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Maternal Employment During Infancy and Toddlerhood: Mechanisms for Associations with Childhood Overweight/Obesity in Canada

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MATERNAL EMPLOYMENT DURING INFANCY AND TODDLERHOOD: MECHANISMS FOR ASSOCIATIONS WITH CHILDHOOD OVERWEIGHT/OBESITY IN CANADA

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Abstract

Background: Childhood overweight and obesity is a major public health issue, with approximately 1 in 3 children classified as overweight or obese in Canada. Research suggests that maternal employment during childhood may be associated with later overweight and obesity risk, but it is not known whether employment during infancy and toddlerhood has a similar effect on weight status. Mechanisms such as reduced breastfeeding and use of informal child care have been proposed in the literature but not been formally tested among infants and toddlers. It is important to identify possible mechanisms that could explain the association with overweight and obesity risk in order to identify strategies for prevention.

Objectives: The objective of this study was to investigate, in a Canadian sample, whether maternal employment during infancy and toddlerhood is associated with a higher risk of childhood overweight/obesity. A secondary objective was to determine whether breastfeeding and type of child care mediate this association.

Methods: Data were obtained from the National Longitudinal Survey of Children and Youth, a nationally representative survey of Canadian children conducted by Statistics Canada. A cohort of children ages 0-2 years in Cycle 3 (1998/1999) with follow-up information in Cycle 7 (2006/2007) was used for the analysis. Modified Poisson regression was used to examine whether maternal employment (no work, part-time, full-time) during infancy and toddlerhood was associated with overweight/ obesity risk at ages 8-10 years. A mediation analysis determined whether breastfeeding (0-4 weeks, 5 weeks to 6 months, >6 months) and child care (no child care, informal care, formal care) mediated the association. Analyses were stratified by gender and adjusted for known confounders.

Results: Maternal employment in infancy and toddlerhood was not significantly associated with overweight/obesity in girls at ages 8 to 10 years. In boys, adjusted analyses indicated an increased risk (RR=1.38, 95% CI=1.04-1.84) of overweight/obesity for full-time maternal employment in infancy and toddlerhood. The association was non-significant in a sensitivity analysis. Breastfeeding for 4 weeks or less was associated with an increased overweight/obesity risk in boys compared to breastfeeding for over 6 months. This study contributes evidence in support of ensuring that all mothers receive the opportunity for maternity leaves for a minimum of 6 months, allowing adequate breastfeeding support.

Keywords

maternal employment; overweight; obesity; childhood; infancy; toddlerhood; breastfeeding; child care

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List of Abbreviations

BMI	Body Mass Index
CDC	Centers for Disease Control
CI	Confidence interval (95%)
ECD	Early Childhood Development
IOTF	International Obesity Task Force
LGA	Large-for-gestational age
NLSCY	National Longitudinal Survey of Children and Youth
OR	Odds ratio
PMK	Person Most Knowledgeable
RDC	Research Data Centre
RR	Relative risk
SGA	Small-for-gestational age
WHO	World Health Organization

Chapter 1 Introduction and Research Objectives

1.1 Introduction

Childhood overweight and obesity reflect a state in which fat accumulation in the body reaches abnormal and excessive levels during childhood.[1] Adverse health consequences resulting from childhood overweight and obesity are well documented in the literature. In particular, overweight and obese children are at increased risk for cardiovascular disease, hypertension, early atherosclerosis and other chronic conditions such as sleep apnea, asthma and Type 2 diabetes.[2–5]

Childhood overweight and obesity is a major public health issue in North America. Recent statistics show that in the US, 32.6% of children aged 6 to 11 years are classified as overweight or obese.[6] Data from the 2009-2011 Canadian Health Measures Survey show that approximately 20% of children aged 5 to 11 years are overweight, and 13% are obese.[7] Obesity rates in children have more than doubled over the last three decades.[6] In Canada, 13% of children aged 6 to 11 years were classified as overweight and obese in 1978/79; by 2004, the prevalence of overweight and obesity among children of the same age increased to 26%.[8]

Body Mass Index (BMI) is the most common method of measuring overweight and obesity for children between the ages of 2 to 20 years. A BMI value is obtained by dividing weight in kilograms by height in metres squared; this value is then used to classify children as either overweight or obese according to established age- and sex- specific standards. Although BMI is an imprecise measure of body fat compared to other measures such as skinfold thickness and underwater measurement, it is the most widely used measure of obesity in epidemiological studies.[9] Epidemiological studies commonly rely on the definitions from the International Task Force on Obesity (IOTF), the Centers for Disease Control (CDC) and the World Health Organization (WHO) to classify child weight status.[10–12]

Given that overweight and obese children are also more likely to become obese adults compared to normal weight children,[13,14] the high prevalence of overweight and obesity in children is alarming. Overweight and obesity and their associated conditions have been shown to place a considerable economic burden on the health care system through both direct

and indirect costs.[15] Estimates show that in 2001, the costs associated with obesity totaled $4.3 billion.[15] This estimate is a sum of obesity's direct costs ($1.6 billion) such as treatment and care expenditures due to illness or injury, and indirect costs ($3.7 billion) such as lost economic output due to work absence, work-related injury and premature death.[15]

The root causes of overweight and obesity are complex and involve a wide range of individual, social, environment and biological determinants.[16] Recently, maternal employment during childhood has been examined in the literature as a possible contributing factor to children's risk of overweight and obesity. Results have generally indicated that children of employed mothers are more likely to be overweight and obese relative to children of mothers who are not employed. Little is known about whether a corresponding association exists when exposure to maternal employment occurs during the first two years of a child's life.

The objective of this study is to investigate whether maternal employment during infancy and toddlerhood is associated with an increased risk of childhood overweight and obesity in Canada. Furthermore, potential mechanisms that may explain the association are examined. Specifically, this research will examine whether breastfeeding and child care mediate the association between maternal employment and childhood overweight and obesity. The ultimate goal of this research is to investigate the complex relationship between maternal employment during infancy and toddlerhood and childhood obesity. A greater understanding of the factors that contribute to childhood overweight and obesity would help to identify appropriate changes in public policy. If maternal employment, through its effects on breastfeeding duration and type of child care arrangement, is found to increase the risk of children's overweight and obesity, mother-friendly policies may be implemented in Canada to provide support for mothers in employment. Changes in policy that address the contributing factors of overweight and obesity risk would serve as prevention strategies that may help decrease the incidence of childhood overweight and obesity among Canadian children.

1.1.1 Maternal Employment and Childhood Overweight and Obesity

In Canada, the employment rate among women with a child under the age of 3 years more than doubled between 1976 and 2009, with 64.4% of women with young children

participating in the labour force in 2009 compared to 27.6% in 1976.[17] The coinciding increases in childhood overweight and obesity and maternal employment over the last three decades have led researchers to investigate whether maternal employment may be one of the factors associated with childhood overweight and obesity.

Maternal employment has been shown to increase children's risk of overweight and obesity.[18–23] Speculation as to whether the relationship between children's weight status and mother's employment status is causal or artifact, and, if causal, what might explain the association, has led some researchers to pay further attention to the mechanisms by which they may be linked. Most studies have focused their attention on potential mechanisms of significance in early and middle childhood (3 to 11 years of age), while fewer studies have focused on factors that may be of significance at earlier ages. Furthermore, among studies examining the link between maternal employment in childhood and childhood overweight and obesity, few have formally investigated whether breastfeeding duration and type of child care arrangement in infancy and toddlerhood mediate the association.

Employment during the first two years of a child's life has a particular impact on children's early-life experiences. Specifically, limitations on a mother's availability resulting from employment may impact breastfeeding behaviour in the first year of life as well as care arrangements during both infancy and toddlerhood. Mothers who return to work following childbirth may be less likely to initiate breastfeeding or to breastfeed for longer durations. Furthermore, employment during the first two years may necessitate alternate care arrangements for infants, who are less likely to be under the sole care of their mothers compared to mothers who do not work.

1.1.2 Breastfeeding and Childhood Overweight and Obesity

Breastfeeding plays an important role in infant health.[24] Exclusive breastfeeding for the first six months of an infant's life meets their nutritional needs[25] and also confers a wide range of immune and physiological benefits, including reduced risk of gastrointestinal infections, respiratory infections, and Sudden Infant Death Syndrome.[24,26] A substantial body of evidence shows that breastfeeding is protective of childhood overweight and obesity.[27–29] Relative to children never breastfed, children who are breastfed are significantly less likely to become overweight or obese.[30–33] In addition, longer breastfeeding duration is associated

with a greater reduction in child and adolescent obesity risk compared to shorter durations of breastfeeding.[27,28,32–34]

Both Health Canada[35] and the American Academy of Pediatrics[36] recommend that women exclusively breastfeed for six months or longer. However, these recommendations are not being followed: in Canada, only 25.9% breastfed for 6 months or longer;[37] among American women, only 13% exclusively breastfed for the recommended duration.[36]

Studies have shown a negative association between maternal employment during an infants' first year of life and the initiation and duration of breastfeeding.[38–41] Women who are not employed within the first six months following delivery are estimated to be 1.55 to 2.85 times more likely to be exclusively breastfeeding at six months compared to women who return to work following childbirth.[38,42] It could be speculated that the reduced duration of breastfeeding associated with maternal employment during an infant's first year may be a mediator in the association between maternal work and overweight and obesity risk.

1.1.3 Child Care and Childhood Overweight and Obesity

Employment during a child's first two years has direct consequences on a woman's ability to provide care for her child in the home.[43] The use of non-parental care for infants and toddlers is common. Statistics from the National Longitudinal Survey of Children and Youth (NLSCY) show that in 2002-2003, 56.1% of Canadian children under the age of two years were under non-parental care, with more than half of that figure consisting of children between six months to one year of age.[44] Two-parent households in which the mother works have been shown to make greater use of alternative child care arrangements compared to households where the mother does not work.[43] In Canada, mothers employed during pregnancy are seven and five times more likely to use both formal (paid) and informal (unpaid) child care arrangements relative to providing care themselves.[45]

Research shows that the use of non-parental care may increase children's risk of becoming overweight or obese. Children in various types of non-parental care arrangements during infancy are more likely to be obese than those under the care of their parents.[46] Some research suggests that the type of alternative care arrangements matter. It has been shown, for instance, that informal care arrangements, such as care by a relative or by a friend, puts

children at increased risk of overweight and obesity compared to formal arrangements such as care in a nursery or by a nanny.[47] Time spent in alternative care may also play a role: results from some studies indicate that the risk of obesity increases with additional hours spent under non-parental child care arrangements per week.[47–49]

These findings highlight the possibility that child care may contribute to the increased risk of overweight and obesity among children of working mothers.

1.2 Research Objectives

This thesis has 3 objectives:

1) Examine whether maternal employment during infancy and toddlerhood (0 to 2 years) is associated with an increased risk of childhood obesity at ages 8 to 10 years.

It is hypothesized that compared to no employment, maternal part-time and full-time work during infancy and toddlerhood is associated with an increased overweight/obesity risk at 8 to 10 years of age. Furthermore, a dose-response relationship between maternal employment and children's obesity risk is expected, where overweight/obesity risk is highest among children whose mothers work full time and is lowest among non-employed mothers.

2) Determine whether breastfeeding duration mediates the association between maternal employment during the first two years and childhood overweight/obesity risk at ages 8 to 10 years.

It is hypothesized that breastfeeding serves as a partial mediator in the association between maternal employment during infancy and toddlerhood and childhood overweight/obesity risk at ages 8 to 10 years.

3) Determine whether child care type during infancy and toddlerhood mediates the association between maternal employment and childhood overweight/obesity risk at ages 8 to 10 years.

It is hypothesized that type of child care arrangement serves as a partial mediator in the association between maternal employment during infancy and toddlerhood and children's risk of overweight/obesity at ages 8 to 10 years.

Chapter 2 Literature Review

2.1 Literature Search Strategy

The Medline - Ovid search engine was used to identify relevant articles relating to this topic. For detailed information on the search strategy, see Table A.1 in Appendix A. Separate searches were conducted for the effect of maternal employment on childhood overweight and obesity, as well as its impact on breastfeeding and child care. Additional searches were conducted on the relationship between both breastfeeding and child care and children's weight status. Journal articles published before the year 2000 and articles not in English were excluded. Further exclusions were made for studies conducted on samples from countries that were not OECD members. Abstracts from the remaining results were reviewed for relevance. Both an ancestry search and a Scopus database search were carried out in order to identify remaining articles and to ensure relevant studies were not missed. The final results are as follows: 1) maternal employment and childhood overweight and obesity (n=28), 2) maternal employment and breastfeeding (n=21), 3) maternal employment and child care (n=4), 4) breastfeeding and childhood overweight and obesity (n=69), and 5) child care and childhood overweight and obesity (n=12). Note that these represent categories that are not mutually exclusive, as one article may be relevant for multiple categories.

2.2 Maternal Employment and Childhood Overweight and Obesity

Research investigating the link between maternal employment and childhood obesity has focused on several aspects of employment patterns, including labour force participation,[18–23,50–55] hours worked,[18,20,21,23,51,56–58] timing of employment,[18,23,56,57] and whether the effect of maternal work on childhood obesity is immediate, lagged, or cumulative.[21,23,51,54,57]

2.2.1 Maternal Employment Status

Work force participation following a child's birth may have significant consequences on children's weight status. In general, studies have shown that mothers who are employed have children who are more likely to be overweight or obese compared to non-employed mothers. Research has demonstrated a significant positive relationship between maternal employment

and childhood overweight and obesity, accounting for a range of demographic, maternal, and child confounders.[18–23,50,51,53–55]

Studies conducted in North America[18,22,56] and internationally[20,21,23,52,59] have found an effect of maternal employment on children's weight status. Data from the National Longitudinal Survey of Youth in the United States reveals a higher prevalence of obesity in 3 to 11 year-old children of employed mothers compared to children of non-employed counterparts.[18] In this sample, an increase in obesity prevalence was observed moving from no employment (9.4%) to part-time (10.1%) and full-time (12.9%) employment.[18] Analyzing 13,113 singleton children from the UK Millennium Cohort Study, one study found a positive association between any employment since the child's birth and the risk of childhood overweight and obesity at age 3 years (adjusted OR=1.15, 95% CI=1.02, 1.29) relative to no employment since the child's birth.[21]

Analysis of the same UK sample showed that compared to children whose mothers did not work following childbirth, children whose mothers worked 21 or more hours per week were 1.23 times as likely to be obese at age 3 years (95% CI=1.10-1.37), adjusting for a wide range of confounders.[52] In Japan, children of non-employed mothers, compared to children of mothers who work full-time, have been found to have a lower likelihood of overweight, but not obesity at 12 to 13 years of age, though this relationship was only marginally significant (OR=0.82, 95% CI=0.68-1.00).[20] Increased odds of overweight and obesity were observed among Japanese children aged 3 to 6 years whose mothers were employed relative to children whose mothers were not employed.[60]

While most research has shown an association between maternal employment and childhood obesity, some studies fail to find a significant positive relationship between maternal work and children's weight status.[61–64] Hubbard,[63] for instance, finds that maternal employment and childhood obesity are negatively associated. After accounting for unobserved heterogeneity, full-time employment, compared to no employment, was associated with a reduced risk of obesity among children under non-parental care arrangements for less than 5 hours a week.[63] Among mothers who are full-time employed and using child care regularly, the negative cross-sectional association between employment and weight status attenuated but remained significant.[63] Looking at long-term effects of maternal employment using

simulated data, Hubbard[63] finds that compared to not working and not using child care, children of full-time and part-time employed mothers who do not use child care have a decreased risk of obesity.

Greve[62] shows that in Denmark, maternal employment is associated with lower BMI in children in formal day care settings, and has no effect in children cared for by family. The Danish example, however, may be a special case, as results from this study lend support to the hypothesis that the quality of child care in Denmark may account for the lack of a statistical relationship between maternal work and the probability childhood overweight.[62] Results from Hubbard[63] and Greve[62] bring attention to the role of child care in the overweight and obesity status of school-aged children.

Using cross-sectional data from 5 to 15 year old Australian children, Taylor et al.[64] did not find an increased likelihood of overweight or obesity for children of full-time employed mothers compared to children of non-employed and part-time employed mothers. Another Australian study[61] shows that adolescent children are more likely to have a lower BMI if their mothers are working on a full- or part-time basis compared to adolescents of non-employed mothers. According to Bishop,[61] this may be due to a differential impact of maternal employment on adolescents and younger children. During the adolescent years, the time and activities that mothers invest to produce their children's health may contribute to some, but not all, dimensions of health such as weight.[61] Mothers' time allocation decisions may, for example, contribute to children's safety by driving them to school, but this could also result in reduced time spent in physical activity.[61] Non-significant findings may also be attributable to relatively small sample sizes resulting in imprecise estimates,[61,64] bias introduced due to self-reported BMI,[64] and failure to control for important confounders such as birth weight.[64]

Research has shown that maternal labour force participation and childhood overweight and obesity are associated. Although the association is fairly well established, the nature of the association is not well understood, as studies demonstrate both positive and negative associations. Studies suggest a differential effect of maternal employment on weight status depending on mother's work status as well as children's ages.

2.2.2 Maternal Work Hours and Evidence of a Dose-response Relationship

Research on the relationship between maternal employment and childhood overweight and obesity has paid a great deal of attention to the effects of the intensity of work participation, measured by a categorical work status variable, or average hours worked per week.[18,19,21,22,51,55–57,61–63] Results from these studies have contributed to the understanding of the nature of the relationship between maternal employment and children's weight status, specifically whether there is a dose-response association.

The intensity of maternal labour force participation has been shown to be associated with children's weight status.[18,20–23,51,54–58] While the majority of results demonstrate positive linear associations between hours worked and childhood overweight and obesity,[18,21,22,50,55,56] findings have not been entirely consistent. Some studies fail to find evidence of a dose-response relationship,[19,61] and others reveal that maternal work and childhood overweight and obesity are negatively associated.[57,62,63] Finally, results from some research show little to no evidence of a relationship between hours spent in employment and children's weight status.[65,66]

Evidence of a dose-response association has been provided by studies that estimate an increase in children's overweight and obesity risk with additional hours worked per week by the mother. The BMI of children with full-time employed mothers has been shown to be significantly higher[20] and more likely to indicate excessive weight gain[67] than part-time employed mothers compared to non-employed mothers. In Hawkins et al.'s research,[21] children of all mothers had 1.12 times the odds of becoming overweight or obese for every additional ten hours worked by their mother. Furthermore, among mothers in employment, every additional 10 hours of work was associated with 1.15 times the odds of overweight and obesity risk in children.[21] Children have been found to have an increased risk of obesity ranging from 1.2 percentage points[18] to as high as 4 percentage points[56] for every additional 10 hours of paid weekly work. Using simulated data that held explanatory variables constant at average values while allowing only maternal work hours to vary, Phipps et al.[55] show that for each additional 15 hours of average paid work a week, the probability of childhood overweight and obesity increases by 3 to 5 percentage points. Anderson[50] finds that working an additional 20 hours per week, similar to moving from part-time to full-time work,

increases children's obesity risk by 1 percentage point, while Ruhm[22] finds that for an extra 20 hours of weekly employment, obesity and overweight risk increases by 1.6 to 3.0 percentage points.

While there is evidence of a dose-response or a linear relationship between maternal employment and childhood overweight and obesity risk, results from some studies provide evidence to the contrary.[19,51,61–63] In one study, an increased risk of overweight/obesity was found for children whose mothers worked 35 to 44 hours per week compared to children of mothers worked 16 to 34 hours per week; however, no significant difference was detected between children of mothers working less than 15 hours or 45 or more hours compared to working 16 to 34 hours.[19]

A number of studies have found that maternal employment is protective of children's overweight and obesity, rather than being associated with an increased risk.[51,57,62] These results are in contrast with other existing studies[18,20–22,50,55,56] that find that the more a mother works, the more likely her child is to become overweight or obese. Brown et al.[51] find that that longer maternal work hours during mid-childhood are directly associated with increased child weight in a cross-sectional analysis. However, researchers discovered a protective association both cross-sectionally and prospectively among children of part-time employed mothers compared to children whose mothers are not employed or are full-time employed. While Miller[57] finds an increased rate of obesity in 9 to 11 and 12 to 14 year old children when their mothers are employed during those periods, maternal work hours at 6 to 8 years was associated with a decreased rate of obesity during the same period, and a decreased rate of obesity several years later. In a Danish study conducted by Greve,[62] additional weekly work hours from 4 years prior were associated with reduced child weight among 7 ½ year old children.

Some studies find little to no relationship between hours worked per week and children's weight status.[65,66] Limited evidence of a relationship between hours spent in employment and childhood overweight and obesity is apparent in two recent studies using Canadian[66] and European[65] data. Chowhan and Stewart show that among Canadian adolescents aged 12 to 17 years, neither maternal average hours worked per week over the past year, nor average hours currently worked are associated with overweight or obesity.[66] However, in some subgroups

and using certain statistical models, hours of work were related to a higher likelihood of overweight.[66] Gwozdz et al. investigated the association between maternal employment and childhood obesity among children aged 2 to 9 years across 8 European countries.[65] Results from this study revealed a modest association between full-time employment and obesity among children of low socioeconomic status mothers, and among children at the upper end of the distribution of child fatness for full-time employment.[65] Little evidence of an association between increased child fatness and part-time employment was provided by this study.[65] Furthermore, the relationships varied significantly with the type of fatness measure used.[65]

Studies that have not detected a dose-response relationship between maternal employment and children's weight status, as well as those that have not detected an association between the intensity of employment and overweight and obesity are generally based on samples outside of North America.[19,51,61,62,65] It is possible that the structure and policies surrounding maternity leave and child care in these countries differ from North American standards and may account for these results. For instance, policies that are targeted towards helping mothers achieve a work-life balance may help to lessen the consequences of maternal absence from the home. Furthermore, differences in eligibility for maternity leave, the length of maternity leave, as well as the cost and quality of available child care, could alter the employment-obesity association.

Other possible explanations for the null and negative findings of the aforementioned studies must be considered. The choice to assign mothers who work 16 to 34 hours per week as the reference group for logistic regression in Champion et al.,[19] rather than selecting mothers who work less than 15 hours as the reference, may have contributed to the difficulty in detecting a dose-response relationship. Some studies relied on relatively small sample sizes[19,61] resulting in imprecise estimates.[61] Although Miller[57] provides evidence of a negative relationship between maternal work hours and childhood overweight and obesity in a sample of children from the US, he finds that the effect is driven primarily by the low-income and single-mother households. Additionally, it is not clear whether the relationship between maternal work and overweight and obesity risk in adolescence[61,66] is comparable to the impact of maternal work during childhood. It may also be the case that the nature of the relationship between employment and children's weight status vary depending on factors such as children's age, household income,[18,22,56,57] maternal leave policies and cultural norms.

Studies conducted in North American settings find that a mother's work status and work intensity are associated with children's overweight and obesity risk. These studies have demonstrated a positive dose-response association, such that more hours worked by a mother results in higher overweight or obesity risk in her children. Based on other studies, however, it appears that the nature of the relationship may vary by the setting and by the sub-sample in which it is examined. Furthermore, some studies show that the association is driven by children from high-income households, and others indicate the strongest association among children from low-income households.

2.2.3 Timing of Maternal Employment

Research investigating the impact of maternal employment on children's weight status has provided some insight as to whether there is a critical stage when children are most vulnerable to the effects of their mother's labour force participation. Several studies have examined whether the timing of mother's employment has a differential impact on childhood obesity depending on children's ages.[18,23,56,57] Results have not been consistent across studies, with some studies emphasizing the importance of work in middle childhood[18,23,57] and others providing some evidence that exposure to work in early childhood[56,57] may also be important.

Anderson et al.[18] separated their study sample of 3 to 11 year old children into preschool children (3 to 5 years) and school-aged children (6 to 11 years) to determine whether the timing of employment since a child's birth is important for the effect of employment on obesity. While descriptive data suggested that the average number of hours worked per week had a larger impact on school-aged children, this finding was not confirmed in statistical analysis.[18] Scholder,[23] who studied whether the timing of maternal employment plays a role in determining overweight and obesity status, also identified the importance of maternal employment during middle childhood. Although full-time employment when the child was 7 years of age was associated with a 5.5 percentage point increase in the probability of being overweight, neither maternal employment during preschool years, nor employment at age 11 years predicted obesity at age 16 years.[23]

While results from some studies emphasize the importance of mid-childhood,[18,23] there is some evidence that maternal labour force participation in early childhood may also play a role in children's weight status.[56,57] Miller[57] found a marginally significant effect ($p<0.10$) for

maternal work during infancy, but employment during this stage was associated with a decrease rather than an increase in obesity rates among 6 to 8 year old children. Investigators studying Canadian children aged 6 to 11 years found that conditional on the mother returning to work between the child's birth and start of school, an increase of an average of 10 weekly work hours upon first returning to work was associated with a 2.5 to 4 percentage point increase in overweight and obesity risk.[56] Since approximately 85% of the sample in this study consisted of women who returned to work before their infants reached the age of 2 years, the authors suggested that maternal work in the first few years of life may affect important mechanisms that lead to obesity in later childhood.[56]

Based on the literature, it is not clear whether children of certain ages are particularly vulnerable to the effect of maternal employment on their overweight and obesity risk. It is also not understood whether employment when children are under 3 years has an impact on later overweight and obesity risk.

2.2.3 Duration of Exposure to Maternal Employment

Several studies have explored whether children exposed to maternal employment for longer durations are more at risk for overweight and obesity compared to children who have been exposed for shorter periods. Results from these studies help determine whether there is a cumulative effect of maternal employment on childhood overweight and obesity, where prolonged exposure and its effects on the child compound over time.[18,21,54,68]

Morrissey et al.[54] find evidence of a cumulative effect by showing that each additional six months of maternal employment over a child's life is more strongly associated with BMI increases for children in the 6th grade than children in lower grades. A later study by Morrissey[68] confirmed the importance of the duration of maternal work; however, in contrast to the previous study,[54] the relationship between maternal work duration and children's BMI was observed only among preschool children aged 2 to 5 years and not among older children.

Not all studies have found that the effect of maternal employment on children's rates of overweight and obesity increase with longer exposure. Hawkins et al.,[21] for instance, show that average weekly hours impact children's obesity risk, while maternal work duration in the first three years of a child's life is not associated with obesity at 3 years of age. Similarly,

Anderson et al.[18] find that the intensity of maternal work (average hours worked per week), rather than the number of weeks worked over a child's life, is most important for predicting children's weight status.

A definitive conclusion cannot be reached based on the existing literature regarding the impact of maternal work duration and child overweight and obesity. However, maternal work intensity has been shown to predict children's weight status, suggesting that maternal time constraints resulting from employment play a role in the development of overweight and obesity.

2.3 Mechanisms Linking Maternal Employment in Infancy and Toddlerhood to Childhood Overweight and Obesity Risk

2.3.1 Breastfeeding

Breastfeeding plays an important role in infant health.[24] Exclusive breastfeeding for the first six months of an infant's life not only meets their nutritional needs in terms of both quantity and quality,[25] but confers a wide range of immune and physiological benefits, including reduced risk of gastrointestinal infections, respiratory infections, and Sudden Infant Death Syndrome.[24,26] Health Canada recommends women exclusively breastfeed their child from birth until at least six months, and up to two years with complementary feeding.[35] Similarly, the American Academy of Pediatrics recommends six months of exclusive breastfeeding, followed by breastfeeding with the introduction of complementary foods up until one year or longer.[36]

Recent data show that most mothers are not following these recommendations. For example, in the United States, 46% of women participate in 'any breastfeeding' for 6 months, while only 13% of women exclusively breastfeed for the same duration.[36] Data from the 2009-2010 Canadian Community Health Survey show that while 87.3% of mothers initiated breastfeeding or tried to breastfeed their last child, only 25.9% exclusively breastfeed for 6 months or longer.[37] Approximately half of Canadian women breastfed for less than three months, and among those women, 13.5% did not breastfeed their last baby.[69] Several systematic reviews and meta-analyses have shown that breastfeeding reduces the risk of

childhood obesity.[27–29] Researchers have paid increasing attention to whether maternal employment significantly disrupts the initiation and duration of breastfeeding.

2.3.1.2 Maternal Employment and Breastfeeding Initiation and Duration

Several studies have demonstrated a negative association between maternal employment during an infants' first year of life and the initiation and duration of breastfeeding. In particular, differences in breastfeeding initiation between full-time employed and non-employed women have been documented.[39,40] Hawkins et al.[40] found that women employed full-time were less likely to initiate breastfeeding than non-employed mothers (adjusted rate ratio=0.92, 95% CI= 0.89-0.96). An earlier study[39] demonstrated that the expectation of full-time versus part-time or no work had unique consequences on the initiation and duration of any breastfeeding. Mothers who expected to return to work on a full-time basis had an initiation rate that was 14.3 percentage points lower than mothers who did not expect to work ($p<0.05$), and expecting to work full-time was associated with decreased odds of breastfeeding.[39] By contrast, there was less than a 3.0 percentage point difference in the initiation rates of mothers who expected to return to part-time work and mothers who did not expect to work, and this difference was statistically non-significant.[39] Furthermore, results did not indicate a significant relationship between the expectation of part-time work and the odds of breastfeeding.[39] These results suggest that 'any' employment may not necessarily interfere with breastfeeding practices, but rather the expectation of time available upon returning to full-time work may discourage women from initiating breastfeeding.

Some researchers investigated the possibility that full-time employment, but not part-time employment has an impact on breastfeeding initiation. Hawkins et al.[40] found no differences in rates of breastfeeding initiation between women who were not working, self-employed, or working part-time. Cooklin et al.,[38] however, found that part-time employed mothers and non-employed mothers differed in breastfeeding practices: compared to non-employed women, women employed on a part-time basis were significantly less likely to be breastfeeding at 6 months (adjusted OR=0.49, 95% CI=0.37–0.64).

Maternal work status has also been shown to impact the duration of breastfeeding. Fein & Roe[39] found that breastfeeding duration differed significantly between full-time working mothers and women who did not expect to work (16.5 weeks versus 25.1 weeks,

respectively), but part-time work did not significantly shorten the duration of breastfeeding compared to non-working mothers, once again suggesting that full-time work rather than any work disrupts breastfeeding practices. Recent studies also show that longer absence from employment is positively associated with longer breastfeeding duration.[38,41] Cooklin et al.[38] found significant differences between mothers employed full-time before 6 months and mothers not employed at 6 months postpartum. Compared to full-time employed mothers, non-employed mothers were 2.85 times as likely to be breastfeeding at 6 months.[38] At 10 months postpartum, women who were breastfeeding were a third less likely to be employed compared to women who were not breastfeeding.[38] Hawkins et al.[41] investigated the association between breastfeeding duration of any breast milk and type of employment (full-time, part-time) in mothers who return to work by the time their infant is 9 months of age. Compared to women who were employed full-time, mothers working part-time had an increased duration of breastfeeding (adjusted rate ratio=1.30, 95% CI=1.17-1.44) of at least four months.[41] Employment has also been shown to predict the duration of exclusive breastfeeding. Canadian women who were not employed within the first 6 months following delivery were 1.55 times more likely (95% CI=1.14-2.10) to be exclusively breastfeeding at 6 months compared to women who had returned to work.[42]

The length of maternity leave may also play a role in breastfeeding initiation and duration. Although it is difficult to examine the direct effect of maternity leave due to its relationship with the timing of employment following birth, several studies have examined this association.[39,40,70,71] As expected, most studies have found longer breastfeeding duration among women with longer periods of maternity leave[71] and higher breastfeeding rates among women whose return to work did not result from financial necessity (maternity pay coming to an end or because of greater financial need) compared to those who returned to work for other reasons.[40] Studying a sample of US women, Guendelman et al.[70] found an increased risk of breastfeeding cessation (adjusted hazard ratio=3.47, 95% CI=1.63-7.34) among women with less than 6 weeks of maternity leave, and a two-fold risk of breastfeeding cessation among women who returned to work between 6 to 12 weeks. In contrast with the aforementioned studies, Fein & Roe[39] detected a significant negative association between length of maternity leave and breastfeeding duration after controlling for maternal work status at 3 months following the infant's birth, showing that women using maternity leave

also had shorter breastfeeding duration. One potential explanation for these findings is that compared to women who do not take maternity leave, women who take maternity leave may be more likely to return to work within the infant's first year. The expectation of work may contribute to the lack of difference in duration of breastfeeding between women who take maternity leave and those who do not.

Studies have consistently demonstrated an association between maternal work and the initiation and duration of breastfeeding. Results from these studies show differences in both the establishment and length of breastfeeding among women who are non-employed, employed part-time, and working full-time.

2.3.1.3 Breastfeeding and Childhood Overweight and Obesity

Among the predictors of childhood obesity, perhaps none have received as much attention in the literature as breastfeeding. Evidence supporting the reduced risk of overweight and obesity among children breastfed in infancy is plentiful,[27–34,72–105] though some studies find statistically non-significant results.[80,82,84,86,106–125] A meta-analysis of nine published studies and over 69,000 participants[27] revealed that breastfeeding was significantly associated with a reduced risk of obesity in childhood (adjusted OR=0.78, 95% CI=0.71-0.85). Other reviews and meta-analyses[28,29] have also confirmed that breastfeeding is protective against childhood overweight and obesity. The impact of any breastfeeding versus never breastfeeding as well as the duration of breastfeeding on children's obesity risk have been well-examined in the literature.

2.3.1.3.1 Breastfeeding: Never versus Ever

Studies have consistently shown a higher risk of overweight and obesity among children who were never breastfed compared to children who were both ever breastfed and breastfed for various durations.[52,84,86,89,91,93–96,98,99]

Children breastfed for 6 months or longer have been shown to have a 1.56 and 1.96 times reduced risk of overweight and obesity, respectively, compared to those never breastfed.[98] A reduced risk of obesity (adjusted OR=0.63, 95% CI=0.41-0.96), but not overweight, was found among 3 to 5 year old children who were ever breastfed as infants compared to those who were never breastfed.[86] Hawkins et al.[52] found that compared to children breastfed for 4

months or longer, never breastfed children were 1.19 times as likely to be overweight or obese at 3 years of age after adjusting for individual, family and community-level confounders. Using sibling difference models to help provide stronger support for a causal relationship, Metzger et al.[95] found that non-breastfed siblings were 1.69 times more likely than their breastfed sibling pair to reach the overweight (>85th percentile) BMI threshold.

Breastfeeding for even a short duration has been shown to make a significant reduction in the risk of overweight and obesity. Kvaavik et al.,[89] for example, found that never breastfed children were 3.7 times as likely to be overweight and over 6 times as likely to be obese compared to children who were breastfed for over 3 months. Li et al.,[91] examining weight status in children ages 4 to 12 years, found that compared to children breastfed for 1 to 3 months, children never breastfed were 1.43 times as likely to be obese.

Higher overweight and obesity risk among never-breastfed children has been found not only in early or middle childhood, but also among pre-adolescents and adolescents. Liese et al.[93] identified an increased obesity risk among pre-adolescents who were never breastfed compared to those who were breastfed, although estimates were notably lower than those found by Kvaavik et al.[89] Having been breastfed for 6 months or longer has been demonstrated to be protective of obesity among adolescents ages 14 years.[99] These studies suggest that the protective effect of breastfeeding may be long-term and persist beyond childhood.

Not all studies have found a significant protective effect of breastfeeding on obesity, however.[82,106,107,109–124] Durmus et al.[111] failed to find any consistent associations between overweight and obesity and breastfeeding duration and exclusivity among children 1, 2 and 3 years of age. Like Metzger et al.,[95] Nelson[118] studied sibling pairs to reduce issues of confounding in determining the impact of breastfeeding on obesity risk. Nelson's results indicated no significant relationship between breastfeeding duration and weight status.[118] In a study examining the duration of both exclusive breastfeeding and any breastfeeding, results showed that neither exposure was associated with children's overweight and obesity status at age 10 years.[123] Two studies on breastfeeding promotion interventions showed that despite the success of the interventions on increasing breastfeeding duration and exclusivity, there

were no associated reductions in overweight or obesity risk at 11.5 years[125] or other measures of adiposity at 6.5 years.[115]

Statistically non-significant findings may be attributed to several methodological issues and data limitations. Some studies lack significant detail on breastfeeding practices[113,122] or fail to include important confounders.[112,122] The ability to detect an effect for breastfeeding duration may have been weakened due to issues of response bias or overly-homogenous samples,[109,113,115] and to the categorization of breastfeeding duration.[110]

It is well documented that breastfeeding has a protective effect on overweight and obesity in children. Though some studies have failed to detect statistically significant differences in the weight status of children who were breastfed and not breastfed as babies, there is a large volume of literature that supports the idea that breastfeeding does reduce children's risk of overweight and obesity.

2.3.1.3.2 Breastfeeding: Duration and Dose-Response

Studies examining the link between breastfeeding and overweight and obesity in childhood have largely focused on the effects of varying breastfeeding durations. In general, these studies show that breastfeeding for a longer duration reduces overweight and obesity risk. It has been estimated that children who are breastfed for less than 3 months are between 1.22 and 2.17 times more likely to be obese compared to those breastfed for over 3 months.[30,73] Breastfeeding for at least 7 months compared to less than 3 months has been shown to reduce obesity risk by 15% to 20%.[32,81]

The literature is divided into studies that find a dose-response relationship between increased duration of breastfeeding and reduced risk of overweight and obesity[27,28,32–34,84,88,91,93,94,98,103] and those that find mixed results or non-linear relationships.[31,86,87,96,104,126]

Evidence of a dose-response relationship between longer durations of breastfeeding and increased protection from childhood obesity has been demonstrated in several meta-analyses and reviews.[27–29] Harder et al.[28] found a 4% decrease in the odds of overweight for every additional month of breastfeeding until infants reach 9 months of age, while every additional 3 months of breastfeeding has been shown to reduce the risk of adolescent overweight by 8%.[32] A strong dose-response relationship is indicated in some studies,[33,84,88] while others

find that adjustment attenuates the effect.[91] Grummer-Strawn et al.[34] find that the protective dose-response relationship in their study is limited to non-Hispanic whites, and find no effect in Hispanic and non-Hispanic black children.

Not all results point to a strong dose-dependent protective effect of breastfeeding on childhood overweight and obesity. In contrast to Kalies et al.[88] and Koletzko and von Kries,[33] Hediger et al.[86] do not find consistent evidence of greater protection from obesity among children exclusively breastfed for increasing durations. Odds ratios of overweight for both 3- and 6- months of exclusive breastfeeding were nearly identical; in addition, both estimates were non-significant.[86] Frye & Heinrich,[31] however, found that the risk of obesity decreased with additional increments of breastfeeding among exclusively breastfed children. In one study, duration of exclusive breastfeeding was significantly associated with reduced risk of overweight and obesity in children breastfed 4 to 6 months compared to those who were not exclusively breastfed, but no relationship was revealed among those breastfed for shorter or longer durations.[87]

Some researchers have found that a dose-response relationship between breastfeeding and weight status emerges only after a given duration of breastfeeding.[96,126] Panagiotakos et al.[96] found no significant differences between infants who were never breastfed and those breastfed for less than 3 months, but a dose-response effect emerged after the 3-month period. Similarly, McRory & Layte[126] found that less than 4 weeks of breastfeeding did not protect against later child obesity, but a dose-response relationship between breastfeeding and reduced obesity risk emerged among infants breastfed for more than 4 weeks. The protective effects of breastfeeding for longer durations have been well-demonstrated in the literature. Though the magnitude of the dose-response effect on children's obesity risk is not conclusive, the trend between decreasing overweight and obesity risk and time spent on breastfeeding is fairly well established.

2.3.2 Child Care

Increases in the rate of maternal employment over the last several decades has had a significant impact on mothers' ability to be their children's sole caregivers at all times. Maternal employment following birth has necessitated the use of non-maternal care arrangements such as formal care (i.e., paid care in a nursery or daycare setting) or informal

care (i.e., unpaid care provided by a grandparent or other relative). The type of child care arrangement has recently received more attention in the literature as a possible predictor of children's overweight or obesity status.

2.3.2.1 Maternal Employment and Child Care

A woman's decision to return to work in the period following the birth of a child is affected by many factors, such as her work status before giving birth,[127] the availability of child care,[128] entitlement to paid or unpaid maternity leave,[129] and spousal income.[130] Because women are largely responsible for child care during the first two years, employment during this time has direct consequences on a woman's ability to care for her child in the home.

The use of non-parental care for infants is common in developed countries. Data show that in 2002-2003, 56.1% of Canadian children under the age of 2 years were under non-parental care, with more than half of that figure consisting of children between 6 months to 1 year of age.[44] Studies have demonstrated that the use of child care is especially common in dual-income households, where both parents may be absent from the child throughout the day. Over 80% of dual-income households with children between the ages of 0 to 2 years use non-parental care, compared to approximately 50% of households with one working parent.[43]

An Australian study[43] found that while an increase in father's work hours increased the use of formal child care arrangements, women's work hours had a much larger effect. This finding suggests that mothers allocate a greater portion of non-working hours at home to child care than their male partners. Compared to two-parent households where the mother was not employed, two-parent households in which the mother worked used an additional 10 hours of both formal and informal child care.[43] Additionally, more hours worked by the mother per week increased the amount of hours children spend in child care, with an additional hour of work being associated with a 0.10 to 0.25 hour increase in child care use.[43]

In Canada, mothers who are employed during pregnancy have been shown to be more likely to use both formal and informal child care arrangements compared to parental care arrangements.[45] Relative to children whose mothers were employed during pregnancy, children of non-employed mothers were 7 and 5 times more likely to be under parental care instead of formal and informal care, respectively.[45] Studies also show that maternal work hours and the timing of the return to work predicts the type of child care arrangement. For

instance, both Fergusson et al.[131] and Vandell et al.[132] found that grandparental care was significantly more likely among women working full-time rather than part-time. Children were found to be more likely to be cared for by their grandparents when mothers returned to work when children were under 6 months old compared to mothers who returned after the 6-month period.[132]

2.3.2.2 Child Care and Childhood Overweight and Obesity

Children's care arrangements while their mothers are at work may have consequences on overweight and obesity risk. Research examining this possibility has provided evidence that child care arrangements are associated with the risk of becoming overweight or obese, taking into to account both the type of arrangement[47,48] and hours spent under non-maternal care.[46–48]

Examining the relationship between child care arrangements and obesity risk in infancy, Gubbels et al.[46] found that compared to no child care attendance, child care attendance at 7 months of age significantly increased the odds of being overweight at 1 year of age (adjusted OR=1.32, 95% CI= 1.04-1.69). Other studies have also investigated the effect of child care during infancy on obesity risk.[47,48] Benjamin et al.[48] explored associations between the time spent in child care during the first 6 months of life, the type of care arrangement, and adiposity at 1 and 3 years of age. It was found that child care attendance in someone else's home was associated with a greater 1-year weight-for-length z-score and 3-year BMI z-score, but neither care in a child care centre nor care in the child's own home by a non-parent predicted measures of adiposity.[48]

Differentiating care type into formal care (cared for in a nursery, childcare centre, registered childminder, nanny or au-pair) and informal care (cared for by friend, neighbour, grandparent, other relative, babysitter or unregistered childminder), Pearce et al.[47] found that the type of care is associated with children's overweight and obesity risk. Results showed that children in informal child care arrangements had an increased risk of overweight (adjusted RR=1.15, 95% CI=1.04-1.27) relative to children in formal arrangements.[47] Further analysis of the informal care category revealed that the increased risk of overweight was significant only in children cared for by their grandparents compared to other types of

informal care.[47] Infants under relative care have also been shown to gain more weight compared to infants under the care of their parents.[133]

The differences in overweight and obesity risk among children cared for by their parents, or in formal or informal arrangements have been found in other studies.[49,134,135] Maher et al.[49] found that in the year before kindergarten, children in family, friend, and neighbour care were 1.22 times more likely to be obese at the start of kindergarten than children in parent care. Compared to parent care, care by relatives has been shown to increase the likelihood of overweight and obesity by 6.9% and 4.8%, respectively.[134] Lin et al.[135] found that informal care at 5 and 11 years of age, compared to parental care at those ages, was associated with higher BMI z-score and with overweight/obesity (OR=1.26, 95% CI= 1.04-1.54). Using a Canadian sample of children aged 2 to 3 years, McLaren et al.[136] found that care by a non-relative was associated with increased BMI percentile among boys aged 6 to 7 years using ordinary least squares (OLS) models (adjusted coefficient=0.10, 95% CI=0.02-0.18). However, when using logistic regression models to examine the odds of moving in or out of overweight and obese BMI percentiles, similar associations were not found for boys or girls.[136]

Not all studies find that child care type plays a significant role in overweight and obesity risk, however. Hawkins et al.[21] found no difference in overweight rates among 3-year old children cared for informally or by a parent. Lumeng et al.[137] found that limited time spent in centre-based care from 3 to 5 years, compared to child care that was not centre-based, was independently associated with a decreased risk of overweight at 6 to 12 years (adjusted OR=0.56, 95% CI= 0.34-0.93). There are several possible explanations for this contradictory finding. Lumeng et al.[137] did not control for children's baseline BMI. Failure to distinguish between types of informal care arrangements may have also contributed to the decrease in obesity risk among children attending centre-based care. Another possibility could be that the quality of child care might have attenuated the negative impact of employment. Although not directly applicable, Gregg and Washbrook[138] find that cognitive outcomes are negatively impacted by maternal employment only among children whose mothers return to full-time work before the child is 1.5 years of age and under non-paid care. This suggests that high-quality child care may actually help improve child outcomes regardless of their mother's

employment status. Furthermore, young children may be particularly vulnerable to the effects of being in alternate care arrangements.

Several studies have explored the possibility that the risk of overweight and obesity increases with longer hours under non-maternal care.[47–49] More time spent under care in someone else's home[48] or in informal care settings[47,49] has been shown to strengthen the relationship between type of care and weight status. Gubbels et al.[46] however, find that significant differences in overweight between children who spend less versus more hours in care is limited to a specific subgroup, and detects no association between hours in care (≤ 16hrs, >16hrs) and BMI z-score. Lumeng et al.[137] similarly find no association between extensive use of centre-based care and limited use of centre-based care on the risk of being overweight.

Research has demonstrated that child care arrangements are associated with children's future overweight or obesity. Children under non-parental care during toddlerhood have been shown to have increased rates of weight gain and higher risk of overweight and obesity compared to those cared for at home by a parent. Exposure to alternative care arrangements during the infancy stage, and possible associations with overweight and obesity risk, has largely been ignored in the literature. Furthermore, studies have generally investigated the effect of child care on BMI outcomes during the same period, or up until several years later. More research is needed to determine whether child care in children ages 2 years and younger has an impact on children's overweight and obesity risk, and whether this effect persists until mid-childhood.

2.4 Sex Differences in the Effect of Maternal Employment

The existing literature on maternal employment and childhood overweight and obesity commonly examines the effect of maternal work in boys and girls simultaneously. Analyzing boys and girls as one unified group, however, ignores important differences between the sexes. Research has shown that in addition to sex-linked brain differences,[139–142] males and females also respond differently to stimuli on psychosocial and neurobiological emotional domains.[143–146] Socialization may lead males and females to interact and respond differentially to their environments[147,148] due to parental reinforcement of gender-typed roles and behaviours.[149] Additionally, research suggests that mother-child interactions may differ by child sex, and these differences appear to be present at infancy.[150] Furthermore, mutual

emotion regulation between sons and their mothers has been shown to differ from mother-daughter interactions, especially during times of stress.[151]

Given the distinct biological and psychosocial context of boys and girls, the importance of separately analyzing the effects of maternal employment on their obesity status becomes clear. Despite some evidence to the contrary,[152] some studies have identified that boys and girls have different cognitive and behavioural outcomes following childhood exposure to maternal employment.[22,153,154] Ruhm,[22] for instance, finds that boys experience the negative consequences of maternal employment to only a slightly greater extent than girls, while Brooks-Gunn et al.[153] show that the detrimental effects of exposure to maternal work during the first 9 months of life are significantly more pronounced among boys. In contrast, Waldfogel et al.[154] reveal that full-time maternal employment impacts the cognitive outcomes of girls more negatively than boys. Sex differences with regards to maternal employment exposure may not necessarily be restricted to differences in magnitude: Waldfogel et al.[154] found that behavioural problems stemming from exposure to maternal work during the first year of life were present in boys, with no indication of a similar relationship in girls.

Justification for stratifying analyses by child gender is supported by the literature. In addition to demonstrated biological and psychosocial differences between sexes, research has identified both qualitative and quantitative differences in the effect of maternal work on a variety of outcomes in childhood. There is sufficient evidence that boys and girls may differ in the effects of maternal work on childhood overweight and obesity.

2.5 Potential Confounding Variables

The identification of variables that are associated with maternal employment and that contribute to children's overweight and obesity risk is critical in selecting potential confounders that may bias the relationship between a mother's work and her child's weight status. Many of the reviewed articles include confounders after testing a large number of potential variables for significant univariate associations with childhood overweight and obesity,[21,123] or have checked for confounding using the collapsibility criteria for confounding in the absence of a priori reasoning.[101] Several studies justify controlling for certain variables because previous articles in the field have done so,[19,55] and acknowledge

that models may reflect over-adjustment due to the possibility that some controlled variables are in fact mediators.[19] In order to avoid introducing bias into the present study, possible confounding variables that are associated with both maternal employment and children's weight status are reviewed below.

2.5.1 Maternal Age at Birth

A mother's age at the birth of her child may influence her decision to participate in the workforce. Mothers over the age of 30 years are less likely to have returned to work at 2 months following their child's birth compared to younger mothers.[155] Compared to 25 to 29 year old mothers, Han et al.[155] found that women under the age of 24 were significantly more likely to be working by 9 months following a child's birth, and mothers 35 years and older were significantly less likely to be working.

Morrissey et al.[54] found that maternal age at birth was associated with childhood obesity. Hawkins et al.[21] have shown that maternal age at first live birth, rather than maternal age at the birth of the child under study, impacted overweight and obesity odds. Rooney et al.[156] found that children's obesity status varied by maternal age, but was not predicted by maternal age in regression models. Weng et al.[157] did not find an association between maternal age at birth and children's odds of overweight and obesity.

2.5.2 Maternal Smoking During Pregnancy

Research has shown an association between smoking status and employment status.[158–161] There is a higher rate of unemployment among smokers than non-smokers,[161] and a greater proportion of both current and ever-smokers are unemployed compared to non-smokers.[159] Additionally, a higher prevalence of smoking has been observed among long-term unemployed individuals relative to all job-seekers.[162] Unemployment has been shown to significantly predict smoking status (adjusted OR=1.51, 95% CI=1.38-1.65).[161]

Studies have demonstrated that maternal smoking during pregnancy is independently associated with childhood overweight and obesity.[101,103,163] Children whose mothers smoke during pregnancy are 1.43 and 2.06 times more likely to become overweight and obese, respectively.[103] The exact mechanisms that link in-utero exposure to cigarette smoke and future weight are unknown. It has been suggested that maternal smoking may affect the

development of structures in the brain that are associated with reward processing, which may increase the preference for dietary fat intake in childhood and adolescence, ultimately leading to fat accumulation.[164,165]

2.5.3 Maternal Pre-pregnancy BMI

An association between weight status and employment has been demonstrated in the literature,[166] with the relationship being especially strong for women rather than men.[167,168] Despite more training and a greater number of job applications sent out, obese women may have worse employment outcomes than non-obese women.[167] Time spent unemployed during working years is significantly associated with increased weight, and once unemployed, regaining employment is significantly less likely.[169] Women who are obese are more likely to face employment discrimination compared to normal-weight women, resulting in difficulty getting hired or promoted.[170] Compared to normal weight women, obese women earn lower annual salaries for the same position.[170] Although the effect of employment on obesity has been less examined in the literature, there is some evidence that unemployment predicts weight gain.[171]

Compared to normal weight women, overweight women are at least 1.5 times more likely to have overweight children.[21] Studies have demonstrated that maternal weight contributes to infant weight gain,[172] and predicts preschooler and childhood overweight.[91,173] Maternal pre-pregnancy obesity has been shown to increase the risk of pre-term birth,[174] contributing to the delivery of low birth-weight babies who are more likely to become insulin resistant.[175] Children who show catch-up growth, the early weight-gain observed among low-birth weight babies, are more likely to be fatter and have more central fat distribution compared to children who do not exhibit post-natal catch-up growth.[176]

2.5.4 Size-for-gestational Age

There is evidence of an association between maternal employment and infant's size for gestational age in the literature.[177,178] Mothers who work irregular or shift-work schedules are at an increased risk of giving birth to a small-for-gestational age baby.[177] Occupational conditions such as lifting loads[179] and standing for extended periods[180] also play a role in increasing the risk of babies being born small-for-gestational age. While associations

between occupational factors while working during pregnancy and birth outcomes have been demonstrated,[181] some studies have shown separate associations for pre-term birth and low birth weight but no significant associations for size-for-gestational age.[181–183] Other indicators of socioeconomic status such as educational attainment and income have been associated with size-for-gestational age outcomes.[184]

Studies have demonstrated that size-for-gestational age is predictive of children's weight status. Small-for-gestational age (SGA) and appropriate-for-gestational age (AGA) infants who exhibit catch-up growth, as well as large-for-gestational age (LGA) infants without catch-down growth have higher BMIs as preschoolers.[185] LGA infants without catch-up growth have been shown to have greater odds of childhood overweight and obesity.[185] SGA infants have been shown to remain significantly shorter and lighter, while remaining taller and heavier was characteristic of LGA infants.[186] Using anthropometric measures, LGA infants, but not SGA infants, continued to accumulate fat after 3 years of age.[186]

2.5.5 Marital Status

Employment has been shown to vary by mother's marital status.[187] In general, lone mothers are in greater need of income than women who are married and are supported by spousal earnings, requiring them to obtain employment in order to meet their financial needs. Results from Han et al.[155] reveal little variation in the proportion of married, cohabiting, or single mothers who return to work in the early months following childbirth; however, by 9 months following a child's birth, a slight gap forms, with single and cohabiting women more likely to be working than married women. Some studies have found the opposite to be true: a higher employment rate for mothers in two-parent families compared to lone-parent mothers.[17] Recent data from Canada show that lone mothers with children under 3 years have a lower rate of employment (45.9%) than women with partners (66.5%), with the gap in the employment rate diminishing with increasing child age.[17] The large differences in rates of employment between lone and two-parent households with young children may be explained by the affordability of child care. In one study, the relationship between employment status and marital status varied by country.[187] In the US, there were fewer differences in the employment rate and employment status between lone mothers and married mothers, while in Germany there was a greater tendency of lone mothers to rely on full-time employment.[187]

The parental status of children is associated with children's obesity status.[188,189] Children of single-parent households are significantly more likely to be overweight or obese than children living with both parents.[188–190]

2.5.6 Maternal Education

Education and employment are closely associated.[191] The positive association between education, occupation type and earnings has been demonstrated consistently in the literature.[192] Individuals who hold university degrees have the highest employment rates compared to less educated individuals.[191] Higher levels of educational attainment allow individuals to seek out better jobs that are associated with higher average earnings.[193]

Studies have shown that parental education is a strong predictor of childhood obesity.[6,194] Maternal education, often used as an indicator for socioeconomic status[195,196] has been shown to predict children's overweight and obesity risk.[197]

2.5.7 Family Size (Number of Siblings in the Household)

Studies have demonstrated an association between maternal employment and family size.[155,198] Results from Han et al.[155] suggest that the number of children a woman has may influence her decision to participate in the workforce. Employment rates following women's first and second births are notably higher than rates following third and subsequent births.[155] The percentage of employed mothers at 9 months following birth is higher among mothers of first-born children compared to those with second-born and third-born children.[155] The probability of working and full-time work is related to having additional children.[198] Results from Frenette[198] suggest that increases in the number of children results in a decline in the proportion of employed Canadian mothers. According to Scholder,[23] the number of children a woman has may influence her decision to participate in the workforce. The decision to work may be impacted by the perceived available time that is remaining after caring for children and completing associated household tasks.

The number of children in a household may impact the risk of childhood obesity. Several studies show that children without siblings are more likely to be obese compared to children with siblings.[188,199–201] Hunsberger et al.[200] found that singleton children were 1.52 times more likely (95% CI=1.34-1.72) to be overweight relative to children with siblings after

adjusting for known confounders. Formisano et al.[199] found a negative dose-response relationship between the number of siblings and the risk overweight/obesity, where children with the greatest number of siblings (>2 siblings) had a significantly reduced risk of obesity relative to those who were an only child.

2.5.8 Household Income

Maternal employment is associated with household income in proportion to the magnitude of a woman's contribution to family income. Mothers who are employed are able to increase the total income of their households with their earnings. In single-parent households, household income may consist entirely of a mother's earnings, whereas in two-parent households, maternal work could be one of multiple sources of income.[202]

Household income and children's overweight and obesity risk are associated.[195,203,204] Compared to children living in low-income households, children living in high-income households have significantly lower odds of overweight and obesity.[204] Living in medium income households and low income households is associated with a 1.8 and 2.8 times increased risk of obesity relative to children from high income households.[205] Canadian data have shown that children from the highest income neighbourhoods are half as likely to be obese as children from the lowest income neighbourhoods.[203] Similarly, annual household income is lower in families with obese children than in families with normal weight children.[206]

2.5.9 Maternal Immigrant Status

Participation in the labour force varies significantly between immigrants and Canadian-born counterparts. In Canada, 2009 data from the Labour Force Survey show that the rate of employment among Canadian-born individuals between 25 to 54 years was 82.9%, while among all immigrants, participation was lower, at 74.9%.[207] An even larger gap exists between Canadian-born individuals and recent immigrants (≤ 5 years).[207] In 2011, there was a 19.4 percentage point difference in the employment rate of Canadian-born individuals and recent immigrants.[207] Gaps in wages between immigrants and Canadian-born individuals with equal education have also been demonstrated.[207] In 2008, the weekly wages of recent

immigrants with a university degree were 70% of those earned by Canadian-born individuals with a university degree.[207]

A Canadian study shows that first-generation children experience greater weight gain relative to third-generation children.[208] The higher rate of unemployment and lower wages observed among immigrants may contribute to the weight gain observed in first-generation children in Canada. Several aspects of maternal immigration may influence the risk of weight gain and overweight and obesity such as exclusive use of native language (which may limit access to healthy food and resources that promote healthy lifestyles),[209] socioeconomic status, and country of origin.[210] In contrast to evidence from Canada, results from studies conducted in the US and Italy show that while immigrant status and childhood overweight and obesity differ by ethnicity and generational status, immigrant status is associated with a lower risk of overweight and obesity compared to native-born individuals.[211,212]

2.6 Gaps in the Literature

Although increasing attention has been given to the role of maternal employment in the development of childhood overweight and obesity, several important gaps are apparent in the literature. One area requiring more focus is the impact of maternal work during the infancy and toddlerhood period on children's subsequent overweight and obesity risk. Studies examining the effect of maternal employment on children's weight status tend to focus on children 3 years of age or older. The influence of maternal employment during infancy and toddlerhood on children's later overweight and obesity risk has been ignored in the literature. Failure to study the relationship in children under 3 years restricts the ability to investigate the impact of maternal work during the critical periods of infancy and toddlerhood as well as any associated mechanisms during this stage that may contribute to later overweight and obesity risk.

It is important to examine, in a unified framework, the relationship between maternal work and other early-life factors that work together to contribute to the incidence of overweight and obesity risk in children. While factors such as breastfeeding and child care have been demonstrated to impact children's overweight and obesity risk, the extent to which these mediate the maternal employment-obesity relationship is less understood.

Among early-life factors that may mediate the employment-obesity relationship, the role of child care in the occurrence of childhood overweight and obesity has received little attention compared to the role of breastfeeding. Additionally, while breastfeeding has been consistently shown to protect against the occurrence of obesity in children, results from studies examining the impact of child care on overweight and obesity risk are significantly more variable and inconclusive. In comparison to studies examining the role of child care among children over the age of 2 years, the role of type of child care arrangement among children under 2 years is unknown.

This study examines whether breastfeeding and type of child care during infancy and toddlerhood mediate the association between employment and childhood overweight and obesity. Gaining insight into the mechanisms that link maternal employment and overweight and obesity risk provides a unique opportunity to understand the long-term impact of early experiences, and to identify possible targets for intervention.

Chapter 3 Conceptual Framework

3.1 The Parental Production of Child Health

The theoretical framework used to guide this research is adapted from Rosenzweig and Schultz's economic model of the parental production of child health.[213,214] The Child Health Production model is inspired by previous work by Grossman[215] whose health production model argues that all individuals strive to achieve health in order to live long and healthy lives. In order to optimize health, individuals allocate resources and make decisions that may augment their stock of health.[215] According to the Child Health Production model,[214] children's health, beyond their inherited baseline health and environmental influences unrelated to parental behaviour, is a function of health-related consumer goods and other resources requiring parental investment .[213,214]

Changes in health associated with parental inputs can be represented by a production function that illustrates changes in health associated with a combination of inputs that are in addition to a child's basic endowment.[214] In general, health-producing inputs increase the efficiency of the production function and can help maximize a child's health beyond their biological or genetic potential. Since there is a limit on the extent to which health can be produced, the production function also depicts the diminishing returns to health with each additional parental input.

Rosenzweig and Schultz's model of Child Health Production[214] facilitates the empirical specification of the influence of maternal labour force participation and related health-producing inputs on children's weight status. Maternal labour force participation can be viewed as a behavioural input that affects the ability to engage in other health-enhancing behaviours for children. Several possibilities for the effect of maternal employment on children's weight status have been proposed in the literature. Maternal employment may have a positive effect on children's health through the allocation of income to health-producing inputs (such as purchasing more nutritious food and enrolling children in organized sports). Maternal employment may also have no effect on children's health if resources are directed towards health-neutral goods or consumer goods that enhance family satisfaction in general. Another possibility is that maternal employment may have a negative impact on child health,

where the benefit of higher income may be outweighed by the cost of having less time available to invest in health-enhancing inputs (such as cooking meals at home rather than getting take out or delivery, and playing with children). Since time is a limited resource, mothers who are employed (or spend longer hours in employment per week) have less time available to devote to behaviours that are protective of overweight and obesity (such as breastfeeding) compared to mothers who are not working during their child's infancy and toddlerhood.

Maternal employment is viewed as the primary behavioural determinant of child health investments in this study. Operationalizing maternal employment this way allows the examination of costs to children's health associated with a mother's decision to work, where limitations to her availability restrict the ability to breastfeed for longer durations and to provide sole care to her infant. In combination with the literature, use of this model guides the present analysis to investigate whether maternal employment, and its impact on other health inputs, is associated with the likelihood of children's overweight and obesity risk. Like Gwozdz et al.,[65] a variety of confounders identified in the epidemiological literature are included in this study.

3.2 Conceptual Model

The conceptual model based on the literature is illustrated in Figure 3.1, and illustrates the relationships between the main predictors and other explanatory variables associated with childhood overweight and obesity. A condensed version of this model illustrating the primary variables of interest is depicted in Figure 3.2. The direct impact of maternal employment on childhood obesity is represented by Path A. In Figure 3.2 Pathways B (type of child care arrangement) and C (breastfeeding duration) represent the hypothesized mechanisms that explain the relationship between maternal employment and childhood overweight/obesity.

Path B and Path C of Figure 3.2 illustrate the indirect effects of maternal employment on childhood obesity. In Path B, maternal employment affects a mother's decision to obtain child care arrangements, and subsequently the type of child care received is associated with the risk of a child becoming overweight and obese. Path C represents the impact of maternal work on breastfeeding duration and its subsequent effect on children's overweight and

obesity. Maternal work status predicts the duration of breastfeeding, which contributes to their weight status in childhood.

The inclusion of the following confounders is supported by the literature: maternal age at birth, maternal pre-pregnancy BMI, maternal education (highest level of education obtained), maternal marital status, size for gestational age, smoking while pregnant, the number of siblings in the household, household income and immigrant status.

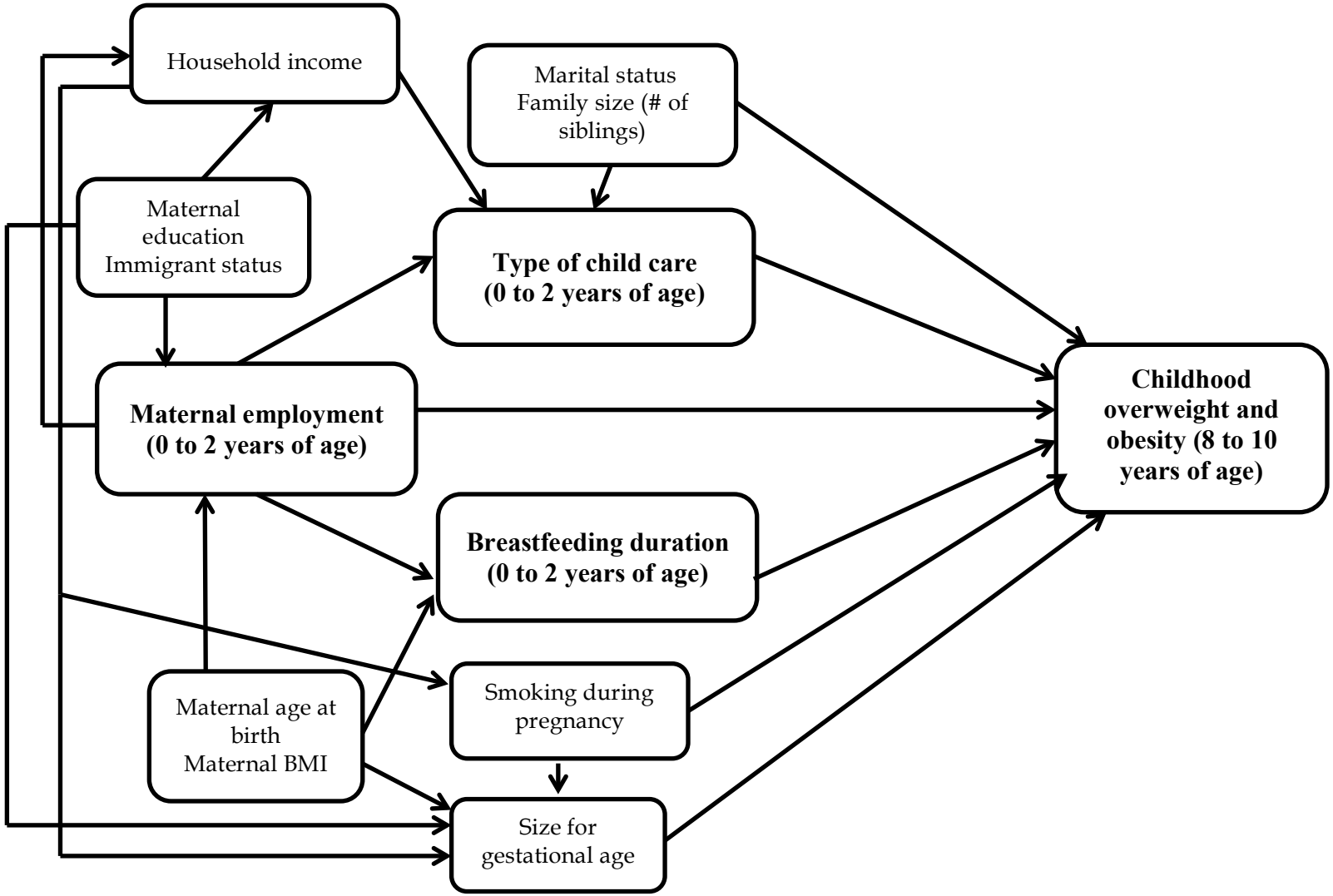

Figure 3.1 A Conceptual Model for Childhood Overweight and Obesity

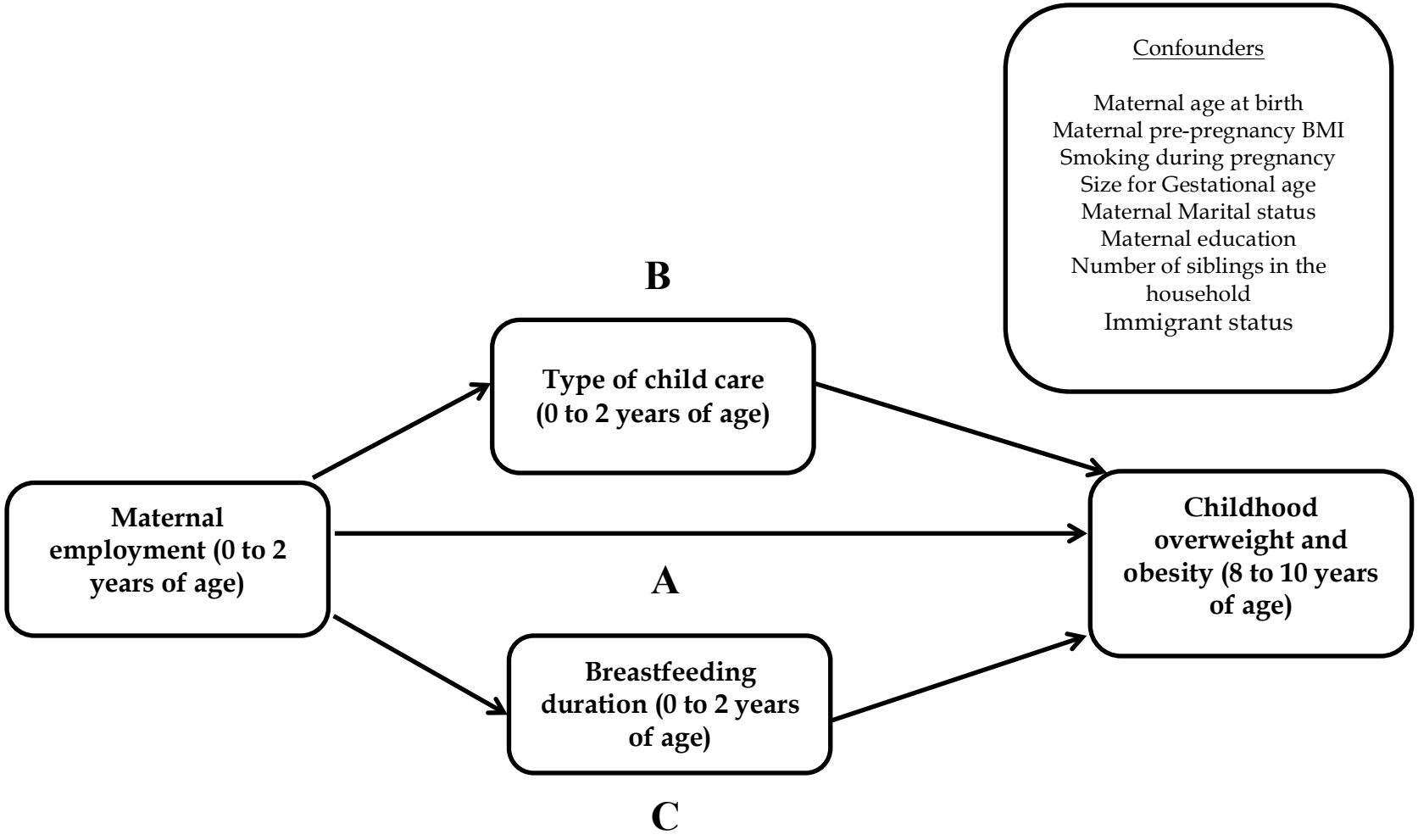

Figure 3.2 Simplified Conceptual Model for Childhood Overweight and Obesity

Chapter 4 Methods

4.1 Data Source and Sample

Data for this study came from the National Longitudinal Survey of Children and Youth (NLSCY), a long-term survey that follows Canadian children's development and well-being from birth to early adulthood.[216] The NLSCY collects detailed information on children's social, emotional and behavioural development over time, as well as information on their parents and guardians.[216] First conducted in 1994/1995 and every two years thereafter, there are currently eight completed survey cycles consisting of both longitudinal and cross-sectional samples.[216]

The NLSCY targets the civilian population from Canada's ten provinces who do not reside in institutions.[216] Children living on Indian reserves or Crown lands, or in some remote regions, or whose parents are full-time Canadian Armed Forces members are excluded from the survey.[216] Data are collected directly from survey respondents using both computer-assisted telephone interviewing and computer-assisted personal interviewing.[217]

Beginning in Cycle 2 (1996/1997), the NLSCY recruited an Early Childhood Development (ECD) cohort consisting of children ages 0 to 1 years.[217] Moving forward, we refer to these children as being 0 to 2 years of age, as the NLSCY refers to infants between 0 months to 12 months as being 0 years old, and children ages 12 months to 24 months as being 1 year of age.

For this project, data from the ECD cohort of children ages 0 to 2 years recruited in Cycle 3 (1998/1999) who were followed until Cycle 7 (2006/2007) were analyzed. The ECD cohort from Cycle 3 was chosen in order to analyze the most recent data possible while also ensuring that children were past the adiposity rebound stage during the cycle in which their weight status information was collected. Although a more recent wave (Cycle 8) is available, Cycle 3 children were not contacted for inclusion for Cycle 8 of the NLSCY.

In Cycle 3, children ages 0 to 2 years and 5 years were sampled from the Labour Force Survey and Birth Registry data.[218] Of children ages 0 to 2 years, there were 8126 children were sampled in Cycle 3 (85.0% response rate).[219] In Cycle 7, 5325 children who were 0 to 2

years in Cycle 3 returned as 8 to 10 year olds, representing a longitudinal response rate of 65.5%.[219] Further information regarding sampling methodology in the NLSCY has been published elsewhere.[219]

The information on children from Cycle 3 and Cycle 7 uses responses to the Child Component of the survey, answered by the Person Most Knowledgeable (PMK) about the child.[219] In the majority of cases, the PMK of the child is the mother, but fathers, step-parents, and adoptive parents living in the same dwelling are also permitted to answer these questions. For this study, observations were limited to those children for whom the PMK was the biological mother. Additionally, data from mothers who were under the age of 21 years at birth were excluded from the study sample. This was done in order to study the relationship between maternal employment and childhood overweight and obesity among adult women who have more likely had the opportunity to complete their education (if pursued) and less likely to be living with their parents.

4.2 Data Access

Data were accessed and analyzed in Statistics Canada's Research Data Centre (RDC) at Western University. Researchers were approved for access to the RDC after becoming deemed employees of Statistics Canada, signing a data use agreement, and undergoing a security clearance. In order to take results off-premises, the RDC must ensure that respondent confidentiality is maintained and protected. The RDC analyst reviewed all data requested for release and ensured that analyses were weighted, and that descriptive statistics and estimates had corresponding cell counts of 5 or greater. Further, the RDC analyst ensured that there was no risk of residual disclosure that may compromise respondent confidentiality.

4.3 Outcome Measure

The outcome variable of interest was whether a child is overweight/obese (versus not overweight/obese) in Cycle 7 at ages 8 to 10 years. Children's overweight/obesity at 8 to 10 years was obtained using a Statistics Canada derived variable that classified children's weight status (normal weight, overweight, obese) using age- and sex- specific BMI cutoffs developed by the IOTF.[10]

The IOTF BMI cutoffs for children were chosen because they are based on corresponding BMI cutoffs for overweight (25kg/m^2) and obesity (30kg/m^2) in adults, which are known to be associated with health risks in individuals aged 18 and older.[10] Using the IOTF cutoffs may thus be less arbitrary than the percentile values provided by the CDC or the WHO.[10] Studies comparing the IOTF, CDC, and WHO cutoffs for overweight and obesity in children have demonstrated that each method results in different prevalence estimates.[220–222] In general, the IOTF and CDC result in similar estimates, with the IOTF producing slightly lower estimates than the CDC in some cases.[220,221] Use of the WHO cutoffs, on the other hand, has been shown to result in a higher prevalence of both overweight and obesity relative to the IOTF and CDC cutoffs.[220] Applying the IOTF cutoffs to American boys and girls ages 6 to 8 years and 9 to 10 years in 1988-1994 resulted in lower or very similar estimates as the CDC for both overweight and obesity.[220] Canadian data from 2004 show that for combined overweight and obesity prevalence, the WHO estimates are higher by at least 10% for the total sample, and for boys and girls separately than the IOTF and CDC cutoffs.[221] The IOTF cutoffs produced lower estimates than the CDC by approximately 2% and 4% for the total sample and for boys, respectively, but an almost identical estimate for girls.[221] Based on this information, a conservative approach was chosen by using the IOTF cutoffs.

The NLSCY-derived variable for the Cole et al.[10] definition of overweight and obesity is calculated using children's BMI score, which is calculated as follows:

$$\text{BMI} = \text{weight (kg)} / [\text{height (m)}]^2$$

Children's height and weight information were reported by the PMK in response to the following questions: "What is his/ her height without shoes on?", and "What is his/ her weight?".

4.4 Predictor Variables

For detailed information on the primary predictors of interest as well as explanatory variables, see Table 4.1.

4.4.1 Maternal Employment Since Birth

Maternal employment since birth was the primary exposure variable for this study. Information on maternal employment since birth was obtained using responses from Cycle 3 to the following questions: “Did [you] work at a job or business since [your child’s] birth?” and (if responded ‘Yes’ to the previous answer) “How many hours a week did [you] usually work at that time?” Based on responses to these questions, maternal employment since birth was classified as “did not work since birth,” “worked part-time since birth,” and “worked full-time since birth.” Mothers who reported working between 1 to 29 hours per week on average were classified as being in part-time employment, while mothers who reported working 30 or more hours per week on average were classified as being employed full-time. Mothers who did not work since birth served as the reference group.

4.4.2 Breastfeeding

Breastfeeding was considered as a potential mediator in the relationship between maternal employment since birth and childhood overweight/obesity risk. Breastfeeding information was obtained using a mother’s responses to the following questions in Cycle 3 “Did you breast-feed [your child] even if only for a short time?” and (for mothers who responded ‘Yes’) “For how long?” The original variable in the NLSCY dataset for length of breastfeeding is a categorical variable with 9 levels. For the analysis, responses regarding whether women breastfed and if yes, the duration of breastfeeding, were combined to form the breastfeeding predictor in the study, which was categorized as 0 to 4 weeks of breastfeeding, 5 weeks to 6 months of breastfeeding, and more than 6 months of breastfeeding. More than 6 months of breastfeeding served as the reference group in regression models.

4.4.3 Type of Child Care

In addition to breastfeeding, the type of child care arrangement was considered as a potential mediator in the relationship between maternal employment and childhood overweight/obesity. Information on children’s care arrangements was obtained using responses reported by the mother in Cycle 3. The NLSCY asked women whether they currently use child care such as daycare, babysitting, or care by a relative or other caregiver

while they (or their spouse/partner) are working or studying. Mothers responding 'Yes' to this question also responded to a question asking which type of care arrangement they consider their main care arrangement (based on the one used for most hours), and were able to choose from a list of 10 types of arrangements. For this study, mothers who responded 'No' to whether they use child care were classified as Does not use child care. For mothers who use child care, the main care arrangement was classified as either formal care or informal care. Formal care was defined in this study as care in someone else's home by a non-relative, care in child's home by a non-relative, daycare centre, or nursery school. Care in someone else's home by a relative, care in child's own home by a relative (other than the child's brother or sister), care in child's own home by the child's brother or sister and 'other' were defined as Informal care. The final coding of the type of child care arrangement was coded as Does not use care, Formal care, and Informal care, with mothers who do not use care serving as the reference group.

4.5 Confounding Variables

Maternal age group at birth was self-reported by the mother in Cycle 3. The original variable in the dataset codes this a 4-level variable. For analysis purposes, categories were collapsed into 3 levels due to sample size considerations and for theoretical reasons. Age at birth was coded as ≤24 years, 25-34 years, and 35+ years, with mothers aged 25-34 years serving as the reference group.

Maternal smoking status during pregnancy was included as a binary Yes/No variable using response information collected in Cycle 3 to the question "Did you smoke during your pregnancy with [your child]?" Mothers who did not smoke during their pregnancy were selected as the reference group.

Since the NLSCY did not collect information on parental height and weight or overweight and obesity status, neither maternal pre-pregnancy BMI nor maternal weight status could be included in this study as confounders. Instead, maternal self-reported health status in Cycle 3 was used as an indicator for maternal health in order to capture any negative health consequences resulting from excess weight. Self-reported maternal health status is originally coded in the dataset as Excellent, Very Good, Good, Fair and Poor. Due to small sample size,

Fair and Poor categories were collapsed for the analysis. Mothers who self-reported being in Excellent health were chosen as the reference.

Size-for-gestational age was derived for this study using responses from mothers regarding their infant's birth weight in kilograms and grams. Using infant's birth weight converted into grams, we applied sex-specific Canadian population-based references established by Kramer et al. in 2001.[223] Size-for-gestational age was originally coded as Small for gestational age (10^{th} percentile of weight for age and sex), Appropriate for Gestational age (10^{th} percentile<gestational age<90^{th} percentile), and Large for gestational age (90^{th} percentile of weight for age and sex). The categories were later reduced to a binary variable of Small or Appropriate for gestational age and Large for gestational age due to small sample size among small for gestational age babies. Small or Appropriate for gestational age was used as the reference category.

Maternal marital status was obtained using a categorical 7-option variable from the NLSCY dataset in Cycle 3. Due to small sample sizes in cells, marital status was reduced to a binary variable indicating whether mothers had a partner or did not have a partner. Married, Common-law, and Living with a partner categories were combined, as were Single (never married), Separated, Divorced and Widowed. The reference category included women who were married, living in a common-law relationship, or living with a partner.

Maternal education was captured using an NLSCY-derived variable in Cycle 3 for the highest level of education obtained by the PMK. Responses are categorized into 4 levels: College/University graduate (including trade school), Some post-secondary education, High school graduate, and Less than high school graduation. College/University graduated mothers were set as the reference group.

Number of siblings in the household was collected in Cycle 3 from the PMK as a continuous variable. The number of siblings in the household refers to siblings of any age who are living in the household. Full, half, step, adoptive and foster siblings are included in the number reported by the mother. The number of siblings was coded into a categorical variable as No siblings, 1 siblings, and 2 or more siblings, with No siblings used as the reference.

Household income adequacy in Cycle 3 is included as a confounder in this study. The NLSCY derives income adequacy using responses to several questions. Income adequacy is categorized based on income and the size of the household into the following categories: Lowest (Household income is < 10,000 and household size is 1-4 persons; or Household income is < 15,000 and household size is 5 or more persons), Lower middle (Household income is 10,000-14,999 and household size is 1-2 persons; or Household income is 10,000-19,999 and household size is 3-4 persons; or House hold income is 15,000-29,999 and household size is 5 or more persons), Middle (Household income is 15,000-29,999 and household size is 1-2 persons; or Household income is 20,000-39,999 and household size is 3-4 persons; or Household income is 30,000-59,999 and household size is 5 or more persons), Upper Middle (Household income is 30,000-59,999 and household size is 1-2 persons; or Household income is 40,000-79,999 and household size is 3-4 persons; or Household income is 60,000-79,999 and household size is 5 or more persons) and Highest (Household income is 60,000 or more and household size is 1-2 persons; or Household income is 80,000 or more and household size is 3 or more persons). Income adequacy was re-categorized as Lowest/Lower Middle, Middle, and Upper Middle/Highest based on expectations regarding associations with childhood overweight/obesity. Being in the Upper Middle/Highest income adequacy group was selected as the reference category in regression analysis.

Immigrant status in Cycle 3 was obtained using a derived sociodemographic variable in the NLSCY dataset regarding age at the time of immigration. Those who provided an age at the time of immigration were coded as Immigrated to Canada, while those who provided Not Applicable responses (applicable only to those who did not immigrate) were coded as Did not immigrate to Canada. Individuals who did not immigrate to Canada were set as the reference.

4.6 Data Analysis

SAS® 9.3, SAS Institute Inc., Cary, NC[224] was used to apply inclusion/exclusion criteria, select and code variables, and merge Cycle 3 and Cycle 7 information. The saved dataset was imported into Stata®[225] using Stat/Transfer version 11[226] for subsequent statistical analysis. All statistical analyses were performed using Stata/SE version 12.1.[225]

4.6.1 Statistical Analyses

4.6.1.1 Missing Data Analyses

Chi-square tests were used to examine differences in baseline characteristics between those included in the study sample (children who had height and weight information in Cycle 7) and those without follow-up information in Cycle 7. Children without follow-up information included children who were recruited in Cycle 3 but did not respond in Cycle 7, and children that had responded in Cycle 7 but were missing outcome information. Cycle 3 cross-sectional weights, rather than Cycle 7 longitudinal weights, were applied for this analysis in order to enable the inclusion of Cycle 3 children who were non-responders. Further, descriptive information on baseline characteristics were examined separately for children lost to follow-up and those who were missing outcome information in Cycle 7.

4.6.1.2 Univariate and Univariable Analyses

All variables were first examined using a univariate approach. Frequencies were calculated for those who were recruited in Cycle 3 of the NLSCY and remained in the survey in Cycle 7, separately for males and females. One-way frequencies were used to assess the sufficiency of sample sizes based on the coding of variables. For univariate analyses, longitudinal survey weights were applied using Stata analytic weights.

Cross-tabulations and regression analyses were used to examine univariable associations. Separate cross-tabulations for males and females were calculated between each variable and the outcome variable. This provided an initial glance at the distribution of variables comparing overweight/obese children to children who were not overweight/obese. Cross-tabulations also helped determine cell-size adequacy for regression models based on standards dictated by Statistics Canada.

Univariable associations between predictors, confounders, and potential mediators and the outcome of interest were calculated using Poisson regression with robust standard errors. Longitudinal survey weights, applied using Stata probability weights, were used in univariable regression analyses.

4.6.1.3 Multivariable Analyses

Poisson regression with robust standard errors[227] was used to estimate the relative risk of children's overweight/obesity. For an explanation regarding the decision to use this method, see Appendix B. All multivariable analyses were stratified by child gender and longitudinal survey weights were applied with the probability weight option in Stata. Confounding variables were retained in multivariable analyses regardless of their statistical significance in univariable associations due to their theoretical importance in the relationship between maternal employment and childhood obesity. All confounding variables were identified through the literature review and included in the conceptual framework.

To examine the relationship between maternal employment during infancy and toddlerhood and childhood overweight/obesity at ages 8 to 10 years (objective 1), a multivariable model was run that included the main predictor and all confounding variables. Potential mediators were excluded in the first multivariable model as their effect must be examined separately.

4.6.1.4 Mediation Analyses

Hypotheses on partial mediation (objectives 2 and 3) were examined using criteria proposed by Baron and Kenny.[228] According to Baron and Kenny, breastfeeding and type of child care would be considered partial mediators if:

> 1) Maternal employment and childhood overweight/obesity are significantly associated.
> 2) Maternal employment is significantly associated with each potential mediator.
> 3) Each potential mediator continues to predict childhood overweight/obesity while controlling for maternal employment.
> 4) The relationship between maternal employment and childhood overweight and obesity is reduced when each mediator is entered into the model (i.e. the estimate is attenuated relative to the multivariable association between maternal employment and childhood overweight/obesity).

In order to test whether breastfeeding mediates the relationship between maternal employment during infancy and toddlerhood and childhood overweight/obesity (objective 2), and whether type of child care mediates the relationship between maternal employment

during infancy and toddlerhood and childhood overweight/obesity (objective 3), corresponding models were run examining each of the Baron and Kenny steps for breastfeeding and child care. To test the first Baron and Kenny criterion, the results of the multivariable association between maternal employment and childhood overweight/obesity were examined. To test whether maternal employment is a significant predictor of the potential mediators, two multinomial logistic regression models were used to regress breastfeeding and type of child care on maternal employment in infancy and toddlerhood. Finally, to examine the third and fourth Baron and Kenny criteria, modified Poisson regression models were run that included maternal employment, and were further adjusted for confounders and each potential mediator separately.

A final multivariable analysis was conducted in a model with maternal employment, confounders, and both mediating variables. This was done to assess the behaviour of the predictors of interest when maternal employment, breastfeeding, and type of child care were estimated simultaneously.

4.6.1.5 Sensitivity Analysis

All children aged 0 to 2 years were included in the main analysis. Since breastfeeding was categorized as 0 to 4 weeks, 5 weeks to 6 months, and more than 6 months, it is possible that information on breastfeeding duration would not reflect the final breastfeeding duration for children 6 months and under, and as a result may bias the association between breastfeeding and childhood overweight/obesity. To explore this possibility, a sensitivity analysis was conducted where all univariable, multivariable, and mediation analyses excluded children aged 6 months and under in Cycle 3. The results of the sensitivity analysis were compared to the main analysis in order to identify whether any of the primary associations of interest differed as a result of the age exclusion.

Table 4.1 Original Variable Forms and Final Recoding

Variable	NLSCY Cycle	Original Question/Variable in the NLSCY	Final Form
Childhood Overweight/Obesity	7	Derived variable of the IOTF[10] sex- and age-specific cut-offs for normal weight, overweight, obese. Derived based on children's BMI value from maternal response to the following questions: "What is his/ her height without shoes on?", and "What is his/ her weight?"	Recoded to binary: overweight/obese; Not overweight/obese
Maternal Employment Since Birth (for infants and toddlers aged 0 to 2 years)	3	"Did [you] work at a job or business since [your child's] birth?" "How many hours a week did [you] usually work at that time?"	Recoded to a Categorical variable: Did not work since birth; Worked part-time since birth (1-29 hours/week); Worked full-time since birth (30+ hours/week)
Breastfeeding	3	"Did you breast-feed [your child] even if only for a short time?" "For how long?"	Recoded to a Categorical variable with 3 levels: Breastfed 0 to 4 weeks; 5 weeks to 6 months; More than 6 months
Type of Child Care	3	Do you currently use child care such as daycare, babysitting, care by a relative or other caregiver, or a nursery school while you (and your spouse/partner) are at work or studying? Derived variable for the main care arrangement (one used for most hours)	Categorical variable: Does not use care; Informal Care (Care in someone else's home by a relative, care in child's own home by a relative (other than the child's brother or sister), care in child's own home by the child's brother or sister and 'other'); Formal Care (care in someone else's home by a non-relative, care in child's home by a non-relative, daycare centre, or nursery school)
Maternal Age Group at Birth	3	Derived categorical variable (4 levels) based on the following question: "At what age did you have your first baby?"	Recoded to a categorical variable with 3 levels: ≤24 years; 25-34 years; 35+ years

Table 4.1 Original Variable Forms and Final Recoding (continued)

Smoking During Pregnancy	3	"Did you smoke during your pregnancy with [your child]?"	Binary variable: Yes; No
Size for Gestational Age	3	Birth weight in kg and g reported by the mother	Recoded to binary using sex-specific reference points established by Kramer et al. in 2001[223] Small or Appropriate for Gestational Age; Large for Gestational Age.
Maternal Health Status	3	Categorical variable (5 levels) based on the following question: "In general, would you say [your] health is…"	Recoded to a categorical variable with 4 levels: Excellent; Very Good; Good; Fair/Poor
Maternal Marital Status	3	Categorical level (7 levels) for the marital status of the PMK	Recoded to a binary: With a Partner (Married/Common-law/Living with a partner); Without a Partner (Single/Widowed/Separated/Divorced)
Maternal Education	3	Derived categorical variable based on the following question: "What is the highest level of education that [you] have ever attained?	Categorical variable: Less than high school graduation; High school Graduate; Some post-secondary; College/University Degree (including Trade)
Siblings in the Household	3	Continuous derived variable: Total number of siblings (of the child) living in the household (including full, half, step, adopted and foster siblings and excluding the child him/herself).	Recoded to a categorical variable with 3 levels: None (no siblings); 1 sibling; 2 or more siblings.
Income Adequacy	3	Derived categorical variable (5 levels) classifying income adequacy based on income and household size	Recoded to a categorical variable with 3 levels: Lowest/Lower Middle; Middle; Upper Middle/Highest
Immigrant Status	3	Derived continuous variable for age at the time of immigration	Used as an indicator for immigrant status and recoded to binary: Immigrated to Canada; Did not immigrate to Canada

Chapter 5 Results

5.1 Sample Characteristics

Figure C.1 in Appendix C illustrates the selection of the final study sample. In Cycle 3, there were 7039 children ages 0 to 2 years whose parents participated to form an ECD cohort, for whom the PMK was the biological mother and whose mother was 21 or over at the time of birth. Of those children, mothers of 4389 children ages 8 to 10 years responded in Cycle 7. There were 3525 children (49% female) with weight status information available in Cycle 7. These children comprised the final study sample, while the children without height and weight information were excluded.

The characteristics of the study sample are summarized in Table 5.1. The prevalence of overweight/obesity was 30% in boys and 33% in girls. 39% of mothers did not work since birth when children were 0 to 2 years, while 27% and 33% worked part-time and full-time, respectively. 28% of children were breastfed between 0 to 4 weeks, 37% were breastfed between 5 weeks to 6 months, and 35% were breastfed for more than 6 months. 55% were not in any child care arrangement during infancy and toddlerhood, while 18% and 27% of children were placed in informal care and formal care arrangements, respectively.

5.1.1 Missing Data Analyses

The results of the missing data analyses are presented in Appendix D. Overall, there were significant differences in baseline variables between the study sample and those who were missing weight status information for every variable except for size for gestational age (Table D.1). In general, the study sample had a higher proportion of women who were more highly educated, classified as having higher income adequacy, and had a higher proportion of women who had a partner (married, common-law, living with a partner). Relative to the study sample, those without follow-up information had a higher portion of women who did not work since birth, breastfed between 0 to 4 weeks, and whose children were not in informal or formal care arrangements.

5.2 Univariable Analyses

The distribution of covariates between children who were overweight/obese and those who were not overweight and obese can be found in Table 5.2 (boys) and Table 5.3 (girls).

Univariable Poisson regression with robust standard errors predicting overweight/obesity is presented in Table 5.4 (boys) and Table 5.5 (girls).

The association between maternal employment during infancy and toddlerhood and overweight/obesity was not found for boys or girls in the univariable analysis. Boys who were breastfed between 0 to 4 weeks, relative to boys who were breastfed for more than 6 months had 1.80 times the risk of overweight/obesity (95% CI=1.31-2.47, $p<0.001$). In girls, a corresponding association between breastfeeding length and overweight/obesity risk was not found. Type of child care arrangement at 0 to 2 years did not predict overweight/obesity status at ages 8 to 10 years for either boys or girls.

The aim of this study is to test a causal relationship, and covariates are included to account for confounding in the association between maternal employment and childhood overweight/obesity. Although the purpose of this study is not to build a model of overweight/obesity in childhood, it can nevertheless be useful to discuss the relationship between potential confounders and overweight/obesity risk.

For boys, having a mother who reported being in fair or poor health in Cycle 3 (RR=2.00, 95% CI=1.19, 3.36), being born large for gestational age (RR=1.39, 95% CI=1.04-1.84), and having a mother who is a high school graduate in Cycle 3 (RR=1.66, 95% CI=1.21-2.28) were all associated with an increased risk of overweight/obesity relative to have a mother in excellent health, being born small or appropriate for gestational age, and having a mother who is a university or college graduate, respectively.

For girls, having a mother who reported being in very good (RR=1.35, 95% CI=1.04, 1.76), good (RR=1.59, 95% CI=1.14, 2.23), and fair or poor health (RR=2.01, 95% CI=1.25, 3.22) in Cycle 3 were all associated with an increased risk of overweight/obesity relative to having a mother who reported being in excellent health. Furthermore, being born large for gestational age (RR=1.43, 95% CI=1.12-1.83) relative to being born small or appropriate for gestational age was associated with increased overweight/obesity risk. Finally, belonging to a middle (RR=1.40, 95% CI=1.08, 1.83) or lowest/lower middle (RR=1.39, 95% CI=1.00, 1.92) income adequacy household was also associated with increased risk of overweight/obesity in childhood relative to girls who are in upper middle/highest income adequacy households.

5.3 Multivariable and Mediation Analyses

5.3.1 Maternal Employment During Infancy and Toddlerhood

The results of multivariable analyses predicting the risk of childhood/overweight and obesity are presented under Model 1 in Table 5.4 (boys) and Table 5.5 (girls). After adjusting for confounders, full-time maternal employment during infancy and toddlerhood, relative to not working since birth, was significantly associated with overweight/obesity risk in boys (RR=1.38, 95% CI=1.04-1.84). Boys whose mothers worked part-time since birth during their infancy and toddlerhood did not have an increased risk of overweight/obesity at ages 8 to 10 years. The adjusted association between maternal employment and childhood overweight/obesity was not significant in girls.

5.3.2 Mediation Analyses

Results for the Baron and Kenny steps are presented in Table 5.4 (boys), Table 5.5 (girls), Table 5.6-Table 5.7 (boys) and Table 5.8-Table 5.9 (girls). General summaries of the mediation results are presented in Table 5.10-Table 5.11 (boys) and Table 5.12-Table 5.13 (girls). Neither breastfeeding nor child care were found to be partial mediators for either boys or girls.

5.3.2.1 Breastfeeding

5.3.2.1.1 Boys

The significant adjusted association between maternal employment and childhood overweight/obesity in boys (Table 4, Model 1) confirmed the first criterion to establish partial mediation (see 4.6.1.4 Mediation Analyses) for breastfeeding in boys. Multinomial logistic regression (Table 5.6) revealed a significant association between maternal employment during infancy and toddlerhood and breastfeeding duration. Full-time maternal employment was associated with increased odds of breastfeeding for 4 weeks or less and for breastfeeding for 5 weeks to 6 months relative to breastfeeding for more than 6 months. Model 2 of Table 5.4 displays the results for the third Baron and Kenny criterion for mediation. Breastfeeding continued to significantly predict overweight/obesity in boys while controlling for maternal employment. Boys who were breastfed for 4 weeks or less had a

higher risk of overweight/obesity (RR=1.59, 95% CI=1.18, 2.16). Examining Model 2 (maternal employment, confounders, and breastfeeding) and Model 1 (maternal employment adjusted for confounders) of Table 5.4, the addition of breastfeeding to the adjusted model reduced the relationship between full-time maternal employment during infancy and toddlerhood and the risk of overweight/obesity in boys below significance. However, the attenuation of the relative risk of overweight/obesity predicted by maternal employment with the addition of breastfeeding (Baron and Kenny criterion 4) is small, representing a 6% decrease in the relative risk.

5.3.2.1.2 Girls

The adjusted association between maternal employment during infancy and toddlerhood and children's overweight/obesity risk was statistically non-significant in girls (Table 5.5, Model 1). While maternal employment was found to significantly predict breastfeeding duration (Table 5.8), breastfeeding was not found to predict the risk of overweight/obesity while controlling for maternal employment during infancy and toddlerhood. Additionally, the relative risk of overweight/obesity predicted by maternal employment did not change with the addition of breastfeeding.

5.3.2.2 Child Care

5.3.2.2.1 Boys

While maternal employment was significantly associated with overweight/obesity risk in boys (Table 5.4), and maternal employment during infancy and toddlerhood was highly predictive of type of child care (Table 5.7), child care did not significantly predict overweight/obesity risk while controlling for maternal employment (Table 5.4).

5.3.2.2.2 Girls

Although maternal employment was highly predictive of type of child care arrangement in infancy and toddlerhood (Table 5.9), there was no significant relationship between maternal employment during infancy and toddlerhood and overweight/obesity risk at ages 8 to 10 years (Table 5.5) Furthermore, type of child care did not predict overweight/obesity risk while controlling for maternal employment (Table 5.5). In girls, there was an attenuation in the relative risk of overweight/obesity predicted by maternal employment adjusted for confounders and child care (Table 5.5, Model 3) compared to maternal employment adjusted

only for confounders (Table 5.5, Model 2). The addition of child care reduced the relative risk by approximately 16%.

5.3.3 Sensitivity Analysis

The detailed results from the sensitivity analysis are excluded due to Statistics Canada rules regarding respondent confidentiality. The exclusion of children ages 6 months and under from the study sample did not significantly alter the main relationships observed in the full sample. For girls, there were no changes in the associations between maternal employment, breastfeeding, child care, and overweight/obesity risk. The exclusion of boys who were ages 6 months and under in Cycle 3 slightly attenuated the coefficient on maternal employment, and it became statistically non-significant. This result does not alter overall conclusions regarding the effect of maternal employment.

Table 5.1 Characteristics of Boys and Girls at Ages 0 to 2 Years

Characteristic	Boys (n=1788) n (%)	Girls (n=1737) n (%)	All (n=3525) n (%)
Mean Age (months) in Cycle 3	13.3	14.2	13.7
Age Group (months) in Cycle 3			
0 to 5 months	165 (9%)	111 (6%)	276 (8%)
6 months to 11 months	599 (34%)	458 (26%)	1057 (30%)
12 months to 24 months	1023 (57%)	1167 (67%)	2190 (62%)
Weight Status in Cycle 7			
Not overweight/obese	1248 (70%)	1168 (67%)	2416 (69%)
Overweight/obese	539 (30%)	568 (33%)	1107 (31%)
Maternal Employment			
Did not work since birth	757 (42%)	631 (36%)	1388 (39%)
Part-time (1-29 hours/week)	458 (26%)	503 (29%)	961 (27%)
Full-time (30+ hours/week)	569 (32%)	599 (35%)	1168 (33%)
Breastfeeding			
0 to 4 weeks	487 (28%)	484 (29%)	971 (28%)
5 weeks to 6 months	707 (40%)	552 (33%)	1259 (37%)
More than 6 months	554 (32%)	640 (38%)	1194 (35%)
Type of Child care			
Does not use care	1028 (58%)	889 (51%)	1917 (55%)
Informal care	342 (19%)	319 (18%)	661 (18%)
Formal care	414 (23%)	524 (30%)	938 (27%)
Maternal Age Group at Birth			
<24	288 (16%)	257 (15%)	545 (15%)
25-34	1173 (66%)	1204 (69%)	2377 (67%)
35+	325 (18%)	275 (16%)	600 (17%)
Smoking During Pregnancy			
Yes	364 (21%)	302 (18%)	666 (19%)
No	1408 (79%)	1419 (82%)	2827 (81%)
Size for Gestational Age			
Small or Appropriate for GA	1546 (87%)	1475 (85%)	3021 (86%)
Large for GA	237 (13%)	259 (15%)	496 (14%)
Maternal Health Status			
Excellent	728 (41%)	759 (44%)	1487 (43%)
Very Good	646 (36%)	602 (35%)	1248 (36%)
Good	343 (19%)	314 (18%)	657 (19%)
Fair/Poor	56 (3%)	48 (3%)	104 (3%)
Maternal Marital Status			
With a Partner	1682 (94%)	1582 (91%)	3264 (93%)
Without a Partner	105 (6%)	154 (9%)	259(7%)
Maternal education			
Less than high school	192 (11%)	223 (13%)	415 (12%)
High school graduate	273 (15%)	233 (14%)	506 (14%)
Some-post secondary	468 (26%)	466 (27%)	934 (27%)
College/University graduate	841 (47%)	802 (47%)	1643 (47%)

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Table 5.1 Characteristics of Boys and Girls at Ages 0 to 2 Years (Continued)

Characteristic	Boys (n=1788) n (%)	Girls (n=1737) n (%)	All (n=3525) n (%)
Siblings in the Household			
No siblings	789 (44%)	729 (42%)	1518 (43%)
1 sibling	699 (39%)	589 (34%)	1288 (37%)
2 or more siblings	299 (17%)	417 (24%)	716 (20%)
Income Adequacy			
Lowest/Lower middle	206 (12%)	249 (14%)	455 (13%)
Middle	508 (28%)	488 (28%)	996 (28%)
Upper middle/Highest	1072 (60%)	998 (58%)	2070 (59%)
Immigrant status			
Immigrated to Canada	250 (14%)	298 (17%)	548 (16%)
Did not immigrate to Canada	1537 (86%)	1438 (83%)	2975 (84%)

Table 5.2 Characteristics of Boys According to Weight Status at Ages 8 to 10 Years

Characteristic	Not Overweight/Obese n (row %)	Overweight/Obese n (row %)
Maternal Employment (n=1783)		
Did not work since birth	562 (74%)	195 (26%)
Part-time (1-29 hours/week)	311 (68%)	146 (32%)
Full-time (30+ hours/week)	373 (66%)	196 (34%)
Breastfeeding (n=1747)		
0 to 4 weeks	293 (60%)	194 (40%)
5 weeks to 6 months	503 (71%)	204 (29%)
More than 6 months	431 (78%)	122 (22%)
Type of Child care (n=1782)		
Does not use care	724 (70%)	304 (30%)
Informal care	230 (67%)	111 (33%)
Formal care	287 (69%)	126 (31%)
Maternal Age Group at Birth (n=1785)		
<24	201 (70%)	86 (30%)
25-34	822 (70%)	351 (30%)
35+	225 (69%)	100 (31%)
Smoking During Pregnancy (n=1771)		
Yes	231 (64%)	132 (36 %)
No	1003 (71%)	405 (29%)
Size for Gestational Age (n=1782)		
Small or Appropriate for GA	1102 (71%)	444 (29%)
Large for GA	142 (60%)	94 (40%)
Maternal Health Status (n=1772)		
Excellent	539 (74%)	188 (26%)
Very Good	432 (67%)	214 (33%)
Good	239 (70%)	104 (30%)
Fair/Poor	27 (48%)	29 (52%)
Maternal Marital Status (n=1786)		
With a Partner	1181 (70%)	500 (30%)
Without a Partner	67 (64%)	38 (36%)
Maternal education (n=1771)		
Less than high school	143 (75%)	48 (25%)
High school graduate	155 (57%)	117 (43%)
Some-post secondary	318 (68%)	150 (32%)
College/University graduate	622 (74%)	218 (26%)
Siblings in the Household (n=1785)		
No siblings	570 (72%)	219 (28%)
1 sibling	458 (66%)	240 (34%)
2 or more siblings	219 (73%)	79 (27%)
Income Adequacy (n=1785)		
Lowest/Lower middle	146 (71%)	60 (29%)
Middle	327 (64%)	180 (36%)
Upper middle/Highest	774 (72%)	298 (28%)
Immigrant status (n=1786)		
Immigrated to Canada	157 (63%)	93 (37%)
Did not immigrate to Canada	1091 (71%)	445 (29%)

Table 5.3 Characteristics of Girls According to Weight Status at Ages 8 to 10 Years

Characteristic	Not Overweight/Obese n (row %)	Overweight/Obese n (row %)
Maternal Employment (n=1732)		
Did not work since birth	422 (67%)	209 (33%)
Part-time (1-29 hours/week)	340 (68%)	163 (32%)
Full-time (30+ hours/week)	401 (67%)	197 (33%)
Breastfeeding (n=1674)		
0 to 4 weeks	310 (64%)	173 (36%)
5 weeks to 6 months	370 (67%)	182 (33%)
More than 6 months	449 (70%)	190 (30%)
Type of Child care (n=1730)		
Does not use care	612 (69%)	276 (31%)
Informal care	203 (64%)	116 (36%)
Formal care	349 (67%)	174 (33%)
Maternal Age Group at Birth (n=1733)		
<24	166 (65%)	90 (35%)
25-34	828 (69%)	375 (31%)
35+	173 (63%)	101 (37%)
Smoking During Pregnancy (n=1719)		
Yes	184 (61%)	117 (39%)
No	969 (68%)	449 (32%)
Size for Gestational Age (n=1733)		
Small or Appropriate for GA	1020 (69%)	455 (31%)
Large for GA	144 (56%)	114 (44%)
Maternal Health Status (n=1721)		
Excellent	559 (74%)	199 (26%)
Very Good	388 (64%)	214 (36%)
Good	182 (58%)	132 (42%)
Fair/Poor	22 (47%)	25 (53%)
Maternal Marital Status (n=1735)		
With a Partner	1078 (68%)	504 (32%)
Without a Partner	89 (58%)	64 (41%)
Maternal education (n=1722)		
Less than high school	141 (64%)	81 (36%)
High school graduate	138 (59%)	95 (41%)
Some-post secondary	317 (68%)	149 (32%)
College/University graduate	556 (69%)	245 (31%)
Siblings in the Household (n=1735)		
No siblings	519 (71%)	210 (29%)
1 sibling	378 (64%)	211 (36%)
2 or more siblings	271 (65%)	146 (35%)
Income Adequacy (n=1734)		
Lowest/Lower middle	152 (61%)	96 (39%)
Middle	296 (61%)	192 (39%)
Upper middle/Highest	719 (72%)	279 (28%)
Immigrant status (n=1735)		
Immigrated to Canada	188 (63%)	110 (37%)
Did not immigrate to Canada	980 (68%)	457 (32%)

Table 5.4 Unadjusted and Adjusted Risk Ratios (95% CI) for Childhood Overweight/Obesity in Boys at Ages 8 to 10 Years

	Univariable	Model 1[1]	Model 2[2]	Model 3[3]	Model 4[4]
	Risk Ratios (95% CI)				
Maternal employment					
Did not work since birth	1	1	1	1	1
1-29 hours/week	1.23 (0.88, 1.75)	1.28 (0.93, 1.77)	1.26 (0.92, 1.73)	1.29 (0.92, 1.82)	1.29 (0.91, 1.82)
30+ hours/week	1.34 (0.98, 1.84)	1.38 (1.04, 1.84)*	1.30 (0.98, 1.72)	1.40 (0.99, 1.98)	1.34 (0.94, 1.91)
Breastfeeding					
More than 6 months	1		1		1
5 weeks to 6 months	1.30 (0.92, 1.84)		1.19 (0.89, 1.61)		1.19 (0.88, 1.60)
0 to 4 weeks	1.80 (1.31, 2.47)***		1.59 (1.18, 2.16)**		1.58 (1.17, 2.13)**
Child care					
Does not use care	1			1	1
Informal care	1.11 (0.75, 1.63)			0.97 (0.65, 1.46)	0.93 (0.62, 1.41)
Formal care	1.03 (0.80, 1.34)			0.94 (0.69, 1.30)	0.93 (0.67, 1.31)
Maternal age at birth†					
25-34	1	1	1	1	1
<24	1.01 (0.68, 1.49)	0.93 (0.63, 1.37)	0.96 (0.65, 1.43)	0.93 (0.63, 1.37)	0.96 (0.65, 1.42)
35+	1.03 (0.72, 1.48)	1.00 (0.74, 1.34)	1.03 (0.77, 1.37)	1.02 (0.76, 1.37)	1.05 (0.78, 1.40)
Smoking during pregnancy†					
No	1	1	1	1	1
Yes	1.26 (0.88, 1.82)	1.31 (0.99, 1.74)	1.22 (0.91, 1.63)	1.31 (0.99, 1.72)	1.21 (0.91, 1.61)
Maternal health rating†					
Excellent	1	1	1	1	1
Very Good	1.27 (0.93, 1.75)	1.23 (0.93, 1.63)	1.25 (0.94, 1.65)	1.24 (0.94, 1.63)	1.25 (0.95, 1.65)
Good	1.17 (0.81, 1.68)	1.05 (0.74, 1.47)	1.04 (0.74, 1.46)	1.05 (0.74, 1.48)	1.04 (0.74, 1.47)
Fair/Poor	2.00 (1.19, 3.36)**	1.72 (1.05, 2.84)*	1.48 (0.79, 2.74)	1.71 (1.04, 2.80)*	1.48 (0.80, 2.73)

[1] Adjusted for confounders; [2]Adjusted for confounders and breastfeeding; [3]Adjusted for confounders and type of child care; [4]Adjusted for confounders, breastfeeding, and type of child care; † confounder; *p<0.05 **p<0.01 ***p<0.001

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Table 5.4 Unadjusted and Adjusted Risk Ratios (95% CI) for Childhood Overweight/Obesity in Boys at ages 8 to 10 Years (Continued)

	Univariable	Model 1[1]	Model 2[2]	Model 3[3]	Model 4[4]
	Risk Ratios (95% CI)				
Size for gestational age†					
Small or Appropriate for GA	1	1	1	1	1
Large for GA	1.39 (1.04, 1.84)*	1.38 (1.04,1.82)*	1.35 (1.00, 1.82)*	1.37 (1.04, 1.81)*	1.35 (1.01, 1.81)*
Maternal marital status†					
With a Partner	1	1	1	1	1
Without a Partner	1.22 (0.81, 1.84)	1.19 (0.69, 2.04)	1.20 (0.69, 2.09)	1.20 (0.69, 2.08)	1.21 (0.69, 2.14)
Maternal education†					
College/Univ. graduate	1	1	1	1	1
Some-post secondary	1.24 (0.91, 1.67)	1.17 (0.88, 1.56)	1.13 (0.85, 1.52)	1.15 (0.87, 1.53)	1.12 (0.84, 1.49)
High school graduate	1.66 (1.21, 2.28)**	1.47 (1.09, 1.99)*	1.35 (1.00, 1.83)*	1.45 (1.07, 1.96)*	1.33 (0.99, 1.81)
Less than high school	0.97 (0.52, 1.83)	0.90 (0.48, 1.66)	0.84 (0.47, 1.51)	0.88 (0.47, 1.63)	0.82 (0.45, 1.49)
Siblings in the household†					
No siblings	1	1	1	1	1
1 sibling	1.24 (0.91, 1.67)	1.13 (0.87, 1.47)	1.13 (0.87, 1.47)	1.14 (0.88, 1.49)	1.14 (0.88, 1.48)
2 or more siblings	0.95 (0.68, 1.34)	0.87 (0.62, 1.24)	0.86 (0.60, 1.23)	0.87 (0.62, 1.23)	0.85 (0.60, 1.21)
Income adequacy†					
Upper middle/Highest	1	1	1	1	1
Middle	1.28 (0.95, 1.71)	1.30 (0.99, 1.72)	1.30 (0.98, 1.71)	1.29 (0.98, 1.69)	1.28 (0.97, 1.69)
Lowest/Lower middle	1.05 (0.67, 1.64)	0.90 (0.50, 1.62)	0.84 (047, 1.50)	0.89 (0.49, 1.62)	0.82 (0.45, 1.50)
Immigrant status†					
Did not immigrate to Canada	1	1	1	1	1
Immigrated to Canada	1.28 (0.93, 1.77)	1.33 (0.96, 1.83)	1.31 (0.93, 1.85)	1.31 (0.94, 1.82)	1.29 (0.91, 1.83)

[1] Adjusted for confounders; [2]Adjusted for confounders and breastfeeding; [3]Adjusted for confounders and type of child care; [4]Adjusted for confounders, breastfeeding, and type of child care; † confounder; *p<0.05 **p<0.01 ***p<0.001

Table 5.5 Unadjusted and Adjusted Risk Ratios (95% CI) for Childhood Overweight/Obesity in Girls at Ages 8 to 10 Years

	Univariable	Model 1[1]	Model 2[2]	Model 3[3]	Model 4[4]
	Risk Ratios (95% CI)				
Maternal employment					
Did not work since birth	1	1	1	1	1
1-29 hours/week	0.98 (0.71, 1.35)	1.20 (0.90, 1.59)	1.20 (0.90, 1.62)	1.03 (0.71, 1.49)	1.04 (0.71, 1.53)
30+ hours/week	1.00 (0.77, 1.28)	1.21 (0.95, 1.54)	1.20 (0.93, 1.55)	1.01 (0.68, 1.50)	1.02 (0.67, 1.55)
Breastfeeding					
More than 6 months	1		1		1
5 weeks to 6 months	1.11 (0.81, 1.52)		1.05 (0.78, 1.42)		1.06 (0.79, 1.45)
0 to 4 weeks	1.20 (0.88, 1.64)		1.05 (0.80, 1.38)		1.04 (0.79, 1.36)
Child care					
Does not use care	1			1	1
Informal care	1.16 (0.83, 1.65)			1.32 (0.87, 2.00)	1.30 (0.86, 1.99)
Formal care	1.07 (0.82, 1.39)			1.27 (0.87, 1.86)	1.26 (0.85, 1.85)
Maternal age at birth†					
25-34	1	1	1	1	1
<24	1.13 (0.85, 1.51)	0.98 (0.73, 1.31)	0.99 (0.74, 1.33)	0.97 (0.72, 1.30)	0.98 (0.73, 1.33)
35+	1.19 (0.89, 1.58)	1.08 (0.84, 1.39)	0.99 (0.76, 1.30)	1.08 (0.84, 1.39)	0.99 (0.75, 1.29)
Smoking during pregnancy†					
No	1	1	1	1	1
Yes	1.23 (0.94, 1.59)	1.18 (0.90, 1.54)	1.19 (0.91, 1.57)	1.15 (0.88, 1.51)	1.17 (0.89, 1.52)
Maternal health rating†					
Excellent	1	1	1	1	1
Very Good	1.35 (1.04, 1.76)*	1.33 (1.03, 1.72)*	1.34 (1.03, 1.75)*	1.36 (1.06, 1.75)*	1.38 (1.07, 1.78)*
Good	1.59 (1.14, 2.23)**	1.49 (1.10, 2.02)**	1.39 (1.02, 1.90)*	1.51 (1.11, 2.06)**	1.41 (1.03, 1.95)*
Fair/Poor	2.01 (1.25, 3.22)**	1.62 (1.05, 2.49)*	1.64 (1.07, 2.53)*	1.58 (1.01, 2.48)*	1.62 (1.03, 2.53)*

[1] Adjusted for confounders; [2]Adjusted for confounders and breastfeeding; [3]Adjusted for confounders and type of child care; [4]Adjusted for confounders, breastfeeding, and type of child care; † confounder; *p<0.05 **p<0.01 ***p<0.001

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Table 5.5 Unadjusted and Adjusted Risk Ratios (95% CI) for Childhood Overweight/Obesity in Girls at ages 8 to 10 Years (Continued)

	Univariable	Model 1[1]	Model 2[2]	Model 3[3]	Model 4[4]
	Risk Ratios (95% CI)				
Size for gestational age†					
Small or Appropriate for GA	1	1	1	1	1
Large for GA	1.43 (1.12, 1.83)***	1.42 (1.12,1.79)**	1.40 (1.10, 1.77)**	1.38 (1.10, 1.74)**	1.36 (1.07, 1.72)**
Maternal marital status†					
With a Partner	1	1	1	1	1
Without a Partner	1.31 (0.97, 1.78)	0.98 (0.70, 1.38)	1.02 (0.72, 1.44	1.00 (0.71, 1.39)	1.04 (0.74, 1.47)
Maternal education†					
College/Univ. graduate	1	1	1	1	1
Some-post secondary	1.04 (0.77, 1.42)	0.93 (0.72, 1.21)	0.94 (0.72, 1.23)	0.94 (0.72, 1.23)	0.95 (0.72, 1.25)
High school graduate	1.34 (0.99, 1.80)	1.21 (0.90, 1.63)	1.23 (0.91, 1.67)	1.19 (0.89, 1.60)	1.21 (0.90, 1.63)
Less than high school	1.20 (0.77, 1.87)	1.12 (0.70, 1.77)	1.11 (0.69, 1.78)	1.09 (0.68, 1.74)	1.08 (0.67, 1.75)
Siblings in the household†					
No siblings	1	1	1	1	1
1 sibling	1.25 (0.97, 1.60)	1.28 (1.00, 1.65)	1.25 (0.97, 1.60)	1.28 (0.99, 1.65)	1.24 (0.97, 1.59)
2 or more siblings	1.21 (0.85, 1.73)	1.11 (0.79, 1.56)	1.08 (0.76, 1.54)	1.13 (0.80, 1.61)	1.10(0.77, 1.59)
Income adequacy†					
Upper middle/Highest	1	1	1	1	1
Middle	1.40 (1.08, 1.83)*	1.32 (1.03, 1.69)*	1.32 (1.03, 1.70)*	1.36 (1.06, 1.74)**	1.36 (1.06, 1.75)*
Lowest/Lower middle	1.39 (1.00, 1.92)*	1.52 (1.08, 2.14)*	1.34 (0.93, 1.93)	1.52 (1.08, 2.15)**	1.35 (0.93, 1.94)
Immigrant status†					
Did not immigrate to Canada	1	1	1	1	1
Immigrated to Canada	1.16 (0.83, 1.64)	1.25 (0.93, 1.67)	1.32 (0.98, 1.77)	1.26 (0.94, 1.69)	1.34 (0.98, 1.81)

[1] Adjusted for confounders; [2]Adjusted for confounders and breastfeeding; [3]Adjusted for confounders and type of child care; [4]Adjusted for confounders, breastfeeding, and type of child care; † confounder; *p<0.05 **p<0.01 ***p<0.001

Table 5.6 Odds Ratios (95% CI) for the Association Between Maternal Employment and Breastfeeding Duration in Boys

	Breastfed for 4 Weeks or Less†	Breastfed for 5 weeks to 6 months†
	Odds Ratios (95% CI)	
Maternal employment		
Did not work since birth	1	1
1-29 hours/week	1.14 (0.66, 1.97)	1.34 (0.68, 2.64)
30+ hours/week	1.84 (1.05, 3.24)*	2.58 (1.40, 4.75)**

† Relative to breastfeeding for more than 6 months
* p<0.05; **p<0.01

Table 5.7 Odds Ratios (95% CI) for the Association Between Maternal Employment and Child Care in Boys

	Informal Care†	Formal Care†
	Odds Ratios (95% CI)	
Maternal employment		
Did not work since birth	1	1
1-29 hours/week	15.14 (4.23, 54.29)***	23.15 (11.80, 45.41)***
30+ hours/week	22.06 (6.29, 77.37)***	50.34 (25.45, 99.58)***

† Relative to children not placed in formal or informal care arrangements
* p<0.05; **p<0.01; ***p<0.001

Table 5.8 Odds Ratios (95% CI) for the Association Between Maternal Employment and Breastfeeding Duration in Girls

	Breastfed for 4 Weeks or Less†	Breastfed for 5 weeks to 6 months†
	Odds Ratios (95% CI)	
Maternal employment		
Did not work since birth	1	1
1-29 hours/week	0.58 (0.33, 1.02)	1.39 (0.79, 2.43)
30+ hours/week	1.39 (0.87, 2.24)	2.49 (1.62, 3.80)***

† Relative to breastfeeding for more than 6 months
* p<0.05; ** p<0.01; *** p<0.001

Table 5.9 Odds Ratios (95% CI) for the Association Between Maternal Employment and Child Care in Girls

	Informal Care†	Formal Care†
	Odds Ratios (95% CI)	
Maternal employment		
Did not work since birth	1	1
1-29 hours/week	65.32 (25.88, 164.90)***	27.01 (13.93, 52.42)***
30+ hours/week	90.98 (40.16, 206.10)***	55.68 (29.72, 104.32)***

† Relative to children not placed in formal or informal care arrangements
* p<0.05; ** p<0.01; *** p<0.001

Table 5.10 Summary of Baron and Kenny Steps Testing Whether Breastfeeding Serves as a Partial Mediator Between Maternal Employment and Childhood Overweight/Obesity in Boys

BARON & KENNY STEP	MODEL STATISTICALLY SIGNIFICANT?	CHANGE IN RISK RATIOS BETWEEN STEPS 1 AND 3?
1) Maternal employment → overweight/obesity	Yes	No (only a 6% reduction in the relative risk with the addition of breastfeeding)
2) Maternal employment → breastfeeding	Yes	
3) Maternal employment + breastfeeding → overweight/obesity	Yes	

Table 5.11 Summary of Baron and Kenny Steps Testing Whether Child Care Serves as a Partial Mediator Between Maternal Employment and Childhood Overweight/Obesity in Boys

BARON & KENNY STEP	MODEL STATISTICALLY SIGNIFICANT?	CHANGE IN RISK RATIOS BETWEEN STEPS 1 AND 3?
1) Maternal employment → overweight/obesity	Yes	No
2) Maternal employment → child care	Yes	
3) Maternal employment + breastfeeding → child care	No	

Table 5.12 Summary of Baron and Kenny Steps Testing Whether Breastfeeding Serves as a Partial Mediator Between Maternal Employment and Childhood Overweight/Obesity in Girls

BARON & KENNY STEP	MODEL STATISTICALLY SIGNIFICANT?	CHANGE IN RISK RATIOS BETWEEN STEPS 1 AND 3?
1) Maternal employment → overweight/obesity	No	No
2) Maternal employment → breastfeeding	Yes	
3) Maternal employment + breastfeeding → overweight/obesity	No	

Table 5.13 Summary of Baron and Kenny Steps Testing Whether Child Care Serves as a Partial Mediator Between Maternal Employment and Childhood Overweight/Obesity in Girls

BARON & KENNY STEP	MODEL STATISTICALLY SIGNIFICANT?	CHANGE IN RISK RATIOS BETWEEN STEPS 1 AND 3?
1) Maternal employment → overweight/obesity	No	Yes
2) Maternal employment → child care	Yes	
3) Maternal employment + breastfeeding → child care	No	

Chapter 6 Discussion

6.1 Overview and Study Contribution

This research contributes to the current literature on maternal employment and childhood overweight and obesity by specifically examining the role of maternal employment during infancy and toddlerhood on children's future risk of overweight and obesity. While the relationship has been well-examined for maternal employment in children ages 6 years or over,[18,22,23,53,56,57,61,65,66] and less so younger children,[18,21,52,55,62,65] this is the first study to focus exclusively on the effects of exposure to maternal employment in infancy and toddlerhood.

The benefit of studying exposure to maternal employment in infancy and toddlerhood is the ability to test early-life events that may contribute to childhood overweight and obesity risk. Since research in this field has tended to focus on maternal employment during mid-childhood, researchers have studied mechanisms that are relevant to children of those ages, such as television viewing, snacking, and physical activity.[50,51,56,229,230] In younger children, breastfeeding has been shown to predict children's weight status, and some evidence suggests that the type of child care is associated with overweight/obesity risk in childhood. However, there has been no formal investigation in the literature as to whether breastfeeding and child care operate along the causal pathway between employment during the first two years and childhood weight status.

Another novel aspect of this thesis is examining the relationship between maternal employment and childhood overweight and obesity separately in males and females. Studies have generally investigated the effect in all children as one group, and in doing so have neglected the possibility that males and females may respond differently to the employment status of their mothers. By conducting separate analyses for boys and girls, this study is able to capture distinct experiences that vary by child gender.

6.2 Interpretation of Findings

6.2.1 Maternal Employment

Results from this study provide little evidence of an association between maternal employment during infancy and toddlerhood and overweight/obesity risk in childhood. A significant but modest association (RR=1.38, 95% CI=1.04, 1.84) was observed for full-time employment during infancy and toddlerhood and overweight/obesity risk in boys. Although this finding may reflect a slight vulnerability to exposure to maternal employment during infancy and toddlerhood in boys, the clinical significance of this is questionable. The confidence interval of the estimate approaches the null value and is close to indicating no association. Based on this, the increase in the risk of overweight/obesity among boys of full-time employed mothers relative to the risk in boys of non-employed mothers is unlikely to be large enough to translate into an observable difference of clinical importance. Further confirmation of this is provided by the sensitivity analysis in which the estimate for boys associated with full-time employment was reduced and became non-significant. In girls, no association was observed between maternal employing during infancy and toddlerhood and overweight/obesity risk. In general, this study's findings do not support those from other studies conducted in North America[18,22,56] and internationally[21,52] that show an association between maternal employment and childhood overweight and obesity.

There are several possible explanations for the absence of an association in girls, and the modest association observed in boys in this study. First, the findings of this study may reflect an actual absence of an association between maternal employment in infancy and toddlerhood and later childhood overweight/obesity risk. The period of exposure to maternal employment during infancy and toddlerhood may be too brief in order to have lasting consequences on children's health. Secondly, the effect of maternal employment on time investments during infancy and toddlerhood may be less critical than among older children, who have significantly more diverse food and exercise behaviours that may be affected by their mother's employment status. Cawley & Liu[230] show that any maternal employment is significantly associated with less time spent with children in activities related to diet and physical activity such as cooking, grocery shopping, and supervising and playing with children. Given infant's limited mobility and dietary restrictions, known predictors of

overweight/obesity such as sedentary behaviour, lack of participation in physical activity,[56] snacking and consumption of calorically-dense but nutrient-deficient foods, and the extent to which these are influenced by maternal work, may not be of relevance. Thus, the lack of an association between maternal employment during infancy and toddlerhood and overweight/obesity risk in childhood may simply be reflective of fewer mechanisms that can link employment to overweight/obesity among children of these ages.

Although we cannot rule out an effect of maternal employment at later ages, the employment-obesity relationship may be over-estimated in some other studies that use the odds ratio as a measure of association when overweight/obesity is a common outcome. This is especially problematic given the tendency to interpret the odds ratio as a relative risk. While the odds ratio approximates the relative risk when the outcome is rare (<10%), it tends to be further from than null when the prevalence of an initial risk is common.[231] Since the prevalence of overweight/obesity in our sample is approximately 30%, we avoid inflated associations by using Poisson regression with robust standard errors to estimate the relative risk. An example using our data demonstrates how the inappropriate use of logistic regression in common outcomes can lead to different conclusions regarding the strength of an association. In boys of full-time employed mothers, we obtain an adjusted relative risk of overweight/obesity of 1.38 (95% CI=1.04, 1.84). An identical model using logistic regression produces an odds ratio of 1.63 (95% CI=1.07, 2.49).

Weak evidence of an association between maternal employment and childhood overweight/obesity is not completely novel, however.[65,66] Recently, Gwozdz et al.[65] found little evidence of an association between maternal employment and obesity among children aged 2 to 9 years from eight different European countries using a variety of anthropometric measures. While it is possible that the European example may be unique due to differences in maternity leave policies and in the cost and quality of child care,[62] it is also possible that other authors' conclusions regarding the contribution of maternal employment to children's overweight and obesity risk may in some instances be overstated. This is especially true when the estimates are modest and when, as in the case of this study, the lower end of the confidence interval is close to the null value. It is important to consider whether the increased

risk associated with modest estimates manifests into a clinically identifiable increase in weight and associated health outcomes.

6.2.2 Mediation Analyses and Univariable Mediator-Outcome Associations

There was no evidence of the hypothesized mediation between maternal employment during infancy and toddlerhood and childhood overweight/obesity for either breastfeeding or child care using criteria proposed by Baron and Kenny.[228]

Our data did not fully demonstrate that there is an 'effect to be mediated', as there was no relationship between employment in the first two years and overweight/obesity risk in childhood. Although traditional approaches to establish mediation require this as a first step, some authors have recently argued that the significance of the exposure-outcome test is not relevant in establishing mediation[232] since it is possible for an exposure to indirectly affect the outcome in the absence of a detectable direct effect.[233] Adopting a flexible approach to this criterion, however, did not alter the results of the mediation analysis.

6.2.2.1 Breastfeeding

A significant effect for breastfeeding on overweight/obesity risk was found in boys, but not in girls. In univariable analyses, boys who were breastfed for 4 weeks or less had an increased risk of overweight/obesity at ages 8 to 10 years relative to boys who were breastfed for more than 6 months. We did not find a similar association between breastfeeding length and overweight/obesity risk in girls. Since breastfeeding was not a predictor of overweight/obesity in girls, it failed to meet mediation criteria. In boys, while breastfeeding remained a significant predictor of the outcome while controlling for maternal employment, it did not attenuate the estimate of maternal employment on childhood overweight/obesity, which remained virtually unchanged with the addition of breastfeeding duration. As a result, we did not find that breastfeeding mediated the modest relationship between employment and overweight/obesity risk in boys.

It is difficult to explain why short breastfeeding duration is strongly associated with overweight/obesity risk in boys ($p<0.001$), but not in girls in this sample. Literature on

breastfeeding shows a protective effect of longer breastfeeding duration in both sexes.[96] Boys and girls in this sample had similar distributions of breastfeeding duration across weight status categories (Tables 5.3 and 5.4).

One possible explanation is that the duration of exclusive breastfeeding might differ between boys and girls in this sample. Since formula feeding does not confer the same protective effects of breastfeeding, if girls are more likely to receive complementary feeding with formula than boys it may diminish the ability to detect an effect based on duration alone. Unfortunately, this potential reason for lack of an association between breastfeeding duration and overweight/obesity in girls cannot be verified, as the NLSCY does not collect data on exclusive breastfeeding.

6.2.2.2 Child Care

Child care arrangement in infancy and toddlerhood did not predict children's risk of overweight/obesity for either boys or girls. Failure to find a mediator-outcome association meant that it does not mediate the relationship between maternal employment during infancy and toddlerhood and the risk of overweight/obesity in childhood.

Since this area is just beginning to be explored in the literature, and results have so far been inconsistent, a conclusion regarding the effect of child care arrangement during infancy and toddlerhood on overweight/obesity risk would be premature. It is possible that lack of variability in the dataset for child care arrangement may have made it difficult to detect an effect. For children who had weight status information, approximately 60% were under parental care in infancy and toddlerhood, while approximately 20% each were in informal and formal child care arrangements. In a study that examined exposure to child care arrangements in infancy and toddlerhood, children in informal care relative to parental care had 1.15 (95% CI=1.04-1.27) times the risk of overweight and obesity.[47] Small sample sizes in the categories for alternative care arrangements may have restricted the ability to detect an effect, especially if the effect is small.

6.3 Study Strengths

A major strength of this study is the use of a nationally representative sample to examine the relationship between maternal employment during infancy and toddlerhood and overweight/obesity risk at ages 8 to 10 years. Since the NLSCY is a longitudinal survey that tracks the development and well-being of children from birth, it contains valuable information not only on children, but also of other exposures that may affect their development such as prenatal and household factors. The richness of this dataset made it possible to study the association between maternal employment since birth and overweight/obesity risk, while accounting for other important confounders of childhood obesity.

Use of a theoretically-based conceptual model is another strong aspect of this study. Identifying the relationships between variables of interest in the literature helped to guide the empirical analysis. The available evidence in the literature informed hypothesized relationships between maternal employment, breastfeeding, child care and overweight/obesity status. Inclusion of possible confounders were decided a priori, following examination of associations in the literature.

A notable strength of this study is the use of modified Poisson regression[227] to estimate the relative risk of overweight/obesity. Of the existing research examining the association between maternal employment and childhood overweight and obesity, this is the first study to estimate the relative risk. Despite non-rare outcomes, other studies have generally estimated the odds ratios with logistic regression which can result in inflated estimates. By using modified Poisson regression, this issue is avoided, and an easier and more intuitive interpretation of risk is made possible.

6.4 Study Limitations

Several limitations in this study are worth noting. Outcome information was not available for 50% of Cycle 3 ECD children who were eligible for the study. Missing outcome information is a combination of mother-child pairs who entered the survey in Cycle 3 and did not remain in the survey until Cycle 7 (38% missing), and those that responded in Cycle 7 but did not have weight status information (20% missing). In addition, there were significant differences

in the characteristics of children who had outcome information and those who did not (Table D.1). Had children with missing information been able to provide height and weight data, it is unlikely that their inclusion in the study would have changed this study's findings as to the relationship between maternal employment and childhood overweight/obesity. Systematic (non-random) differences in childhood weight status between study children and children without follow-up information are not expected. A random, or non-differential loss to follow-up of children means that their overweight/obesity status is independent of their status on maternal employment and other explanatory variables.[234] Non-differential misclassification for a binary variable biases relationships towards the null.[234–236]

While maternal pre-pregnancy BMI has been shown to be strongly associated with children's overweight/obesity risk, we were not able to include it as a confounding variable in our adjusted regression models, as the NLSCY does not collect mother's height and weight information either pre-pregnancy or at the time of interview. As a proxy, maternal self-reported health status was used, but the extent to which this variable accounts for the increased risk of overweight/obesity among mothers who are obese pre-pregnancy is unknown.

There are a number of important limitations of this study related to the outcome measure that are inherent with the use of the NLSCY. Classification into weight status depends on children's derived BMI scores. In the NLSCY, there is a higher rate of non-response for BMI due to the exclusion of invalid height and weight responses relative to other variables.[219] In this study sample, only 80% (n=3525) of children who entered in Cycle 3 and remained in Cycle 7 (n=4389) had information on their weight status.

Data quality issues in the outcome measure also arise as a result of parental self-reported values for children's height and weight. In the NLSCY, the PMK reports the height and weight of all children ages 2 to 11 years, which is then used to yield a BMI score, and subsequently a weight classification using standards established by Cole et al.[10] Studies have demonstrated, however, that there are discrepancies between parental estimates of children's height and weight and clinically measured values,[237–239] and that these discrepancies result in the misclassification of children's weight status.[239,240] Using data from the 2007 to 2009

Canadian Health Measures Survey, Shields et al.[239] compared parental self-reported height and weight and children's measured height and weight. The authors found that parents tended to underestimate their children's height and weight by 3.3 centimetres (1.3 inches) and 1.1 kilograms (2.4 pounds), respectively.[239] Among children ages 6 to 8 the effects were particularly pronounced, with parents underestimating their children's height by 4.2 centimetres.[239] The substantial underestimation in height among children 6 to 8 years was not negated by weight underestimation, resulting in BMI scores based on parental report to be significantly higher (1.4kg/m^2) than BMI scores based on measured data.[239] Misclassification stemming from parental estimates of their children's height and weight was common. Using IOTF standards, children who were classified as normal weight based on empirical estimates were placed in the overweight (10%) and obese (7%) categories respectively using parental estimates.[239] Only 24% of children who were classified as obese using parental report were actually obese; of these children, 47% belonged in the normal weight category.[239] Under-reporting of child height by an average of 21.1 centimetres (8.3 inches) drove erroneous classification in the obese category.[239]

Based on this evidence, it is possible that this study overestimated the prevalence of overweight/obesity in children and may have biased towards the null the association between maternal employment and overweight/obesity observed in boys. However, combining overweight and obese categories into a single outcome helped minimize, to some extent, the effect of some misclassification error, specifically those children who were overweight and were erroneously misclassified as obese.

6.5 Conclusions and Directions for Future Research

Using a large, nationally representative sample of Canadian children, this study finds little evidence of an association between maternal employment during infancy and toddlerhood and children's later risk of overweight/obesity. Since this is the first study to exclusively examine exposure to maternal employment in infancy and toddlerhood, we cannot rule out the results of other studies conducted in North America and elsewhere that find an effect of maternal employment at later ages. Research in other populations is needed in order to verify

whether the lack of an effect for maternal employment during infancy and toddlerhood accurately reflects the true absence of an association.

Several avenues for future research are warranted. It would be useful to investigate whether the association between maternal employment and childhood overweight/obesity varies by various jurisdictions. This would provide a unique opportunity to assess whether differences in maternity leave and daycare policies alter the association between employment and childhood overweight and obesity risk. Furthermore, examining maternity leave eligibility will also provide insight into whether child age when the mother returns to work has an effect on the employment/obesity association.

Another direction for future research is to examine the effect of child age during the infant and toddler period on the relationship between maternal employment and future risk of overweight/obesity. It is possible that the effect of maternal employment during infancy and toddlerhood differs by the age of the child. A child aged six months to 1 year whose mother has been employed since birth has had considerably less exposure to maternal employment than a child who is aged 2 years. Any differences that are detected between children at the higher end of the age distribution and those at the lower end may reflect differences in cumulative exposure to maternal employment. In addition, differences may also reflect the opportunity for maternal employment to impact potential mechanisms in a way that would may have a more appreciable effect on children's future weight status.

Maternal occupation and the type of schedule worked, whether standard or non-standard (such as shift work, work on the weekends, or work in the evenings) may play a role in the association between maternal employment and childhood overweight and obesity. It is possible that mother's work schedules have distinct effects on children's future risk of overweight/obesity, particularly through their effect on mechanisms such as breastfeeding, child care arrangements, or other factors of the household environment that could impact children's weight status.

Finally, further investigation into whether boys are particularly affected by the employment status of their mother is warranted. While we find a modest association between full-time

employment during infancy and toddlerhood and overweight/obesity risk in boys, it is possible that the effect of maternal employment observed among boys in other studies may be more pronounced relative to girls.

Although this study fails find that breastfeeding or child care are mechanisms that link maternal employment in infancy and toddlerhood to children's future risk of overweight/obesity, it nevertheless demonstrates that breastfeeding for more than 6 months is protective of overweight/obesity. These findings support the promotion of policies to facilitate maternity leave for all mothers for a minimum of six months following birth in order for optimal breastfeeding duration to be achieved.

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APPENDICES

Appendix A: Medline – Ovid Search Strategy

Table A.1 Medline-Ovid Literature Search Strategy

#	Search Term	Articles identified*
1	Child, Preschool/ OR Child/ OR Children OR Childhood	n=1767416
2	Childhood obesity OR Pediatric obesity/ OR Obesity/ OR Overweight/	n=132970
3	Maternal Employment OR (Maternal AND Employment) OR (Employment/ AND Mothers/)	n=1272
4	Breast Feeding/	n=26118
5	Child Care/	n=4684
6	#1 AND #2 (Childhood overweight and obesity)	n=25768
7	#3 AND #6 (Association between maternal employment and childhood overweight and obesity)	n=43
8	#4 AND #6 (Association between breastfeeding and childhood overweight and obesity)	n=430
9	#5 AND #6 (Association between child care and childhood overweight and obesity)	n=46
10	#3 AND #4 (Association between maternal employment and breastfeeding)	n=168
11	#3 AND #5 (Association between maternal employment and child care)	n=91

*Prior to application of exclusion criteria (published in 2000 or later, article in English, OECD country) and review for relevance.

Appendix B: Deviation from Original Analysis Plan

Initial analyses were conducted using multinomial logistic regression in SAS 9.3 using childhood overweight and childhood obesity at ages 8 to 10 years as the outcomes of interest. However, due to instability in regression models likely attributable to inadequate sample sizes, the outcome was recoded as binary by combining overweight and obesity status, with not being overweight or obese as the reference. Analysis on the binary outcome was conducted at first using logistic regression; however, wide confidence intervals around estimates necessitated a change in approach. Because the outcome of interest in this study was prevalent (>30% for both boys and girls), estimating the relative risk of overweight/obesity was determined to be the best approach.

Appendix C: Study Flow Chart

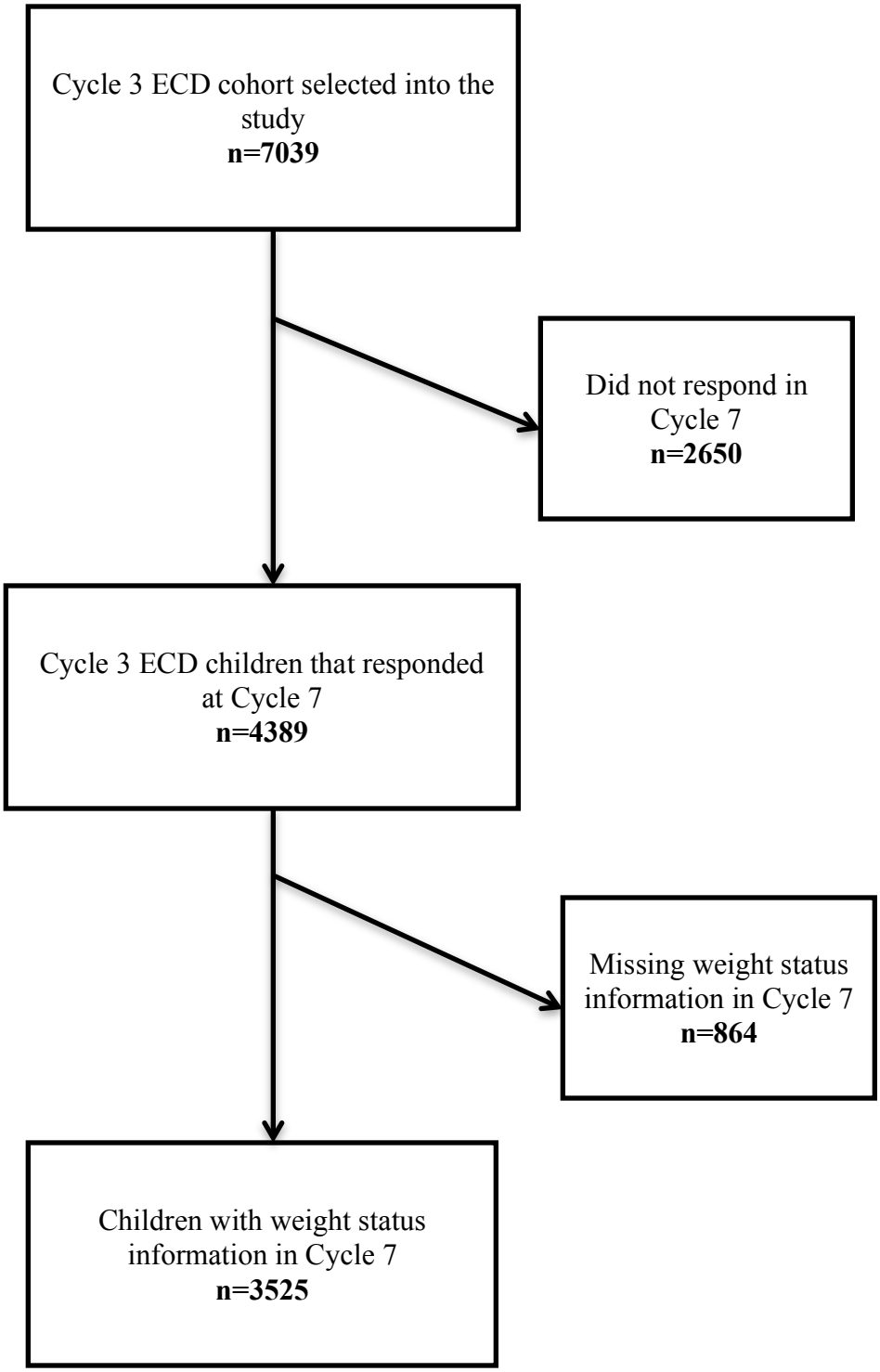

Figure C.1 Participant Eligibility and Retention

Appendix D: Missing Data Analyses

Table D.1 Study Sample versus No Follow-up Information (Missing Outcome and Lost to Follow-up)

Characteristic	Study Sample (n=3264) n (%)	No follow-up information (n=3774) n (%)	p-value
Maternal Employment			<0.001
Did not work since birth	1365 (42%)	2059 (55%)	
Part-time (1-29 hours/week)	864 (27%)	724 (19%)	
Full-time (30+ hours/week)	1030 (32%)	971 (26%)	
Breastfeeding			<0.001
0 to 4 weeks	876 (27%)	1341 (39%)	
5 weeks to 6 months	1229 (38%)	1283 (37%)	
More than 6 months	1140 (35%)	819 (24%)	
Type of Child care			<0.001
Does not use care	1853 (57%)	2463 (66%)	
Informal care	523 (16%)	576 (15%)	
Formal care	879 (27%)	717 (19%)	
Maternal Age Group at Birth			<0.001
<24	429 (13%)	675 (18%)	
25-34	2255 (69%)	2467 (65%)	
35+	579 (18%)	632 (17%)	
Smoking During Pregnancy			<0.001
Yes	518 (16%)	734 (20%)	
No	2722 (84%)	2973 (80%)	
Size for Gestational Age			0.663
Small or Appropriate for GA	2744 (84%)	3146 (84%)	
Large for GA	512 (16%)	604 (16%)	
Maternal Health Status			<0.001
Excellent	1383 (43%)	1481 (40%)	
Very Good	1219 (38%)	1315 (36%)	
Good	558 (17%)	733 (20%)	
Fair/Poor	89 (3%)	152 (4%)	
Maternal Marital Status			<0.001
With a Partner	3062 (94%)	3287 (87%)	
Without a Partner	202 (6%)	487 (13%)	

Continued on next page

Table D.1 Study Sample versus No Follow-up Information (Missing Outcome and Dropped Out) (Continued)

Characteristic	Study Sample (n=3264) n (%)	No follow-up information (n=3774) n (%)	p-value
Maternal education			<0.001
Less than high school	239 (7%)	552 (15%)	
High school graduate	450 (14%)	671 (18%)	
Some-post secondary	869 (27%)	999 (27%)	
College/University graduate	1691 (52%)	1461 (40%)	
Siblings in the Household			0.001
No siblings	1357 (42%)	1490 (39%)	
1 sibling	1304 (40%)	1431 (38%)	
2 or more siblings	602 (18%)	852 (23%)	
Income Adequacy			<0.001
Lowest/Lower middle	328 (10%)	704 (19%)	
Middle	851 (26%)	1215 (32%)	
Upper middle/Highest	2084 (64%)	1855 (49%)	
Immigrant status			<0.001
Immigrated to Canada	439 (13%)	929 (25%)	
Did not immigrate to Canada	2824 (87%)	2845 (75%)	

Table D.2 Characteristics of Participants Who Dropped Out in Cycle 3 and Those Who Were Missing Outcome Information in Cycle 7

Characteristic	Dropped out (n=2932) n (%)	Missing Outcome (n=880) n (%)
Maternal Employment		
Did not work since birth	1641 (56%)	432 (49%)
Part-time (1-29 hours/week)	549 (19%)	166 (19%)
Full-time (30+ hours/week)	725 (25%)	278 (32%)
Breastfeeding		
0 to 4 weeks	1046 (40%)	295 (35%)
5 weeks to 6 months	1020 (39%)	277 (33%)
More than 6 months	551 (21%)	276 (33%)
Type of Child care		
Does not use care	1936 (66%)	532 (60%)
Informal care	453 (16%)	137 (16%)
Formal care	525 (18%)	213 (24%)
Maternal Age Group at Birth		
<24	547 (19%)	135 (15%)
25-34	1905 (65%)	573 (65%)
35+	479 (16%)	170 (19%)
Smoking During Pregnancy		
Yes	601 (21%)	132 (15%)
No	2278 (79%)	736 (85%)
Size for Gestational Age		
Small or Appropriate for GA	2451 (84%)	722 (82%)
Large for GA	461 (16%)	155 (18%)
Maternal Health Status		
Excellent	1124 (40%)	355 (41%)
Very Good	1026 (36%)	300 (34%)
Good	566 (20%)	189 (22%)
Fair/Poor	128 (5%)	29 (3%)
Maternal Marital Status		
With a Partner	2511 (86%)	786 (89%)
Without a Partner	421 (14%)	93 (11%)
Maternal education		
Less than high school	469 (16%)	123 (14%)
High school graduate	527 (19%)	147 (17%)
Some-post secondary	733 (26%)	267 (31%)
College/University graduate	1117 (39%)	330 (38%)
Siblings in the Household		
No siblings	1192 (41%)	302 (34%)
1 sibling	1087 (37%)	350 (40%)
2 or more siblings	653 (22%)	226 (26%)
Income Adequacy		
Lowest/Lower middle	590 (20%)	155 (18%)
Middle	952 (32%)	285 (32%)
Upper middle/Highest	1389 (47%)	438 (50%)
Immigrant status		
Immigrated to Canada	763 (26%)	222 (25%)
Did not immigrate to Canada	2168 (74%)	657 (75%)

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