% CI:0.90,2.80). Overall, between 1998-2011, children who reported eating family supper never or less than once a week had a 61% higher rate of mental health-related physician visits compared to children who ate family supper five or more times a week (IRR=1.61; 95% CI:1.20,2.16). Between 1998-2011, children who reported eating supper alone five or more times a week had a 62% higher rate of mental health-related physician visits overall compared to children who reported eating supper alone never or less than once a week (IRR=1.62; 95% CI:1.11,2.36). When examined after stratification by sex, this IRR was 3.14 (1.63,6.06) for girls and 1.16 (0.74,1.82) for boys. Overall, eating breakfast was not significantly associated with mental health-related physician visits (IRR=1.43; 95%CI: 0.97,2.11).

3.3.3 Multivariable analysis

Between 1998-2011, compared to children who ate supper in front of the television never or less than once a week, children who ate supper in front of the television five or more times a week had a 52% higher rate of mental health-related physician visits overall (IRR=1.52; 9%% CI: 1.20,1.93). This relationship was significant in boys (IRR=1.66; 95% CI: 1.24, 2.21) but not in girls (IRR=1.17; 95% CI: 0.76,1.82). Overall, eating lunch was significantly associated with mental health visits in the adjusted analysis (IRR=1.81, 95%CI: 1.05,3.14). However, this association was significant in girls (IRR=2.71; 95% CI: 1.21, 6.09) but not in boys (IRR=1.67; 95% CI: 0.83,3.36). In the fully adjusted analysis, eating family supper, eating supper alone, and eating breakfast were not significantly associated with mental health-related physician visits.

3.4 Discussion

The present study observed a novel association between meal regularity and mental health-related physician visits in elementary-school aged children. Results from our multivariable-adjusted analysis predicting mental health-related physician visits in children demonstrated a strong, significant association between skipping lunch and mental health-related physician visits in girls but not in boys. Eating in front of the television was significantly associated with mental health-related physician visits for boys but not girls. Eating supper alone, eating family supper, and skipping breakfast were not significantly associated with mental health-related physician visits in our adjusted analysis. To the best of our knowledge, the present study is the first to examine whether an association exists between meal regularity and mental health-related physician visits in children using administrative health data.

Results from the present study are in line with other studies that have reported a relationship between meal skipping and mental health, although no prior studies had examined elementary school-aged children. A large British study examined the association between meal skipping and mental health in 10,645 12-16 year olds (29), and found those who reported never eating regular meals had a 3-fold greater odds of self-reported mental health difficulties compared to those who reported never skipping meals (OR=3.10; 95% CI: 2.24-4.32) (29). Findings from a Korean study of 1,413 adolescents aged 13-18 echoed these results, suggesting that adolescents who skipped breakfast were at greater risk of reporting depressive mood (OR=1.77; 95% CI: 1.07,2.92) (28). Although the present study did not find an association between skipping breakfast

and mental health-related physician visits, we did observe a significant relationship between skipping lunch and increased mental health-related physician visits. Differences in findings from the present study compared to previous studies of meal skipping may be due to differences in age of participants, countries of study, and outcomes examined. Self-reported mental health and mental health physician visits are related yet distinct outcomes that may represent differences in severity of mental health symptoms and may have different mechanisms for their connection to meal skipping.

Previous studies have observed an association between family meals and the outcomes of physical aggression, non-aggressive delinquency, reactive aggression, and oppositional behaviour (77), depressive symptoms (78,79) and disordered eating (104,105). In a Canadian sample of 1,492 children from the Quebec Longitudinal Study of Child Development, higher quality family meal environment at age 6 lead to lower physical aggression, non-aggressive delinquency, reactive aggression, and oppositional behaviour four years later at age 10 (77). In a sample of 4,746 middle and high-school students in the United States, family meals were inversely associated with depressive symptoms in the multivariate analysis (OR=0.92; 9%% CI: 0.86,0.98) (78). Another study of 99,462 middle and high-school students in the United States observed a significant inverse association between family meals and risk of depression and suicide after adjusting for demographic and family variables (OR=0.60; 95% CI: 0.54,0.65) (79). A longitudinal study of 2,516 middle and high-school students observed that more frequent family meals were significantly associated with lower odds of extreme weight control behaviours among girls only (OR=0.71; 95% CI:0.52,0.97). Similarly, another

longitudinal study among 7,535 girls and 5,913 boys ages 9-14 years observed significant associations between family meal frequency and binging, purging, and frequent dieting in girls (104). Unlike these previous studies, the present study did not identify an association between family meals and mental health-related physician visits. Potential reasons for differences in results from the current study compared to previous studies may be due to differences in the outcomes examined. Previous studies have used self-reported mental health outcomes, while the present study examines mental health-related physician visits captured by administrative health data. Although elementary school-aged children may be able to identify and self-report their mental health difficulties, mental health problems often present somatically in children (57) and therefore may not be coded as a mental health presentation. Grade five children are also likely to be unable to access medical services independently without support from their parents/guardians.

There are many potential reasons that could explain the association we observed in the present study between eating in front of the television and increased mental health-related physician visits in boys. For example, eating in front of the television could be related to mental health-related physician visits through the association between screen time and mental health in children (110–112). Eating in front of the television is a contributor to overall screen time. A Canadian study of 2,482 middle and high-school aged youth found that increased screen time is associated with increased self-reported anxiety and depression (110). Another large study of 40,337 children aged 2-17 years in the United States observed that screen time over one hour a day was

associated with lower well-being, emotional stability, and self-control, and greater distractibility, more trouble making friends, and more trouble finishing tasks (111). In the present study, the association between eating in front of the television and mental health-related physician visits was significant for boys and not girls. Previously, screen time has been weakly associated with attention problems in children (111,113), and a greater proportion of boys are diagnosed with attention related mental health problems compared to girls (114). Increased television viewing in boys may exacerbate existing attention difficulties thus increasing mental health-related physician visits for boys but not girls. Eating in front of the television is correlated with additional outcomes that may affect mental health. For example, previous studies have demonstrated that eating in front of the television is associated with higher weight status (115) and lower diet quality (49) in children. Although the present study controlled for diet quality and weight status, other variables such as family function and parental mental illness may be important factors affecting childhood mental health that we could not control for in the present study.

The present study's finding of a significant association between lunch skipping and mental health-related physician visits in girls is plausible through both physiological and psychological mechanisms. The physiological response to hunger, which could be induced if lunch is not eaten, is a stress-response characterized by the release of hormones such as adrenaline and cortisol (53) and a decrease in blood sugar which can cause difficulty concentrating and controlling emotions, both symptoms related to mental health (53,73,74). However, if the stress-response of hunger is the primary

mechanism contributing to the results of the present study, it does not fully explain why we observed a significant association between skipping lunch and mental health-related physician visits in girls but not in boys. The psychological mechanism of disordered eating may be precipitating the association between lunch skipping and mental health-related physician visits instead. Disordered eating is defined by subclinical but unhealthy eating behaviours including binging, purging, dieting, and meal skipping (104,105) and is associated with mental health outcomes such as anxiety, mood, and eating disorders (116,117). An increased risk of anxiety, mood, and eating disorders may cause increased mental health-related physician visits. Previous studies have suggested that girls have a higher prevalence of disordered eating compared to boys (104,105). A study by Neumark-Sztainer et al reported that three times as many girls engaged in extreme disordered eating behaviours compared to boys (105). If disordered eating plays a role in the association between eating lunch and mental health service use, the differences in significance observed by sex in the present study may be due to the greater prevalence of disordered eating in girls compared to boys (104,105). More recent literature suggests that eating disorders in males have been underrepresented in previous research, and that the use disordered eating measurement tools are more suited to measure female presentations that may not capture disordered eating presentations as well in males (118,119). More research is necessary to understand sex differences in disordered eating among children and how this may relate to the differences observed in our findings.

3.5 Strengths & limitations

Our study is the first to examine whether a relationship exists between meal regularity and mental health-related physician visits in children using administrative health data. Through linkage of administrative health data with survey data, we were able to control for many factors that may impact the relationship between meal regularity and mental health in children such as food insecurity, socioeconomic status, diet quality, obesity, and previous stressful events. Our analysis was conducted overall and by sex, facilitating the ability to observe the relationship between meal regularity and mental health-related physician visits separately for boys and girls. A robust sample size and the use of validated instruments are other strengths of this study.

There are several limitations to acknowledge. Given the proportion of participants who reported two of the exposures, skipping breakfast (3.3%) and lunch (0.95%) and the sample size of 4,009, this study is underpowered to detect an association between these exposures with self-esteem employing a cross-sectional study design. Although mental health service use measured by administrative health data is an objective measure, this measure will have both low sensitivity (missing true cases) and specificity (including false positives) if used as a measure of mental health of a population. Mental health service use derived from administrative health data may not capture children with subclinical or less severe mental health problems, those who do not seek help due to stigma, and those seeking help from psychologists in both the public and private healthcare systems. Further, when examining mental health of children, measurement is challenging as mental health problems often present

somatically and may therefore not be reported by children or recognized and coded by healthcare practitioners as a mental health presentation in administrative health data (57). Although 80% of those accessing mental health care receive care from a physician, a considerable portion of mental health practitioners are accessed outside the public system (120), and this care would not be captured by administrative health data measures. In terms of specificity, one diagnostic code from physician billing data is unlikely to represent a true clinical childhood mental health disorder. Due to this potential bias, we defined our outcome as 'mental health service use' instead of 'mental health disorders'. Further, mental health service use cases captured by administrative health databases are more likely to include children with mental health problems that are more evident and disruptive, such as attention-deficit/hyperactivity disorder. Therefore, we are likely over-capturing false positives. As boys are more often diagnosed with attention-deficit/hyperactivity disorder compared to girls (114), over-capture cases will be biased towards boys. Our outcome definition did not include the codes to capture physician visits for suicidal behaviour or self-harm, observation for suspected mental and behavioural disorders, and counselling for mental health. ED or other admissions where physicians billed for service will be captured, but assessment, counselling, and discharge codes were not included in the present study, meaning we cannot not identify hospitalizations specifically. The lack of data for parental mental illness and family function, and the use of a binary variable for sex which does not capture intersex children are other limitations of this present study. Lastly, as this is a cross-sectional study, we cannot assume causality or rule out reverse causation where

poor mental health is causing reduced meal regularity. However, plausible mechanisms exist to explain how meal regularity may influence mental health in children, and regardless of its direction, the significant association between meal regularity and mental health-related physician visits observed in the present study identifies a novel target of intervention (meal regularity) for children's mental health programs.

3.6 Future directions and implications

The present study contributes new information about the association between meal regularity and mental health service use in elementary school aged children. Although this research is cross-sectional, meaning we cannot imply causation, knowing that a significant relationship exists between meal regularity and mental health service use is important for future research and policy/programming. We believe that a complex, bidirectional relationship exists between meal regularity and mental health-related physician visits, and so regardless of the direction of the association, solutions that address either variable will ultimately likely affect the other. Therefore, multi-pronged solutions that address both mental regularity and mental health simultaneously within the context of socioenvironmental and socioeconomic factors are likely to be most successful. Future research examining the mechanisms of this association should include family-level variables such as family function or family cohesion. The use of a longitudinal design would be able to better assess causality and reverse causation; however, as mechanistic pathways for this relationship are likely bidirectional, establishing causation is less important than the identification of modifiable mediating variables for the improvement of both meal regularity and mental health of children.

If results are replicated in future studies, this research has important implications for strategies to improve meal regularity and mental health. Strategies that incorporate meal regularity and mental health together may include eating together programs at schools and in family or community mental health programs. Other strategies may include interventions that encourage decreased screen time for children, education and awareness regarding the negative effects of disordered eating, and earlier interventions targeted at younger children that encourage positive body image and focus on healthy habits instead of weight.

3.7 Conclusion

In summary, this is the first study to examine whether an association exists between meal regularity and mental health-related physician visits in children. A strong, significant association was observed for the relationship between lunch skipping and mental health-related physician visits in girls and the association between eating in front of the television and mental health-related physician visits was significant in boys. If confirmed by future studies, these results provide a focus for strategies and interventions to improve childhood mental health and meal regularity.

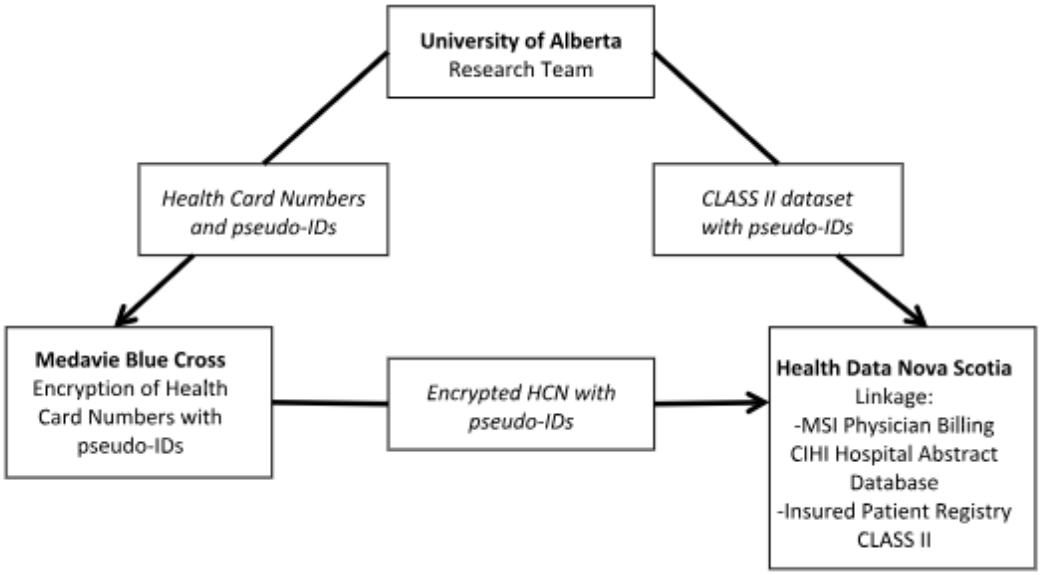

Figure 3.1: Process of data linkage for CLASS-II data with MSI Physician Billing data through Health Data Nova Scotia

Table 3.1: ICD-9-CM 290-319 codes

Mental health disorder	ICD9 codes
Depressive mood disorders	296, 311
Anxiety, dissociative and somatoform disorders	300
Acute reaction to stress	308
Adjustment reaction	309
Disturbance of emotions specific to childhood and adolescence	313
Attention deficit hyperactivity disorder	314
Learning disability	315.0-315.3
Eating disorders	307.1, 307.50, 307.51, 307.54
Schizophrenia/ Psychotic / Paranoia	295.0-295.9, 298.8-298.9, 297.1-297.3
Other Mental Health (codes not specified above) that are relevant to this population	Within mental health categories, all other codes (290 – 319) not included above

Table 3.2: Participant characteristics of grade five children overall and by sex from the 2011 Children's Lifestyle and School-performance Study in Nova Scotia

Variable **N=3907**	**Overall** Frequency (%)	**Girls** Frequency (%)	**Boys** Frequency (%)
Family Income **N=3789**			
<$20,000/year	240 (6.33)	114 (6.00)	117 (6.39)
$20-40,000/year	525 (13.86)	274 (14.42)	243 (13.26)
$40-60,000/year	555 (14.65)	287 (15.11)	261 (14.25)
>60,000/year (Ref[A])	1872 (49.41)	928 (48.84)	919 (50.16)
Prefer not to answer	597 (15.76)	297 (15.63)	292 (15.94)
Parental education **N=3794**			
Secondary school or lower	688 (18.13)	359 (18.87)	315 (17.17)
Community college/technical school	1508 (39.75)	734 (38.59)	751 (40.93)
University	1001 (26.38)	491 (25.81)	494 (26.92)
Graduate university (Ref)	506 (13.34)	265 (13.93)	238 (112.97)
Prefer not to answer	91 (2.40)	53 (2.79)	37 (2.02)
Rurality **N=3907**			
Rural	1369 (35.04)	679 (34.64)	657 (34.87)
Urban (Ref)	2538 (64.96)	1281 (65.36)	1227 (65.13)
Family Structure **N=3800**			
2 members	132 (3.47)	60 (3.14)	68 (3.71)
3 members	656 (17.26)	331 (17.35)	315 (17.17)
4 members (Ref)	1716 (45.16)	872 (45.70)	823 (44.85)
5 members	857 (22.55)	421 (22.06)	426 (23.22)
>5 members	439 (11.55)	224 (11.74)	203 (11.06)
Food insecurity **N=3804**			
Often	140 (3.68)	65 (3.41)	70 (3.81)
Sometimes	501 (13.17)	266 (13.94)	224 (12.18)
Never (Ref)	3110 (81.76)	1548 (81.13)	1521 (82.71)
Prefer not to answer	53 (1.39)	29 (1.52)	24 (1.31)
Physical activity score **N=3907**			

Table 3.2: Participant characteristics of grade five children overall and by sex from the 2011 Children's Lifestyle and School-performance Study in Nova Scotia

Variable **N=3907**	**Overall** Frequency (%)	**Girls** Frequency (%)	**Boys** Frequency (%)
<= median score	1951 (49.94)	1054 (53.78)	834 (44.27)
>median score (Ref)	1956 (50.06)	906 (46.22)	1050 (55.73)
Obesity **N=3495**			
No obesity (Ref)	2818 (80.63)	1485 (84.09)	1333 (77.10)
Obesity	677 (19.37)	281 (15.91)	396 (22.90)
Diet Quality Index (DQI) **N=3696**			
<= median score	1854 (50.16)	924 (48.79)	930 (51.41)
>median score (Ref)	1842 (49.84)	963 (51.03)	879 (48.59)
Stressful life event **N=3801**			
Yes	1120 (29.47)	589 (30.87)	515 (28.05)
No (Ref)	2551 (67.11)	1253 (65.67)	1258 (68.52)
Prefer not to answer	130 (3.42)	66 (3.46)	63 (3.43)
Supper with family **N=3663**			
Never-<1/week	442 (12.07)	198 (10.59)	244 (13.61)
1-2 times/week	505 (13.79)	246 (13.16)	259 (14.45)
3-4 times/week	555 (15.15)	306 (16.36)	249 (13.89)
5+ times/week (Ref)	2161 (59.00)	1120 (59.89)	1041 (58.06)
Supper alone **N=3679**			
Never-<1/week (Ref)	2888 (78.50)	1518 (80.83)	1370 (76.07)
1-2 times/week	579 (15.74)	257 (13.68)	322 (17.88)
3-4 times/week	110 (2.99)	57 (3.04)	53 (2.94)
5+ times/week	102 (2.77)	46 (2.45)	56 (3.11)
Supper in front of the television **N=3668**			
Never-<1/week (Ref)	1479 (40.32)	768 (40.92)	711 (39.70)
1-2 times/week	1146 (31.24)	602 (32.07)	544 (30.37)
3-4 times/week	469 (12.79)	243 (12.89)	227 (12.67)
5+ times/week	574 (15.65)	265 (14.12)	309 (17.25)
Breakfast **N=3684**			

Table 3.2: Participant characteristics of grade five children overall and by sex from the 2011 Children's Lifestyle and School-performance Study in Nova Scotia

Variable **N=3907**	**Overall** Frequency (%)	**Girls** Frequency (%)	**Boys** Frequency (%)
Eats breakfast at home/school, or other (Ref)	3564 (96.74)	1805 (96.11)	1759 (97.40)
Does not eat breakfast	120 (3.26)	73 (3.89)	47 (2.60)
Lunch **N=3733**			
Eats lunch (Ref)	3661 (99.05)	1870 (99.10)	1791 (99.00)
Does not eat lunch	35 (0.95)	17 (0.90)	18 (1.00)

A. Ref= reference group

Table 3.3: Univariate zero-inflated Poisson regression analysis predicting the risk of mental health-related physician visits[A] by sex and overall according to MSI Physician Billings for grade five students from the 2011 Children's Lifestyle and School-performance Study in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Variable	%	IRR	95%CI	p	IRR	95%CI	p	IRR	95% CI	p
Supper with family N=3663										
Never-<1 /week	12.07	1.61	1.20,2.16	0.002	1.52	1.03,2.25	0.034	1.66	1.13,2.43	0.010
1-2 times/week	13.79	1.29	1.00,1.65	0.046	1.13	0.68,1.85	0.64	1.29	0.97,1.72	0.082
3-4 times/week	15.15	1.06	0.80,1.39	0.69	1.12	0.72,1.74	0.61	1.05	0.75,1.48	0.77
5+ times/week	59.00	1.00			1.00			1.00		
Supper alone N=3679										
Never-<1 /week	78.50	1.00			1.00			1.00		
1-2 times/week	15.74	0.98	0.77,1.25	0.88	1.25	0.87,1.82	0.23	0.88	0.65,1.20	0.42
3-4 times/week	2.99	1.45	1.01,2.08	0.045	1.44	0.80,2.56	0.22	1.53	1.00,2.34	0.048
5+ times/week	2.77	1.62	1.11,2.36	0.012	3.14	1.63,6.06	0.001	1.16	0.74,1.82	0.51
Supper in front of the tv N=3668										
Never-<1 /week	40.32	1.00			1.00			1.00		
1-2 times/week	31.24	1.16	0.89,1.52	0.27	0.94	0.63,1.39	0.76	1.27	0.90,1.79	0.18
3-4 times/week	12.79	1.45	1.09,1.93	0.011	1.00	0.70,1.44	0.98	1.72	1.22,2.44	0.002

Table 3.3: Univariate zero-inflated Poisson regression analysis predicting the risk of mental health-related physician visits[A] by sex and overall according to MSI Physician Billings for grade five students from the 2011 Children's Lifestyle and School-performance Study in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Variable	%	IRR	95%CI	p	IRR	95%CI	p	IRR	95% CI	p
5+ times/week	15.65	1.64	1.32,2.04	<0.001	1.36	0.86,2.14	0.18	1.69	1.30,2.18	<0.001
Breakfast N=3684										
Eats breakfast at home/ school, or other	96.74	1.00			1.00			1.00		
Does not eat breakfast	3.26	1.43	0.97,2.11	0.067	1.71	0.83,3.53	0.14	1.40	0.94,2.09	0.096
Lunch N=3696										
Eats lunch	99.05	1.00			1.00					
Does not eat lunch	0.95	1.59	0.90,2.80	0.11	1.95	0.86,4.44	0.11	1.62	0.84,3.15	0.15
Family income N=3789										
<$20,000/year	6.33	1.76	1.33,2.34	<0.001	2.20	1.40,1.36	0.001	1.72	1.21,2.44	0.003
$20-40,000/year	13.86	1.04	0.801.36	0.77	1.40	0.90,2.17	0.14	0.93	0.66,1.31	0.66
$40-60,000/year	14.65	1.37	1.07,1.74	0.011	1.35	0.9,2.03	0.15	1.45	1.08,1.94	0.013
>$60,000/year	49.41	1.00			1.00			1.00		
Prefer not to answer	15.76	1.18	0.93,1.50	0.17	1.39	0.89,2.19	0.15	1.10	0.82,1.49	0.52

Table 3.3: Univariate zero-inflated Poisson regression analysis predicting the risk of mental health-related physician visits[A] by sex and overall according to MSI Physician Billings for grade five students from the 2011 Children's Lifestyle and School-performance Study in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Variable	%	IRR	95%CI	p	IRR	95%CI	p	IRR	95% CI	p
Parental education N=3794										
Secondary school or lower	18.13	1.60	1.17,2.19	0.003	1.87	1.26,4.29	0.002	1.56	1.05,2.30	0.027
Community college/ technical school	39.75	1.40	1.05,1.85	0.020	1.55	1.45,2.87	0.035	1.28	0.90,1.82	0.17
University	26.38	0.93	0.66,1.31	0.67	0.85	0.72,1.38	0.49	0.92	0.61,1.38	0.69
Graduate university	13.34	1.00			1.00			1.00		
Prefer not to answer	2.40	1.37	0.83,2.25	0.22	2.14	0.88,2.21	0.028	1.08	0.55,2.10	0.83
Stressful life event N=3801										
Yes	29.47	1.27	1.07,1.52	0.007	1.54	1.15,2.07	0.004	1.19	0.95,1.48	0.13
No	67.11	1.00			1.00			1.00		
Prefer not to answer	3.42	1.25	0.78,1.99	0.36	1.30	0.72,2.33	0.39	1.26	0.69,2.32	0.45
Obesity N=3495										
No obesity	80.63	1.00			1.00			1.00		

Table 3.3: Univariate zero-inflated Poisson regression analysis predicting the risk of mental health-related physician visits[A] by sex and overall according to MSI Physician Billings for grade five students from the 2011 Children's Lifestyle and School-performance Study in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Variable	%	IRR	95%CI	p	IRR	95%CI	p	IRR	95% CI	p
Obesity	19.37	0.95	0.76,1.18	0.63	0.86	0.59,1.26	0.43	0.90	0.69,1.17	0.42
Diet Quality Index score N=3696										
<= median score	50.16	1.15	0.95,1.40	0.15	1.25	0.92,1.69	0.15	1.08	0.86,1.35	0.51
>median score	49.84	1.00			1.00					
Physical activity score N=3907										
<= median score	49.94	1.20	1.00,1.44	0.055	1.46	1.08,1.98	0.013	1.15	0.91,1.45	0.24
>median score	50.06	1.00			1.00			1.00		
Rurality N=3907										
Rural	35.04	0.88	0.72,1.09	0.25	0.98	0.74,1.29	0.88	0.87	0.65,1.16	0.34
Urban	64.96	1.00			1.00			1.00		
Family structure N=3800										
2 members	3.47	1.73	1.23,2.44	0.002	2.21	1.14,4.29	0.019	1.65	1.10,2.48	0.016
3 members	17.26	1.43	1.12,1.83	0.004	2.04	1.45,2.87	<0.001	1.23	0.89,1.69	0.20
4 members	45.16	1.00			1.00			1.00		

Table 3.3: Univariate zero-inflated Poisson regression analysis predicting the risk of mental health-related physician visits[A] by sex and overall according to MSI Physician Billings for grade five students from the 2011 Children's Lifestyle and School-performance Study in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Variable	%	IRR	95%CI	p	IRR	95%CI	p	IRR	95% CI	p
5 members	22.55	0.94	0.76,1.17	0.58	1.00	0.72,1.38	0.99	0.95	0.71,1.26	0.73
>5 members	11.55	1.13	0.87,1.46	0.37	1.40	0.88,2.21	0.16	0.99	0.71,1.39	0.95
Food insecurity N=3804										
Often	3.68	1.89	1.41,2.53	<0.001	2.18	1.31,3.63	0.003	1.83	1.27,2.65	0.001
Sometimes	13.17	1.22	0.96,1.55	0.096	1.14	0.81,1.61	0.45	1.31	0.98,1.75	0.066
Never	81.76	1.00			1.00			1.00		
Prefer not to answer	1.39	1.23	0.69,2.18	0.49	1.40	0.57,3.46	0.46	1.31	0.70,2.43	0.40

A. Mental health visits measured as a count variable, determined by physician billing data (Health Data Nova Scotia) from calendar year 1998–2011 using ICD codes 9/10 indicating mental health visit.

Table 3.4: Multivariable[A] zero-inflated Poisson regression analysis predicting the risk of mental health-related physician visits[B] by sex and overall according to MSI Physician Billings for grade five students from the 2011 Children's Lifestyle and School-performance Study in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Exposure	%	IRR	95%CI	p	IRR	95%CI	p	IRR	95% CI	p
Supper with family n=3663										
Never-<1 /week	12.07	1.22	0.95,1.54	0.12	1.06	0.71,1.58	0.78	1.26	0.93,1.96	0.13
1-2 times/week	13.79	1.30	0.99,1.72	0.064	0.98	0.58,1.66	0.95	1.35	0.99,1.84	0.060
3-4 times/week	15.15	1.03	0.78,1.35	0.85	0.99	0.69,1.41	0.96	1.04	0.73,1.49	0.81
5+ times/week	59.00	1.00			1.00			1.00		
Supper alone n=3679										
Never-<1 /week	40.32	1.00			1.00			1.00		
1-2 times/week	31.24	1.04	0.81,1.33	0.78	1.00	0.71,1.44	0.97	1.00	0.73,1.36	0.99
3-4 times/week	12.79	1.47	0.98,2.21	0.062	1.17	0.66,2.09	0.59	1.55	0.97,2.50	0.069
5+ times/week	15.65	1.35	0.78,2.35	0.28	1.93	0.62,6.01	0.25	1.14	0.58,2.25	0.70
Supper in front of the tv n=3668										
Never-<1 /week	78.50	1.00			1.00			1.00		
1-2 times/week	15.74	1.09	0.87,1.36	0.47	0.96	0.66,1.40	0.83	1.19	0.89,1.60	0.24
3-4 times/week	2.99	1.32	0.98,1.78	0.064	0.87	0.59,1.29	0.50	1.64	1.15,2.35	0.007
5+ times/week	2.77	1.52	1.20,1.93	0.001	1.17	0.76,1.82	0.48	1.66	1.24,2.21	0.001

Table 3.4: Multivariable[A] zero-inflated Poisson regression analysis predicting the risk of mental health-related physician visits[B] by sex and overall according to MSI Physician Billings for grade five students from the 2011 Children's Lifestyle and School-performance Study in Nova Scotia, Canada

		Overall			**Girls**			**Boys**		
Exposure	%	IRR	95%CI	p	IRR	95%CI	p	IRR	95% CI	p
Breakfast n=3684										
Eats breakfast at home/ school, or other	96.74	1.00			1.00			1.00		
Does not eat breakfast	3.26	1.32	0.88,2.40	0.18	1.56	0.78,3.13	0.21	1.28	0.84,1.95	0.24
Lunch n=3696										
Eats lunch	99.05	1.00			1.00					
Does not eat lunch	0.95	1.81	1.05,3.14	0.034	2.71	1.21,6.09	0.016	1.67	0.83,3.36	0.15

A. Model adjusted for rurality, family structure, food insecurity, stressful life event, physical activity questionnaire score, Diet Quality Index score, obesity, highest parental education, and family income.
B. Mental health visits measured as a count variable, determined by physician billing data from Health Data Nova Scotia from 1998–2011 using ICD codes 9/10 indicating mental health visit.

Chapter IV: Sensitivity analyses: associations between meal regularity, self-esteem, and mental health-related physician visits

4.0 Overview of sensitivity analyses

This thesis determined the cross-sectional relationship between meal regularity and mental health in children. Two aspects of mental health were examined, including self-esteem and mental health-related physician visits. Although both self-esteem and mental health-related physician visits are indicators of the mental health status of children, they are different measures of overall mental health, and may not necessarily capture the same population (122). To investigate how self-esteem and mental health-related physician visits may be related in our sample, a univariate analysis examining whether self-esteem significantly predicted mental health-related visits was conducted. The variable "mental health-related physician visits" was then categorized into a binary variable (zero mental health-related physician visits/one or more mental health-related physician visits) and Pearson correlation and chi-squared tests were conducted. Further, a cross-tabulation of these two variables was conducted and a 2x2 table was constructed (See Table 4.1). Lastly, we ran a sensitivity analysis to determine whether the inclusion of self-esteem as a covariate in the model of the association between meal regularity and mental health-related physician visits (as a count variable) would change the previously observed associations.

4.1 Results

Results of univariate analysis for the association between mental health-related physician visits and self-esteem were significant ($p<0.001$). Children with lower self-esteem had a 68% higher rate of mental health-related physician visits compared to children with higher self-esteem (IRR=1.68; 95% CI: 1.35,2.09) (See Table 4.2). The Pearson correlation coefficient for mental health-related physician visits and self-esteem was 0.098 ($p <0.001$), demonstrating that although these variables are significantly related, the magnitude of the association is weak. The chi-squared test statistic for the relationship between self-esteem and mental health-related physician visits was 34.1 ($p <0.001$). This indicates a significant difference between the variables of self-esteem and mental health-related physician visits in our sample. Results of the cross-tabulation between self-esteem and mental health-related physician visits demonstrated that approximately 36% of those with lower self-esteem had one or more mental health-related physician visits, while approximately 26% of those with higher self-esteem had one or more visits. Only 20.6% of children in the sample fell into the category of both lower self-esteem and one or more mental health-related physician visits. Lastly, although the inclusion of self-esteem in the model of meal regularity and mental health-related physician visits slighted decreased the magnitude of the observed effect, it did not significantly change the association between meal regularity and mental health-related physician visits. Please see Table 4.3 for a comparison of the results.

4.2 Discussion

Results of the Pearson correlation test and univariate analysis demonstrate that self-esteem and mental health-related physician visits are significantly associated.

However, although self-reported self-esteem and mental health-related physician visits derived from administrative health data are both indicators of overall mental health and are related in our sample, they are not necessarily the same measure and do not capture the same participants. These findings are in line with previous research that has compared capture of mental health problems by self-reported measures versus capture of mental health problems by mental health service use administrate health data (122). A study by *Statistics Canada* compared the number of primary care mental health-related physician visits in self-reported Canadian Community Health Survey (CCHS) data against provincial administrative health data (122). Results observed by this study indicated that participants self-reported more mental health-related physician visits to general practitioners compared to numbers represented in administrative health data (122). Interestingly, exact agreement between the two measures (self-report versus administrative health data) was only observed in approximately 50% of the sample, even when all general practitioner visits (regardless of diagnostic code) were included in the administrative health data measure of mental health visits (122). In the present study, the chi-squared test indicated significant differences exist between self-esteem and mental health-related physician visits, and agreement between lower self-esteem and one or more mental health-related physician in the sample was 20.6%. Although we would not anticipate perfect agreement between these two measures, 20.6% agreement is lower than we may expect.

The significant differences observed between self-esteem and mental health-related physician visits in the present study confirm that self-reported mental health and

mental health visits derived from administrative health data measures do not capture the same populations. This may help explain why we observed differences in our results for the association between meal regularity and self-esteem compared to meal regularity and mental health-related physician visits. This information has important implications for the monitoring and evaluation of mental health in children. As these measures capture different populations and indicate different rates of mental health problems, it is important to collect data using both methods of evaluation as a multifaceted approach to ensure more complete capture of mental health problems.

Table 4.1 Cross-tabulation of self-esteem and mental health-related physician visits

	Mental health-related physician visits		**Total**
Self-esteem	*0*	*1 or more*	
Higher self-esteem	1,111	397	1,508
Lower self-esteem	1,338	737	2,075
Total	2,449	1,134	3,583

Table 4.2 Univariate zero-inflated Poisson regression analysis predicting the risk of mental health-related physician visits[A] according to MSI Physician Billings for grade five students from the 2011 Children's Lifestyle and School-performance Study in Nova Scotia, Canada

Exposure	**IRR**	**95% CI**	**p-value**
Self-esteem			
Higher self-esteem	1.00		
Lower-self-esteem	1.68	1.35,2.09	<0.001

A. Mental health visits measured as a count variable, determined by physician billing data from Health Data Nova Scotia from 1998–2011 using ICD codes 9/10 indicating mental health visit.

Table 4.3 Comparison of Zero-Inflated Poisson regression analysis predicting risk of mental health-related physician visits[A] with and without controlling for self-esteem in the model[B]

		Without self-esteem			**With self-esteem**		
Exposure	%	IRR	95%CI	p	IRR	95%CI	p
Supper with family n=3663							
Never-<1 /week	12.07	1.22	0.95,1.54	0.12	1.20	0.94,1.53	0.15
1-2 times/week	13.79	1.30	0.99,1.72	0.064	1.18	0.89,1.57	0.26
3-4 times/week	15.15	1.03	0.78,1.35	0.85	1.08	0.82,1.43	0.59
5+ times/week	59.00	1.00			1.00		
Supper alone n=3679							
Never-<1 /week	40.32	1.00			1.00		
1-2 times/week	31.24	1.04	0.81,1.33	0.78	0.99	0.77,1.27	0.93
3-4 times/week	12.79	1.47	0.98,2.21	0.062	1.35	0.90,2.03	0.15
5+ times/week	15.65	1.35	0.78,2.35	0.28	1.24	0.72,2.15	0.44
Supper in front of the tv n=3668							
Never-<1 /week	78.50	1.00			1.00		
1-2 times/week	15.74	1.09	0.87,1.36	0.47	1.03	0.82,1.31	0.78
3-4 times/week	2.99	1.32	0.98,1.78	0.064	1.30	0.97,1.75	0.082
5+ times/week	2.77	1.52	1.20,1.93	0.001	1.48	1.15,1.90	0.002
Breakfast n=3684							
Eats breakfast at home/ school, or other	96.74	1.00			1.00		
Does not eat breakfast	3.26	1.32	0.88,2.40	0.18	1.31	0.86,2.00	0.21
Lunch n=3696							
Eats lunch	99.05	1.00			1.00		
Does not eat lunch	0.95	1.81	1.05,3.14	0.034	1.83	1.11,3.03	0.018

Table 4.3 Comparison of Zero-Inflated Poisson regression analysis predicting risk of mental health-related physician visits[A] with and without controlling for self-esteem in the model[B]

		Without self-esteem			With self-esteem		
Exposure	%	IRR	95%CI	p	IRR	95%CI	p

A. Mental health visits measured as a count variable, determined by physician billing data from Health Data Nova Scotia from 1998–2011 using ICD codes 9/10 indicating mental health visit.

B. In both models, analysis incorporated the following covariates: rurality, family structure, food insecurity, stressful life event, physical activity questionnaire score, Diet Quality Index score, obesity, highest parental education, and family income.

Chapter V: Conclusions

5.0 Summary of overall findings for objectives 1 and 2

This thesis demonstrates that significant associations exist for the relationship between meal regularity and both lower self-esteem and increased mental health-related physician visits in Nova Scotian children, even after adjustment for demographic, nutrition, and social factors. In general, we observed an overall pattern where reduced meal regularity was associated with lower self-esteem and increased mental health-related physician visits in children. In both girls and boys, eating supper in front of the television, eating supper alone, and eating fewer family suppers were associated with lower self-esteem. A significant relationship was observed between skipping breakfast and lower self-esteem in boys but not girls. Eating in front of the television was significantly associated with mental health-related physician visits for boys but not girls, while the association between skipping lunch and mental health-related physician visits was significant for girls but not boys.

5.1 The relationship between self-esteem and mental health-related physician visits

Self-esteem and mental health-related physician visits are different measures related to overall mental health in children. Results of our sensitivity analyses demonstrated that only approximately one fifth of the sample were measured as having both lower self-esteem and one or more mental health-related physician visits. Further, a chi-squared test demonstrated that these variables were significantly different from each other in our sample. These results are in line with past research and indicate that a multifaceted approach that incorporates both self-reported and administrative health

data measures is necessary to accurately evaluate and monitor population mental health (122).

5.2 Potential mechanisms relating meal regularity and mental health in the present study

In the present study, reduced meal regularity was associated with both lower self-esteem and increased mental health-related physician visits in children while controlling for many potentially confounding variables such as food insecurity, SES, diet quality, and stressful life events. Although lower self-esteem and mental health-related physician visits are distinct outcomes, they are both related to childhood mental health. While certain risk factors for lower self-esteem and mental health-related physician visits in children may be similar, it is likely that some mechanisms for their relationship with meal regularity differ, especially in younger children who are likely unable to access medical care without assistance from their parents/guardians. Mechanisms relating meal regularity to mental health in children are complex and intertwined.

Bidirectional mechanisms where meal regularity impacts mental health and mental health impacts meal regularity are likely at play in the current thesis. There are plausible socioenvironmental, socioeconomic, and physiological mechanisms that may explain the observed relationships between meal regularity and mental health in children. These mechanistic pathways are complex and interrelated, and factors influencing the relationship between meal regularity and mental health are likely to exist simultaneously. For example, families of children with mental health problems may experience turbulent and stressful mealtimes due to symptoms associated with

childhood mental health problems such as difficulty controlling emotions (54,55). Further, childhood mental health problems may present somatically in the form of stomach aches or headaches, which may reduce a child's appetite and add stress to mealtimes (57). Family resources such as positive family climate and parental support are associated with childhood mental health (22). Loneliness and reduced family cohesion, caused by eating alone, eating in front of the television, or a lack of family meals may contribute to lower mental health for both boys and girls (101,102). Previous longitudinal research has certainly demonstrated that more frequent family meals may lead to increased family cohesion and better coping skills in youth, mediating the association between family meals and mental health (100). Another mechanism relating meal regularity and mental health in both girls and boys is the experience of hunger, which may be caused by socioeconomic and/or socioenvironmental factors. Regardless of the cause, prolonged hunger caused by meal skipping facilitates a decrease in blood sugar and may cause a stress response and mental health-related symptoms such as decreased concentration, irritability, and trouble controlling emotions (53,73,74). Therefore, if meal skipping occurs habitually, it may impact self-esteem and cause increased mental health difficulties in children.

Mechanisms connecting meal regularity to mental health in children may affect boys and girls differently. For example, breakfast skipping was significantly associated with lower self-esteem in boys, but not girls, while lunch skipping was significantly associated with mental health-related physician visits for girls, but not boys. As boys are diagnosed with attention related mental health issues more often compared to girls

(114), the detrimental effects of low blood sugar on attention may exacerbate existing attention issues in boys and lead to lower self-esteem (75). In contrast, girls who skip lunch may be more likely to be participating in disordered eating patterns such as dieting that could lead to the development of emotional difficulties and eating disorders that require physician care (104,105,116,117). As boys are more likely to be diagnosed with attentive-related difficulties compared to girls (114), they may also be more vulnerable to the negative impact of increased screen time including television watching during meals (110–112). Further research is necessary to elucidate mechanisms for sex differences in the associations between meal skipping and both self-esteem and mental health-related physician visits.

Additional factors associated with meal regularity that may also affect a child's self-esteem and mental health include academic performance (78), diet quality (49,60,103), parental mental health (123), race/ethnicity (124), food insecurity (69,70), and weight status (103). Although the present study included food insecurity, diet quality, and weight status in the analysis, academic performance, parental mental health, and race/ethnicity were not examined, and we cannot rule out that our findings were due to confounding of an unmeasured variable. A bidirectional relationship between meal regularity and mental health is socially and physiologically plausible, and results of the present study align with those of past studies which have certainly demonstrated an association between meal regularity mental health and numerous mental health problems in youth such as depressive symptoms (78,103) and disordered eating (104,105).

5.3 Future directions for research

Future research of meal regularity and mental health in children should focus on the identification of modifiable mediating factors. Independent of the direction of the relationship between meal regularity and mental health, the identification of modifiable mediating factors could represent important targets for multi-pronged interventions to address multiple determinants of childhood health. Longitudinal studies may help address the potential for reverse causality that exists in cross-sectional research; however, as a bidirectional relationship likely exists between meal regularity and mental health, the identification of factors that mediate this relationship may be more relevant for real life interventions than establishing causality.

Although we included many important variables in the current analysis, future studies should include additional variables such as family function, family cohesion, and parental mental health, which may be important mediating factors that could affect both meal regularity and mental health in children. The inclusion of intersex children when capturing sex and a distinct variable for gender are important for future studies to ensure children of all sexes and genders are captured. Research in middle and high school-aged children should ensure sexuality is captured, as studies have shown that youth who identify as lesbian, gay, and bisexual are at greater risk for mental health issues (21). Similarly, race/ethnicity data should be collected and included in the analysis due to the negative effects of racism on mental health (124). Mixed methods studies that include the participant's perspectives may also be valuable for identifying

mechanisms and understanding the relationship between meal regularity and mental health in children.

5.4 Implications for policy makers and practitioners

It is important to acknowledge that meal regularity represents only a fraction of the solution necessary for addressing the complexity of mental health problems in children. However, this study still has important implications that apply to both meal regularity and mental health policy and interventions. As meal regularity and mental health are related, we believe that interventions which incorporate aspects of both meal regularity and mental health are likely to be most successful. Strategies to improve childhood mental health may include meal provision programs (such as school breakfast programs) as well as programs that encourage a healthy eating environment (such as eating together programs). Although the present research demonstrates that an association exists between increased family meals and better self-esteem, families with significant dysfunction or who have children with mental illness may be reluctant to increase family meals due to past negative experiences. Strategies should be respectful of the hardships faced by families and be mindful not to place blame on the parents/caregivers. Instead, mental health programs that work with families to address problems that may arise during mealtimes could be helpful if families wish to try and increase frequency of shared mealtimes. Strategies that encourage family meals and promote decreased screen time for children, especially during mealtimes, may be other targets of intervention. Early awareness of disordered eating patterns in younger

children and programs that incorporate body positive messages that do not focus on weight may be other important strategies to improve both childhood meal regularity and mental health. Lastly, community programs with an interdisciplinary health team that incorporates both mental health professionals (social workers, psychologists, counsellors), and dietitians may be helpful for addressing the complex issues related to meal regularity and mental health.

A variety of strategies exist to help encourage meal regularity in Canada across the life span. Existing strategies include the SOUP (Sharing our underappreciated produce) program in Nova Scotia, designed to decrease loneliness and increase the mental health of community members through shared meals (125), the Nova Scotia provincial school breakfast program (126), and Meal Exchange, a university student-led program that coordinates food accessibility initiatives such as campus kitchens, food banks, gardens, and farms across Canada (127). Notably, existing programs incorporate multi-pronged solutions, focusing not only on meal regularity but also addressing issues such as mental health, socioeconomic status, and food insecurity.

Awareness of and autonomy over of meal regularity are important. It is crucial to raise awareness among policy-makers and practitioners of the complexity of meal regularity and mental health and the necessity for multi-pronged solutions. Family autonomy over mealtimes is essential to keep in mind when working with patients or designing community programs and policy. Individualized, family-oriented solutions that ensure children are well-nourished while also allowing families to decide whether increased mealtimes are a goal they are able to pursue are optimal. It is important to

recognize that family function (21,22,58,59), parental mental health (21,22), socioeconomic status (25), food insecurity (67,69,70), and race/ethnicity (25) are all associated with meal regularity and/or mental health of children; therefore, initiation of empathetic and culturally sensitive strategies that work together with children and their families are essential for success.

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Appendix A: Table 1.1: Known brain function of selected major nutrients, vitamins and minerals in brain function

Table 1.1: The role of selected major nutrients, vitamins and minerals in brain function

Nutrient	Brain function
Major nutrients	
Carbohydrates	Provides glucose, the preferred energy source for erythrocytes and nerve cells, including those of the brain. Eating carbohydrates triggers the release of insulin that helps blood glucose enter the cells. As insulin levels rise, more of the amino acid tryptophan crosses the blood brain barrier that affects levels of neurotransmitters such as serotonin.
Fat	The lipid concentration of the brain partly reflects the dietary intake. About 35% of the brain/nervous system tissue comprises polyunsaturated fatty acids that include the essential fatty acids, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA). EPA and DHA form phospholipids in brain cell membranes and have important roles in signal transduction.
Protein	Provide amino acids; the precursors of neurotransmitters, and therefore facilitates neurotransmission and neuromodulation. The dietary precursors of serotonin (precursor is tryptophan), dopamine (precursor is phenylalanine), norepinephrine (precursor is tyrosine), and histamine (precursor is histamine) have been the main protein derivatives investigated.
Vitamins	
Thiamin (Vitamin B1)	Functions as a coenzyme in the synthesis of acetylcholine, γ-aminobutyric acid (GABA), and glutamate Can mimic action of acetylcholine
Thiamin (Vitamin B3)	Nicotinamide adenine dinucleotide (NADH) increases tyrosine hydroxylase activity and dopamine production in pheochromocytoma cells Involved in synthesis of serotonin (5-HT)
Pyridoxine (Vitamin B6)	Role in the synthesis of many neurotransmitters (e.g., dopamine, serotonin, norepinephrine, epinephrine, histamine, GABA) Deficiency tends to reduce production of serotonin and GABA

Table 1.1: The role of selected major nutrients, vitamins and minerals in brain function

Nutrient	Brain function
Folate, Folic Acid (Vitamin B9)	Functions as a cofactor for enzymes that convert tryptophan into serotonin and tyrosine into norepinephrine/noradrenaline Can heighten serotonin function by slowing destruction of brain tryptophan Helps form compounds involved in brain energy metabolism Involved in the synthesis of dopamine
Cobalamin (Vitamin B12)	Involved in the synthesis of monoamine neurotransmitters Involved in maintaining myelin sheaths for nerve conductance Functions in folate metabolism
Pantothenic Acid	Changes to coenzyme A that helps convert macronutrients into energy Production of red blood cells, hormones, and nerve regulators Needed for the uptake of amino acids and acetylcholine Is necessary to make vitamin D and works closely with B vitamins such as biotin, niacin, vitamins B1, B2, and B6
Vitamin C	Acts as part of the intracellular antioxidant network, and is an important neuroprotective constituent Acts as a neuromodulator and enzyme cofactor in noradrenaline and dopamine synthesis
Vitamin D	1,25-Dihydroxyvitamin D3 affects cholinergic activity in several brain regions and may have a role in the neuroendocrine regulation of certain aspects of anterior pituitary function
Vitamin A	Retinoids influence hormone pathways (steroid and thyroid hormones) known to cause mood elevation and depression
Vitamin E	Alpha-tocopherol protects cells from damage by free radicals May reduce brain amyloid beta peptide accumulation, known to be relevant in Alzheimer's disease
Vitamin K	Involved in the development of the nervous system and affects calcium regulation in the brain through osteocalcin
Choline	Essential roles in structural integrity of cell membranes, cell signaling (precursor to acetylcholine), and nerve impulse transmission Major source of methyl groups for methylation reactions
Minerals	
Calcium	Important intracellular messenger, cofactor for enzymes and release of neurotransmitters
Copper	Modulator of NMDA-receptor activity

Table 1.1: The role of selected major nutrients, vitamins and minerals in brain function

Nutrient	Brain function
Chloride	Negatively charged chloride ions cause influx of sodium ions and reverts the brain cell to its resting state
Chromium	Involved in glucose and lipid homeostasis
Iron	Essential cofactor for the production of ATP Plays an essential role in hemoglobin for ensuring there is sufficient oxygen in the brain for oxidative metabolism Functions in the enzyme system involved in the production of serotonin, norepinephrine, epinephrine, and dopamine
Magnesium	Functions as a coenzyme; roles in the metabolism of carbohydrates and fats to produce ATP, and in the synthesis of nucleic acids (DNA and RNA) and proteins Important for the active transport of ions (such as potassium and calcium) across cell membranes, and for cell signaling
Manganese	Manganese deficiency results in lowering the catecholaminergic content of the brain
Phosphate	Helps maintain membrane potential and role in energy metabolism
Potassium	In the brain, potassium channels regulate neuronal signaling. Potassium channels may also regulate cell volume and protect neurons under metabolic stress. Role in energy metabolism
Selenium	Glutathione peroxidase maintains the integrity of the cellular and subcellular membranes. This antioxidative protective system of glutathione peroxidase depends heavily on selenium.
Sodium	Voltage-gated sodium channels allow sodium ions to enter the brain cells
Vanadium	Inhibits Na+-K+-ATPase pump activity
Zinc	Roles in protein synthesis, as well as structure and regulation of gene expression Serves in neurons and glial cells. Certain zinc-enriched regions (e.g., hippocampus) are especially responsive to dietary zinc deprivation, which can cause learning impairment and olfactory dysfunction

Appendix B: Copyright permission letter from Dietitians of Canada for request to use Table 1.1: The role of selected major nutrients, vitamins and minerals in brain function

Arbab Qayyum, Nov 28, 15:22 EST:

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Appendix C: Univariate analysis comparison

Table 2.5: Univariate analysis comparison predicting the odds of lower self-esteem a using four different specifications of logistic regression for grade five children of the 2011 Children's Lifestyle & School performance Study (CLASS-II) in Nova Scotia, Canada

Variable	**Method 1[b]**	**Method 2[c]**	**Method 3[d]**	**Method 4[e]**
Family income				
0 (<20,000$/year)	2.07 (1.46,2.92)	2.12 (1.49,3.01)	2.10 (1.45,3.04)	2.27 (1.60,3.22)
1 (20,000-40,000$/year)	1.83 (1.48,2.27)	1.91 (1.55,2.36)	1.91 (1.54,2.35)	2.06 (1.65,2.57)
2 (40,000-60,000$/year)	1.35 (1.11,1.65)	1.36 (1.12,1.66)	1.35 (1.12,1.63)	1.37 (1.13,1.66)
3 (>60,000)	1.00	1.00	1.00	1.00
4 (Prefer not to answer)	1.19 (0.98,1.45)	1.18 (0.97,1.44)	1.18 (0.97,1.43)	1.21 (0.99,1.47)
Parental education				
0 (secondary or less)	1.57 (1.24,2.00)	1.68 (1.33,2.13)	1.63 (1.26,2.11)	1.66 (1.26,2.19)
1 (Community or tech college)	1.37 (1.11,1.69)	1.39 (1.13,1.76)	1.35 (1.08,1.69)	1.35 (1.07,1.69)
2 (University)	1.09 (0.87,1.36)	1.07 (0.86,1.34)	1.07 (0.85,1.34)	1.05 (0.83,1.33)
3 (Graduate university)	1.00	1.00	1.00	1.00
4 (prefer not to answer)	1.75 (1.08,2.83)	1.73 (1.07,2.81)	1.74 (1.08,2.79)	1.70 (1.05,2.76)
Rurality				
0 (rural)	1.49 (1.27,1.74)	1.47 (1.27,1.71)	1.46 (1.23,1.74)	1.42 (1.27,1.81)
1 (urban)	1.00	1.00	1.00	1.00
Family structure				
0 (2 people)	1.31 (0.87,1.96(	1.25 (0.84,1.85)	1.28 (0.85,1.92)	1.35 (0.92,1.98)
1 (3 people)	1.34 (1.10,1.63)	1.36 (1.11,1.66)	1.36 (1.10,1.67)	1.38 (1.12,1.69)
2 (4 people)	1.00	1.00	1.00	1.00
3 (5 people)	1.12 (0.94,1.35)	1.12 (0.94,1.34)	1.12 (0.91,1.39)	1.13 (0.92,1.40)
4 (more than 5 people)	1.20 (0.95,1.91)	1.21 (0.97,1.51)	1.29 (0.95,1.5)	1.23 (0.97,1.56)

Table 2.5: Univariate analysis comparison predicting the odds of lower self-esteem a using four different specifications of logistic regression for grade five children of the 2011 Children's Lifestyle & School performance Study (CLASS-II) in Nova Scotia, Canada				
Food insecurity				
0 (Often true)	1.87 (1.16,3.02)	2.03 (1.25,3.3)	1.98 (1.21,3.24)	2.18 (1.42,3.35)
1 (Sometimes true)	1.56 (1.24,196)	1.56 (1.24,1.95)	1.55 (1.23,1.94)	1.63 (1.32,2.03)
2 (Never true)	1.00	1.00	1.00	1.00
3 (Prefer not to answer)	1.08 (0.61,1.90)	1.09 (0.62,1.91)	1.12 (0.59,2.12)	1.09 (0.54,2.18)
Physical activity				
0 (<=median)	1.88 (1.62,2.19)	1.83 (1.58,2.13)	1.87 (1.59,2.20)	1.89 (1.62,2.21)
1 (> median)	1.00	1.00	1.00	1.00
Diet quality				
0 (<= median)	1.83 (1.59,2.10)	1.89 (1.65, 2.18)	1.88 (1.65,2.15)	1.89 (1.66,2.15)
(REF) 1 (>median)	1.00	1.00	1.00	1.00
Stressful life event				
0 (yes)	1.48 (1.27,1.71)	1.48 (1.28, 1.72)	1.49 (1.27,1.75)	1.56 (1.32,1.84)
1 (no)	1.00	1.00	1.00	1.00
2 (unsure/prefer no answer)	1.73 (1.14,2.62)	1.81 (1.19,2.77)	1.80 (1.18,2.75)	1.97 (1.32,2.93)
Breakfast				
0 (eats breakfast at home/school, or other)	1.00	1.00	1.00	1.00
1 (Does not eat breakfast)	1.81 (1.21,2.72)	1.94 (1.29,2.90)	1.89 (1.20,2.97)	1.84 (1.15,2.94)
Lunch				
0 (Eats lunch)	1.00	1.00	1.00	1.00
1 (Does not eat lunch)	2.37 (1.06,5.29)	2.21 (0.98, 4.96)	2.31 (0.93,5.71)	2.45 (0.97,6.19)
Supper in front of the tv				
0 (never/<1 time/week)	1.00	1.00	1.00	1.00
1 (1-2 times/week)	1.27 (1.07,1.51)	1.29 (1.09,1.52)	1.27 (1.08,1.51)	1.28 (1.09,1.50)

Table 2.5: Univariate analysis comparison predicting the odds of lower self-esteem a using four different specifications of logistic regression for grade five children of the 2011 Children's Lifestyle & School performance Study (CLASS-II) in Nova Scotia, Canada				
2 (3-4 times/week)	1.71 (1.38,2.12)	1.76 (1.42, 2.19)	1.74 (1.39,2.17)	1.74 (1.39,2.18)
3 (5+ times/week)	2.11 (1.69,2.63)	2.16 (1.74,2.68)	2.16(1.70,2.74)	2.15 (1.70,2.73)
Supper alone				
0 (never/<1 time/week)	1.00	1.00	1.00	1.00
1 (1-2 times/week)	1.84 (1.51,2.25)	1.86 (1.53, 2.26)	1.86 (1.52,2.28)	1.86 (1.52,2.27)
2 (3-4 times/week)	1.96 (1.29,2.96)	2.00 (1.32, 3.06)	2.01 (1.25,3.22)	2.01 (1.24,3.25)
3 (5+ times/week)	3.61 (2.19,5.96)	3.97 (2.41, 6.54)	3.85 (2.32,6.4)	3.84 (2.29,6.45)
Supper with family				
0 (never/<1 time/week)	2.19 (1.75,2.74)	2.25 (1.79,2.18)	2.25 (1.80,2.82)	2.22 (1.76,2.80)
1 (1-2 times/week)	2.07 (1.68,2.57)	2.19 (1.76,2.71)	2.18 (1.74,2.74)	2.20 (1.74,2.76)
2 (3-4 times/week)	1.31 (1.08,1.59)	1.34 (1.10,1.62)	1.32 (1.09,1.59)	1.30 (1.08,1.58)
3 (5+ times/week)	1.00	1.00	1.00	1.00

A. Self-esteem originally measured as a score from 10-30. Self-esteem was categorized by self-esteem score; 0 = <=median score (26) & 1= >median score (26)
B. Method 1: Analysis conducted using multiple imputation and mixed effects model
C. Method 2: Analysis conducted using multiple imputation and survey weights
D. Method 3: Analysis conducted using multiple imputation, mixed effects model & survey weights
E. Method 4: Analysis conducted using mixed effects model & survey weights

Appendix D: HDNS Contractual Agreement for Data Access and Management statement

“Portions of the data used in this report were made available by Health Data Nova Scotia of Dalhousie University. Although this research is based on data obtained from the Nova Scotia Department of Health and Wellness, the observations and opinions expressed are those of the authors and do represent those of either Health Data Nova Scotia or the Department of Health and Wellness”.

Appendix E: Student contribution to manuscript

For both manuscripts, I, the student, developed the topic, completed a review of the literature, applied for ethics and data access, analyzed data, interpreted results, and wrote the manuscripts.

Appendix F: Publication status statement

Both Chapter II (manuscript 1) and Chapter III (manuscript 2) are under development and have not yet been submitted for publication.