Three Essays on Determinants of Child Developmental Outcomes

by

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Abstract

This dissertation consists of three essays examining the determinants of child developmental outcomes using the Canadian National Longitudinal Survey of Children and Youth (NLSCY). The first essay estimates the relationship between birth weight and cognitive and behavioral outcomes for children aged 0 to 13. Using family fixed effects models to control for household heterogeneity, I find that every ounce counts; additional birth weight for infants born weighing less than 2,500 grams (low birth weight infants) is related to better outcomes for measures of math ability, pro-social behavior and property offense. Additional birth weight for those born weighing 2,500 grams or more is related to higher scores of motor and social development and verbal competence for young children. The second essay, using a sample of Canadian boys and girls aged 10 to 15 in dual-earner families, finds that parental work schedules play an important role in adolescents' engagement in risky behaviour, especially for boys. Non-standard parental work schedules (i.e. work during evenings, nights, weekends and rotating shifts) are positively related to fighting, drinking and trying drugs among boys and fighting among girls. In the third essay, I investigate relationships between symptoms of hyperactivity-inattention and being read to for a sample of children aged 2 to 4. The main finding, based on family fixed effects estimates, is that children who have higher hyperactivity-inattention are read to less. However, results from interactions suggest that this relationship is only present when the person most knowledgeable of the child (usually the biological mother) has less than a post-secondary degree or diploma.

List of Abbreviations Used

ADHD Attention Deficit Hyperactivity Disorder

ADD Attention Deficit Disorder

CPNP Canada Prenatal Nutrition Program

CAT/2 Test Canadian Achievement Test, 2nd edition

CDC United States Centre for Disease Control and Prevention

ECLS-B Early Childhood Longitudinal Survey-Birth Cohort (U.S.)

HBW High Birth Weight

NBW Normal Birth Weight

LBW Low Birth Weight

LIS Luxembourg Income Study

MSD Motor and Social Development

NLSCY National Longitudinal Survey of Children and Youth (Canada)

NLSY National Longitudinal Survey of Youth (U.S.)

OLS Ordinary Least Squares

PSID Panel Survey of Income Dynamics (U.S.)

PMK Person Most Knowledgeable (of the child)

PPVT Peabody Picture Vocabulary Test

PSE Post-Secondary Education

SE Standard Error

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Chapter 1

Introduction

This dissertation consists of three chapters examining the determinants of child developmental outcomes using the Canadian National Longitudinal Survey of Children and Youth (NLSCY).

Knowing that gaps in cognitive and non-cognitive abilities appear at young ages and tend to widen over the life cycle, evidence regarding factors that influence the development of young children would imply that resources may be more effective if directed towards children in the short-run so as to encourage improved outcomes and smaller gaps in the longer run. In Chapter 2, I examine the effect of birth weight on several measures of child development. In particular, I investigate the effect of additional weight on cognitive and behavioral outcomes for children born with low birth weight (i.e. 2,500 grams or less) as well as children born weighing 2,500 grams or more. Since unobservable factors related to birth weight and child outcomes (such as parental background and home environment) may not be fully taken into account, cross-section estimates may be biased. To deal with potential family-level confounding factors, I estimate the effect of birth weight on child outcomes using a sample of sibling pairs and family fixed effects models. After controlling for household heterogeneity, I find that every ounce counts; additional birth weight for infants born weighing less than 2,500 gram is related to better outcomes for measures of math ability, pro-social behavior and property offense. Additional birth weight for those born weighing 2,500 grams or more is related to higher scores of motor and social development and verbal competence for young children.

While participation in risky behaviours is undesirable at any age, the involvement of young adolescents is particularly unwelcomed and uncovering the determinants of their involvement is important for future prevention. In Chapter 3, I investigate the relationship between parental work schedules and engagement in risky behaviours for adolescents. In particular, I examine the effect of parental work schedules on adolescents' engagement in stealing, fighting, drinking and illicit drugs using a representative sample of Canadian boys and girls aged 10 to 15 years old from dual-earner Canadian families. Using separate regressions for boy and girls, and after controlling for an extensive set of explanatory variables, I find that mother-father combined work schedules play an important role in adolescents' involvement in risky behaviour, especially for boys. Non-standard parental work schedules (i.e. having usual work hours during evenings, nights, weekends and rotating shifts) are positively related to fighting, drinking and doing drugs among boys and fighting among girls.

Almost all parents know that it good to read to their children, especially during the pre-school years. However, for some parents it may be too difficult to read to their children as often as desired – the amount of time devoted to reading to children is not necessarily a choice. The amount of time children are read to will depend on a number of factors including family structure, parental labour supply, household income, parental education as well as characteristics of the child. Hyperactive-inattentive behaviour among children has already been linked to poorer achievement test scores, school-related outcomes and academic motivation (Currie and Stabile 2006, Chen *et al.* 2011, Chen *et al.* 2012). In Chapter 4, I investigate whether children's hyperactive-inattentive behaviour influence the amount of time they are read to by parents or other adults. For example, if a child can't sit still or can't pay attention for long, it may be difficult for parents or other caregivers to read to the child – are such children read to less often? Using sibling pairs and family fixed effects regression techniques to control for unobserved heterogeneity common to the household, I find that children who have higher hyperactivity-inattention are read to less. However, the results for interaction variables related to parental education suggest that this relationship is only true when the person-most-knowledgeable of the child (usually the biological mother) has less than a post-secondary degree or diploma.

Chapter 2

Every Ounce Counts: Birth Weight and Development Outcomes Among Canadian Children

2.1 Introduction

The economics literature has already established a link between birth weight and long-run human capital and labour market outcomes, such as educational attainment, employment and earnings (Oreopoulos *et al.* 2008; Black *et al.* 2007; Johnson and Schoeni 2007; Case *et al.* 2005; Behrman and Rosenzweig 2001, 2004; Conley and Bennett 2000; Conley *et al.* 2003). However, little work has investigated the effect of birth weight on shorter-run outcomes among children. This is despite evidence that shows that gaps in cognitive and non-cognitive abilities appear at young ages, even before school entry, and that these gaps appear to increase with age (Carneiro and Heckman 2003). The identification of a relationship between birth weight and outcomes among young children would have two policy implications. First, if birth weight affects child development then it would provide additional empirical support for programs that promote proper prenatal nutrition and care with the objective of encouraging healthy birth weight. Second, the presence of such results would indicate that the adverse effects of lower birth weight can be seen early in life and would suggest that resources could be directed to children in the early years to reduce the continuation of the ill effects on subsequent long run labour market outcomes.

This paper addresses several gaps in the literature. In particular this is the first study to examine the effect of birth weight on cognitive ability using a nationally representative sample of Canadian children. The dataset used, the National Longitudinal Survey of Children and Youth (NLSCY), has the advantage that it contains information on similar outcomes for a large number of siblings. Cross-sectional estimates of the relationship between birth weight and child outcomes may be biased if unobservable factors related to both are not taken into account. With a sample of siblings I can reduce potential bias by analyzing the effect of within-sibling differences in birth weight on within-sibling differences in outcomes.

Second, the returns to non-cognitive skills have been estimated to be high yet few studies have looked at links between such skills and birth weight. This is the first analysis using samples of siblings and family fixed effects models to estimate the relationship between birth weight and behavioral outcomes among children.

This paper also provides some of the first evidence of non-linear effects of birth weight in order to determine whether additional birth weight for those born with normal birth weight benefits outcomes. Ignoring any benefits would imply that prenatal programs have been under-invested in the past.

Unlike the case of twins, sibling differences in birth weight not only represent differences in in utero nutrition intake but also differences in prenatal care.[1] I add to the literature by including additional variables related to prenatal care to determine whether prenatal care is driving the relationships between birth weight and outcomes among singletons. In particular, this is the first paper to investigate the degree to which maternal smoking and drinking during pregnancy are influencing the estimated effect of birth weight on measures of child development.

There is also the possibility that parental investment after birth varies systematically with birth weight and that this behavior may be confounding the effects of birth weight. This paper contributes to the literature with some of the first evidence on the relationship between birth weight and maternal investment measured in terms of breastfeeding behavior, and whether this relationship is influencing the results. Not only does controlling for parental investment help uncover the true effect of birth weight but it also provides insight on the mechanisms between birth weight and child development.

Finally, this is the first analysis using a nationally representative sample of Canadian children. As Canada offers generous health insurance and a parental benefit program,

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[1] The fetal origins hypothesis, proposed by Barker et al. (1989), suggests that nutrient deprivation in utero affects physiological development and consequently, subsequent health outcomes. In general, infants that received lower levels of nutrients in utero have lower birth weight.

which presumably buffer the negative effects of lower birth weight on later outcomes, results in the Canadian context can be considered conservative and represent a lower bound of the effect of birth weight.

The main findings are that additional birth weight for infants born with birth weight greater than 2,500 grams is significantly and positively related to motor and social development (MSD) among children aged 0 to 3 and verbal competence for children aged 4 to 6. For children born with low birth weight, additional birth weight is significantly and positively related to math scores among children aged 7 to 13. I also find that additional birth weight for children born with low birth weight is associated with improved levels of pro-social behavior (among younger and older children) and lower rates of property offense. For some of the outcomes the benefit of additional birth weight is concentrated among children born with low birth weight while for other outcomes additional birth weight benefits those born with 2,500 grams of more. These findings provide evidence to support programs that direct resources towards reducing the incidence of infants born with low birth weight, and suggest that programs that encourage additional birth weight for women who are already likely to give birth to normal birth weight infants may also be beneficial for certain outcomes.

Additionally, I find that birth weight is correlated with maternal smoking and drinking during pregnancy. However, when I include these variables in the analysis, the estimated effects of birth weight do not change. This suggests that the effect of birth weight being estimated relates to fetal nutrient intake and not maternal smoking or drinking during pregnancy. I also find that breastfeeding is positively correlated with birth weight. After I include a variable on breastfeeding in the analysis I find that the results do not change and I conclude that parental investment in terms of breastfeeding is not confounding the effect of birth weight on child outcomes.

This paper is organized as follows: Section 2.2 provides a review of the existing literature in this area. Section 2.3 describes the dataset, variables and sample used in the analysis. Section 2.4 presents descriptive statistics to provide preliminary evidence that children born with low birth weight experience poorer cognitive and behavioral outcomes than their heavier counterparts. Section 2.5 describes the econometric methods used for analysis. Section 2.6 extends the evidence presented in Section 2.4 and provides OLS and OLS with family fixed effect regression results regarding the effect of low birth weight on child outcomes. In Section 2.7, I present evidence on the non-linear effects of birth weight using piece-wise regressions. Section 2.8 provides some robustness checks. In Section 2.9, I discuss the implications of the results and conclude.

2.2 Literature Review

Over the last two decades there has been an emerging body of research examining the effects of birth weight on health and socio-economic outcomes. Among health outcomes, results from past studies show that those born with low birth weight are at increased risk of infant mortality, are more likely to be hospitalized and have more physician-visits than their peers (Oreopoulos *et al.* 2008, Conley *et al.* 2003, Almond *et al.* 2005). The literature that has looked at human capital and labour market outcomes shows that birth weight has a positive and significant effect on educational attainment, earnings, employment and the likelihood of not receiving social assistance (Oreopoulos *et al.* 2008, Black *et al.* 2007, Johnson and Schoeni 2007, Case *et al.* 2005 Behrman and Rosenzweig 2001, 2004, Conley and Bennett 2000 Conley *et al.* 2003).

There are also several empirical studies that have examined the effect of birth weight on cognitive ability. Initially this literature relied on cross-sectional variation,[2] however all of the most recent research, summarized in Table 2-1, uses either family or twin fixed effects with samples of siblings or twins (monozygotic or dizygotic)[3] to control for possible confounding influences. In the case of family fixed effects using sibling samples, within-sibling differences in outcomes are regressed on sibling differences in birth weight. Such models control for many unobservable factors that are invariant across siblings, such as family background (parental preferences, abilities, resources, etc.), home

[2] For example: Hoddinott *et al.* (2002), Case *et al.* (2005).
[3] Monozygotic twins are offspring that develop from the same egg. Dizygotic twins are offspring that develop from two separate eggs.

environment and neighborhood.

Within this recent literature examining outcomes related to cognitive ability there are two papers using administrative data from the Canadian province of Manitoba, Oreopoulos *et al.* (2008) and Currie *et al.* (2008). Oreopoulos *et al.* (2008) investigate the relationship between birth weight and Grade 12 language arts scores. Using a sample of siblings, the ordinary least squares (OLS) results show a significant, negative relationship between low birth weight indicator variables and language arts scores. However, this effect becomes insignificant when family and twin fixed effects are used. Currie et al. (2008) extend the work of Oreopoulos *et al.* (2008) to examine whether health is the mechanism through which birth weight influences the Grade 12 language art scores as well as the probability of taking college-preparatory math courses. Before including any variables related to child health, their OLS results suggest that birth weight has a negative and significant effect on Grade 12 language arts scores and the probability of taking college-preparatory math courses. OLS with family fixed effects results are smaller and less precise. Once early health conditions (between ages 0 to 3) are included, the magnitude of the effect of birth weight on these schooling outcomes decreases but is not eliminated. The addition of later health problems does not further alter these effects.

Black *et al.* (2007) use administrative data from Norway to investigate the relationship between birth weight and cognitive ability using IQ scores for males aged 18 to 20 who were registered for mandatory military service. The OLS and OLS with fixed effects estimates both suggest a positive, significant relationship between log birth weight and IQ among these men, and both estimates are of similar magnitude.

There are two studies, Johnson and Schoeni (2007) and Royer (2007), which look at the link between birth weight and cognitive outcomes for children. Using the U.S. Panel Survey of Income Dynamics (PSID), a sample of brothers and family fixed effects models, Johnson and Schoeni (2007) find a significant, negative relationship between birth weight and cognitive ability measured by the Woodcock-Johnson standardized tests (measuring passage comprehension, overall reading ability and math problem solving).

Royer (2007) estimates the effect of birth weight on a score of mental development and a score of motor development using a sample of 858 female twins from the U.S. Early Childhood Longitudinal Survey-Birth Cohort (ECLS-B) and finds that the effect of birth weight on these outcomes is negligible.

Unlike outcomes related to cognitive development, there has been little research that has looked at the relationship between birth weight and behavioral outcomes. The only work in this area is Gupta *et al.* (2010). Using Danish longitudinal data, Gupta *et al.* (2010) suggest that birth weight is associated with behavioral problems among children. More specifically, their OLS estimates suggest that boys born with low birth weight are more likely to suffer from hyperactivity problems that worsen over time. Low birth weight among girls is associated with more emotional problems that manifest into conduct disorders in later years. Their study does not use twin or family fixed effects models.

2.3 Data, Variables and Sample

This analysis uses data from cycles 1 to 3 of the National Longitudinal Survey of Children and Youth (NLSCY). The NLSCY is a nationally representative sample of Canadian children, which in its first cycle in 1994-95 included 22,831 children aged 0 to 11.[4] Biennially since then the NLSCY has conducted a follow-up survey with this sample. The NLSCY was designed to collect detailed information on factors influencing children's cognitive, emotional and physical development and to monitor the impact of these factors over time. The unit of analysis for the NLSCY is the child but the person most knowledgeable (PMK) of the child provides the information for each selected child in the main longitudinal file.[5] The PMK also provides personal and family information (including information on the spouse when present).

2.3.1 Dependent outcome variables

[4] The target population for the NLSCY is the non-institutionalized civilian population in Canada's 10 provinces. Therefore, the survey excludes children living on Indian reserves, residents of institutions, full-time members of the Canadian Armed Forces, and residents of the territories.

[5] For approximately 95% of the children in the sample the PMK is the biological mother.

For this analysis, there are four cognitive outcome variables, four behavioral outcome variables for children aged 2 to 6 and six behavioral outcome variables for children aged 7 to 11. Among the cognitive outcome variables, there are two for young children, a Motor and Social Development (MSD) score and a Peabody Picture Vocabulary Test (PPVT) score. There are two cognitive outcomes for older children, aged 7 to 13: a math test score and a reading test score. The behavioral outcomes for children aged 2 to 6 include scores of hyperactivity, emotional disorder, pro-social behavior and opposition disorder/physical aggression. For the older children, the behavioral outcomes include scores of hyperactivity, emotional disorder, property offense, indirect aggression, pro-social behavior and conduct disorder.

For the analyses related to the MSD, PPVT and behavioral scores, I pool children from cycles 1 to 3 of the NLSCY. For analysis related to the math and reading scores, I pool children from cycles 2 and 3. While Cycle 1 includes math scores for children aged 7 to 11, the response rate was low and the responses are problematic (Statistics Canada 1998). In Cycle 1, the same versions of math tests were administered to two grade levels. As a result there is a ceiling effect with many children in the upper grades having perfect scores, especially in grades 3 and 5. Starting in Cycle 2, different tests are given for each grade level. Reading scores were only collected in cycles 2 and 3 of the NLSCY.

The MSD score is a standardized score collected for children aged 0 to 3 years and is based on 15 questions that measure dimensions of motor, social and cognitive development. The questions are answered by the PMK on whether or not a child is able to perform a specific task, with the questions varying with the child's age. The MSD scores have been adjusted by age by Statistics Canada to have a mean of 100.

The PPVT score is a standardized score collected for children aged 4 to 6 years. The test, administered by an NLSCY interviewer, assesses verbal competence. The score has been used extensively in previous studies on child development and is considered a reliable measure of child cognition, school readiness, and a predictor of later academic achievement (Hoddinott *et al.* 2002). The PPVT scores have been adjusted by age by

Statistics Canada to have a mean of 100.

The math and reading test scores are collected for children aged 7 to 13. For both the math test and the reading test, each child receives a raw score, which is the number of items answered correctly during the Mathematics Computation Exercise and the Reading Computation Exercise of the NLSCY. The math test is a shortened version of the mathematical operations test of the standardized Canadian Achievement Tests, Second Edition (CAT/2).[6] The reading test is also based on CAT/2 but since the CAT/2 only contains English passages, French passages were added from another source.[7] Scaled math and reading scores are derived from the raw scores for each combination of grade and test level and will increase as grade level and ability increase. Since the collection period varies across cycles, the scaled scores were also adjusted to take the collection period into account. Both tests were administered in the child's school. The scores are normalized to have a mean of zero and standard deviation of 1.

The behavioral scores for the younger and older children are based on the PMKs responses to a series of questions. For example, some of the questions that form the hyperactivity score include, "How often would you say that your child can't concentrate, can't pay attention?", "How often would you say that your child is distractible, has trouble sticking to any activity?" and "How often would you say that your child fidgets?". The responses to each question in the series are added together to give a score for each behavioral outcome. A higher score indicates a higher presence of that behavior. Appendices 2.1 and 2.2 provide a list of questions that form each behavioral index.

2.3.2 Independent variables

The main independent variable is birth weight. For all children, the PMK was asked to

[6] The CAT/2 is a series of tests designed to measure achievement in basic academic skills. The CAT/2 mathematical operations test measures the student's ability to do addition, subtraction, and multiplication and division operations on whole numbers, decimals, fractions, negatives and exponents. Problem solving involving percentages and the order of operations are also measured (Statistics Canada 1999).

[7] The reading test is designed to measure basic reading skills including information recall, analysis of passages, identification of the main idea, interpretation of various types of writing, and critical evaluation (Statistics Canada 1999).

recall the child's birth weight. While misreporting may lead to mismeasurement, Tate *et al.* (2005) and Walton *et al.* (2000) provide evidence that parental recall of birth weight is an accurate proxy for recorded birth weight. In the cases where the PMK reports very low birth weight[8], Statistics Canada (1999) took extra measures to verify that the responses were legitimate. They checked for consistency between the birth weight and length of the baby at birth, the number of days early of the delivery, the conditions of the delivery (e.g., multiple birth, special medical care) and the health of the child at birth. If the responses to these variables did not corroborate with a very low birth weight infant then birth weight was set to not stated.

2.3.3 Control variables

The literature suggests that there are important gender differences in childhood development outcomes so I control for gender in the regressions using a dummy variable for being a female child.[9] Since Hanushek (1992) finds that birth order and family size directly affect children's achievements I control for being the first-born as well as the number of siblings. In particular, Hanushek finds that, on average, first-born children have better outcomes than children of other birth orders. He argues that this relation is not due to parents' favoritism for first-born children but rather that being early in the birth order implies a higher probability of being in a small family. Increases in the number of siblings will dilute the resources available for each child. Also, the greater the number of siblings the more likely mothers will witness interactions with other children, which may affect scores of pro-social behavior or conduct disorder. The math, reading and behavioral scores are not standardized by age so I include child age in years in those regressions to ensure comparability across ages. I also control for child age in years in all of the behavioral score regressions, as children may be more likely to show certain behaviors at some ages than at other ages.

Maternal age at birth has been associated with infant health and child development

[8] Very low birth weight is defined as birth weight less than 1500 grams.
[9] All control variables are from the same time period as the outcome.

(Levine *et al.* 2001). I account for such effects with variables for mother's age at child's birth and mother's age at birth squared. Currie and Moretti (2003) find that higher maternal education is related to better infant health, measured as birth weight and gestational age. Several studies including Behrman and Rosenzweig (2002) have found that children of better-educated mothers have better cognitive and non-cognitive outcomes due to intergenerational transfers of endowments as well as higher quality maternal investment. I control for maternal education using a dummy variable for mothers with less than high school education and a dummy variable for mothers having a post-secondary degree or diploma.

Family structure is also expected to affect outcomes. In general, the presence of two parents in the home increases parental time and resources available to children. Other family structures, such as lone parent families, are expected to negatively affect child development. To capture such effects, a dummy variable for lone-parent status is included. As household income has been associated with child development (Dooley and Stewart 2004, 2007), I include log real household equivalent before-tax income[10] (in 2006 dollars) in all regressions. Living in a rural area is hypothesized to decrease access to resources and therefore negatively influence outcomes. A dummy for rural residence is used to control for this effect. I also include a set of dummy variables for the provinces to take into account differences in family policies that affect households' disposable incomes and accessibility to childcare. These dummy variables will also capture possible differences in preferences toward investment in children that may result in differences in curriculum and resources devoted to education that could ultimately affect math and reading outcomes. Cycle dummies are included to control for possible cycle effects.

2.3.4 Sample

Several studies in the literature (Oreopoulos *et al.* 2008, Black *et al.* 2007, Royer 2007, Luciano *et al.* 2004, Newcombe *et al.* 2007) use samples of twin pairs to address

[10] Equivalent income is per capita income that is adjusted to take into account that individuals living in households benefit from economies of scale. Here equivalent income is equal to real household income divided by the square root of the family size.

problems associated with unobserved heterogeneity across families and children. That is, samples of twins and twin fixed effects are used to control for important and often unobservable characteristics that are shared by both individuals in a twin pair. These characteristics include genetics, maternal prenatal behavior and gestational length, three characteristics that samples of sibling pairs and sibling fixed effects cannot difference out.[11] It is not possible to conduct a twin fixed effects analysis with the NLSCY because it contains too few twins.

Instead of twin fixed effects, this analysis uses family (or sibling) fixed effects. For several reasons the inability to use twin fixed effects does not limit this analysis. First, evidence suggests that the believed benefits of twin models have been exaggerated in the past. Oreopoulos *et al.* (2008) and Black *et al.* (2007) find that estimates of the effect of early life events on adult outcomes are similar in sibling and twin models. Newcombe *et al.* (2007) and Black *et al.* (2007) use results from samples of mixed twins (that is, both monozygotic (MZ) and dizygotic (DZ) twins), same-sex twins (larger fraction of MZ twins than full mixed twins sample) and MZ twins, and argue that genetics are not confounding their results of the effect of birth weight on cognitive outcomes. While IQ scores are known to be influenced by genetics, their results suggest that there are influences from the prenatal environment that affect cognition that are independent of the direct effect of genetics (Newcombe *et al.* 2007).[12] In addition, many twin-sample studies do not perfectly control for genetics. Oreopoulos *et al.* (2008) and Royer (2007) use a mix of dizygotic and monozygotic twins, and cannot distinguish between monozygotic and dizygotic. Dizygotic twins share on average the same genetic make-up as siblings in non-twin pairs. Genetic differences may even remain in studies with only monozygotic twins since monozygotic twins are not always genetically identical (Gringras and Chen

[11] However, sibling (and dizygotic twin) samples and family fixed effects models improve on the ability to control for genetics as compared to samples solely made up of individuals since full biological, non-identical siblings (including dizygotic twins) share, on average, 50 percent of their genetic make-up (Johnson and Schoeni 2007).

[12] Black *et al.* (2007) point out that, "Nutritional intake in twins can differ because of two placentas (called dichorionic, including all fraternal twins and about 30 percent of identical twins) and because one twin is better positioned in the womb. Among single-placenta (monochorionic) twins, nutritional differences have been related to the location of the attachment of the two umbilical cords to the placenta (Bryan 1992, Phillips 1993). Hence, since there are no genetic differences, birth weight differences within monozygotic twin pairs appear to come primarily from differences in nutritional intake."

2001).

Second, although twin fixed effects would perfectly control for prenatal care, it is not clear if prenatal care confounds the relationship between birth weight and developmental outcomes. In section 8, I investigate whether two commonly believed prenatal behaviors (smoking during pregnancy, drinking during pregnancy) influence the estimated effect of birth weight on a subset of the cognitive and behavioral outcomes. I conclude that they do not.

Gestational length is almost always equal for both individuals in twin pairs, and twin fixed effects would control for the effect of gestational length on outcomes. However, several studies (Royer 2007, Oreopoulos *et al.* 2008) argue that birth weight affects outcomes independent of gestational length. In fact, Royer (2007) finds that OLS estimates are larger in magnitude when holding gestational length constant. I examine the influence of gestational length on a subset of the cognitive and behavioral outcomes in Section 8. I also conclude that the effect of gestational length on these outcomes is independent of birth weight.

Finally, another reason using a twins sample may not be desirable is that children of multiple births are known to carry a higher risk of cerebral palsy (Pharoah 2006) and congenital anomalies (Mastroiacovo *et al.* 1999) than singletons. However, several twin studies, including Behrman and Rosenzweig (2004) and Oreopoulos *et al.* (2008), do not mention controlling for congenital anomalies. Black *et al.* (2007) and Currie *et al.* (2008) drop all observations with congenital defects to avoid potential confounding effects. Royer (2007) compares estimates for samples that include twins with congenital anomalies to estimates using a sample in which neither twin has a congenital anomaly. While the estimates from the sample of twins with congenital defects are larger, Royer finds that the estimates for the two samples are not statistically different and concludes that the estimates derived from the full sample of twins are not driven by congenital anomalies. As this analysis does not use twins and excludes children that report having cerebral palsy or a mental handicap, it reduces potential confounding effects from congenital defects and produces more conservative results.

I exclude children of multiple births from the full sample and sibling analyses since they are not representative of singletons that constitute a majority of the population. Twins are unique since they are more likely to be born low birth weight, premature and with birth complications. Furthermore, it is not clear that the effect of lower birth weight on outcomes for twins is the same as the effect for singletons (Black *et al.* 2007). While multiples are different from the general population, I nonetheless re-estimate all regressions with the inclusion of multiples and compare the estimates from both samples in Section 2.8.

Children that report being mentally handicapped or having cerebral palsy are excluded from this analysis. Also omitted are observations with missing data or invalid responses to any of the outcome or independent variables. For each outcome, I pool non-paired children (i.e. without a sibling in the sample) and sibling pairs across the first three cycles with the children in the sibling pairs always from the same cycle. To avoid repeated observations, I keep only the first observation of the non-paired child or sibling pair. The NLSCY initially surveyed a maximum of four children per economic family in Cycle 1 but in subsequent cycles, for reasons of response burden, a maximum of only two children were chosen randomly from each Cycle 1 household to be followed longitudinally thereafter (Statistics Canada 2005). As a result, for the family fixed effects analysis there is a maximum of two children per household.

All analyses use cross-sectional sampling weights. To account for the complex survey design of the NLSCY all reported standard errors for OLS regressions are calculated using bootstrap weights provided by Statistics Canada (with 1000 replications). Estimation is carried out using the software package Stata.

2.4 Low Birth Weight Correlated with Poorer Outcomes

Figures 2-1 to 2-3 show the mean scores by birth weight for the cognitive scores, the behavioral scores for young ages and the behavioral scores for older ages respectively.

The means are given for each birth weight in 100-gram intervals except at the two ends of the distribution. To meet disclosure requirements set by Statistics Canada to protect the confidentiality of respondents the bottom three and top three categories of birth weight are grouped into intervals of 500 grams. The points in the figure correspond to the minimum in each birth weight interval. For example, the point for birth weight equal to 3.5 kg corresponds to the mean of that outcome for children born weighing 3500 to 3599 grams. There is a vertical line at 2,500 grams (or 5.5 pounds) to indicate the low birth weight threshold. Points on and to the right of the line are above the threshold.

There are two things to point out about these plots. First, for many of the outcomes, those born with low birth weight often have poorer outcomes. An important exception is that children with low birth weight have lower mean scores in terms of oppositional disorder in their younger years. Also, little pattern is seen in the scores for older ages in terms of property offense, indirect aggregation, pro-social behavior or conduct disorder. Second, for several of the outcomes (scores for younger ages related to emotional disorders, pro-social, oppositional disorder and scores for older ages related to hyperactivity and emotional disorders), the mean of the outcome variables changes with birth weight beyond the low birth weight threshold. This suggests that additional birth weight can improve outcomes even for those born above the low birth weight threshold. However, in the cases of math and reading scores, the mean scores increase beyond the low birth weight cut-off but then start to decrease at very high birth weights. For these outcomes birth weight beyond a certain level may be detrimental. Although many recent studies in the literature have focused on low birth weight or birth weight in general, Section 8 investigates the effect of high birth weight (that is, birth weight greater than 4,500 grams) and whether it may be influencing estimates.

To further support that low birth weight children have poorer outcomes as witnessed in Figures 2-1 to 2-3, Table 2-2 provides evidence of statistical significance for differences in outcomes for low birth weight and normal birth weight children. Columns 1 and 2 in Table 2-2 present the unconditional means for each outcome variables for low birth weight children as well as children born with normal birth weight. Column 3 reports the difference in the means between the two groups and if the difference is statistically significant.

The results in Column 3 show that, on average, children born with low birth weight have lower scores for all four cognitive outcomes than their heavier peers, and the difference is statistically significant in all cases, which is consistent with the patterns observed for these outcomes in Figure 2-1. Among the behavioral outcomes for young children, low birth weight children have poorer average scores in terms of hyperactivity and emotional disorder but a better average score in terms of oppositional disorder. The difference in the pro-social behavior scores for the two groups is not statistically significant. These relationships are also in line with observations made above. The unconditional means for the behavioral outcomes for older children in columns 1 and 2 show that children born with low birth weight have poorer scores for only three of the six outcomes, namely, hyperactivity, emotional disorder and property offense scores. However, Column 3 shows that for only two of the outcomes, for the hyperactivity and emotional disorder scores, are the differences statistically significant. This is consistent with patterns viewed in Figure 2-3.

2.5 Empirical Strategy

To further investigate the relationships between birth weight and the outcomes described above, I begin by describing the OLS and OLS with family fixed effects models to be estimated. The OLS models, which control for a wide range of potentially confounding variables, use the following base-line specification:

$$y_i = \alpha + \beta(BW_i) + \phi(X_i) + e_i, \qquad (1)$$

where y_i represents one of the outcomes for each child i. BW_i is the birth weight variable of interest for each child i. X_i is a vector of covariates that represent characteristics of the child, the mother and the household in the year of the outcome. The child characteristics include age in years, gender, whether the child was the first-born and number of siblings. Maternal characteristics are mother's age at child's birth, and whether the mother has less than a high school diploma or whether the mother has a post-secondary diploma or degree. Household characteristics include: family structure, log real household equivalent before-tax income, whether the household resides in a rural area and province of residence (Ontario is the base). Dummy variables to control for cycle are also included. If additional birth weight is positively correlated with other omitted factors that have a positive (negative) effect on child outcomes then these estimates will overstate (understate) the true effect of birth weight.

While the above model controls for many observed factors that may be correlated with both birth weight and child outcomes, bias from other unobserved factors might remain. For example, bias may remain as a result of unobserved characteristics of the household, such as parenting styles and common heredity (physical and cultural). To account for such unobservable household heterogeneity, I first extend the OLS model in (1) to include a vector of household invariant factors:

$$y_{ji} = \alpha + \beta(BW_{ij}) + \phi(Z_{ij}) + \gamma(H_j) + e_{ij}\,, \qquad (2)$$

where ij indexes individual i in family j and H_j captures characteristics common to the household. Z_{ij} is similar to X_i in (1) but excludes factors that are common to the individuals in that year, such as, maternal education, province of residence and rural residence. In order to remove the household-invariant characteristics, I use an OLS model with family fixed effects and a sample of sibling pairs. The family fixed effects model assigns a dummy variable to each household and estimates the differences between sibling pairs in each household j. Since H_i represents factors common to both siblings, it is differenced from the model. The resulting equation to be estimated is:

$$(y_{1j} - y_{2j}) = \beta(BW_{1j} - BW_{2j}) + \phi(Z_{1j} - Z_{2j}) + (e_{1j} - e_{2j}). \qquad (3)$$

The controls that are included in Z_{ij} include mother's age at birth, whether the child was first born and gender. The sample of sibling pairs are observed in the same cycle so potential confounding time variant household factors, such as household income, family structure, location of residence and cycle dummies, are differenced out and therefore are not included in the estimated equation. Comparison of the effects of birth weight on outcomes from the OLS regressions against the OLS with family fixed effects results will indicate if unobserved family level factors are driving the results. By holding constant factors that are common to the sibling pair, the effect of birth weight on y_{ij} is identified from differences in birth weight within each sibling pair. The crucial assumption underlying this identification strategy is that the sibling differences in birth weight (BW_{ij}) are independent of sibling differences in e_{ij}. This assumption will be violated and the family fixed effects estimator will be biased if there are unobserved factors not shared within the sibling pairs that are correlated with both differences in sibling birth weights and differences in sibling outcomes. For example, unobserved individual level factors, like inherited ability, motivation and parental investment, might be correlated with birth weight and outcomes. While individual-level fixed effects would remove such characteristics, it would also remove birth weight since it is invariant. The family fixed effects estimator will also be biased if lower birth weight for one sibling has a negative effect on the outcomes of the other heavier sibling. In this case the difference between the two siblings will provide an underestimate of the effect of birth weight.

2.6 Effect of Low Birth Weight on Cognitive and Behavioral Outcomes

Section 2.4 presented preliminary evidence of a negative relationship between low birth weight and several developmental outcomes. This section extends those findings by regressing each outcome on a low birth weight dummy in the two models described above: the baseline OLS model with an extensive set of covariates and the OLS model with family fixed effects.

Table 2-3 shows that the OLS low birth weight coefficient estimate is significant for all four cognitive outcomes. However, after accounting for unobserved household heterogeneity low birth weight is only associated with math and reading scores. Being born with low birth weight is associated with math and reading scores that are respectively 0.26 and 0.27 standard deviations lower than scores for children born weighing 2,500 grams or greater.

Table 2-4 shows that among the behavioral outcomes for children aged 2 to 6, the estimated coefficient for being low birth weight is only significant for scores of hyperactivity in the OLS model and scores of emotional disorder in the OLS and fixed effects models. The fixed effects estimate in the emotional disorder regression suggests that children born with low birth weight on average have emotional disorder scores that are 0.41 points, or a quarter of a standard deviation, higher than normal birth weight children. According to the OLS and fixed effects results for behavioral outcomes for children aged 7 to 11 in Panels A and B of Table 2-5, the average behavioral scores for those born with low birth weight are not statistically different than those born with normal birth weight.

2.6.1 Covariates

This section briefly describes the relationships between the covariates and the outcomes in the OLS and OLS with family fixed effect regressions. I first describe relationships for covariates that appear in the family fixed effect regressions and then for those that appear only in the OLS regressions.

An increase in mother's age at child's birth is associated with lower scores of pro-social behavior and higher scores of oppositional disorder among young children. Scores of hyperactivity among older children are positively related to mother's age but at a decreasing rate. In these cases older mothers are associated with poorer outcomes. This is inconsistent with the literature that suggests that children of young mothers, in particular teen mothers, have poorer outcomes.

The estimated coefficients for the dummy variable for being the oldest child in the family are often significant in the OLS regressions but only four maintain statistical significance in the fixed effect regressions. The fixed effect coefficient estimate for the dummy variable for being the oldest is not significant for any of the cognitive outcomes, which is inconsistent with relationships suggested by Hanushek (1992). Among behavioral outcomes for young children, those who are oldest are estimated to have better scores of hyperactivity and pro-social behavior but poorer scores for emotional disorders. The results also suggest that the oldest child in the household is less likely to show signs of indirect aggression when aged 7 to 11.

Even after controlling for many household-level factors, the coefficient estimate for the gender dummy is statistically significant for many of the outcomes. Among cognitive outcomes, the results suggest that girls, on average, have higher scores of motor and social development. At younger ages, girls have better scores in terms of hyperactivity, emotional disorders and pro-social behavior. For behavioral outcomes among older children, girls have better scores for hyperactivity, property offense, pro-social behavior and conduct disorder but higher scores for indirect aggression.

Among the covariates that appear in only the OLS regressions, I first describe relationships related to log equivalent income. Consistent with the literature, there is a positive and statistically significant relationship between income and the four cognitive outcomes. The results also suggest that income is negatively related to scores of hyperactivity and emotional disorders among young children. The coefficient estimates for income are also associated with better scores for five of the six behavioral outcomes for older children, all except pro-social behavior.

Having a mother with less than a high school diploma is estimated to have a negative relationship with all four cognitive outcomes as well as poorer scores of hyperactivity among younger and older children. The coefficient estimates suggest that children with mothers who have a college or university degree have higher scores in PPVT, math and reading tests. These children also have better scores in terms of hyperactivity among younger and older ages and pro-social behavior among young children. In general these results are consistent with the literature that suggests that higher maternal education is associated with better developmental outcomes for their children.

The coefficient estimates for the dummy variable for lone parent status suggest a negative relationship with math and reading scores among 7 to 13 year olds, which is consistent with the traditional hypothesis. Lone parent status is also associated with poorer scores of hyperactivity, emotional disorder and oppositional disorder but higher scores of pro-social behavior. The estimated coefficients also suggest poorer outcomes for five of the six behavioral outcomes among older children, all except pro-social behavior.

The coefficient estimate for number of siblings suggests that having more siblings is related to higher math and reading scores. Among the behavioral outcomes, the estimated coefficients for the number of siblings variable suggests that having more siblings is related to better scores for hyperactivity at young and old ages as well as pro-social behavior among young children. However, having more siblings is related to higher scores of oppositional disorder or conduct disorder. The results also suggest that children from rural areas are more likely to have higher scores of oppositional disorder at younger ages and higher scores of indirect aggression and conduct disorder at older ages.

2.7 Effect of Additional Birth Weight on Cognitive and Behavioral Outcomes

Some of the plots presented in Section 2.4 showed large increases in mean scores for increases in birth weight below the low birth weight threshold followed by smaller increases in mean scores beyond the threshold. Such plots suggest that the effect of birth weight on these outcomes may be non-linear. While the previous section provided evidence regarding the average differences in outcomes faced by children born below and above 2,500 grams conditional on a wide range of factors, they did not estimate the effect of additional weight in each category. This section uses piecewise regressions to examine the effect of additional birth weight for both groups of children. A new birth weight variable is created, BW^*, and is centered at 2,500 grams such that $BW^* = BW - 2500$. Each regression includes a dummy variable for low birth weight as well as two interactions terms. One term interacts BW^* and the low birth weight dummy variable, and the other interacts BW^* with the normal birth weight dummy variable. The OLS and OLS family fixed effect piecewise regression can, respectively, be expressed as:

$$y_{ji} = \beta_1(LBW_{ij}) + \beta_2(LBW_{ij})(BW_{ij}^*) + \beta_3(NBW_{ij})(BW_{ij}^*) + \phi(Z_{ij}) + \gamma(H_j) + e_{ij}\,, \qquad (4)$$

$$(y_{1j} - y_{2j}) = \beta_1((LBW_{1j}) - (LBW_{2j})) + \beta_2((LBW_{1j})(BW_{1j}^*) - (LBW_{2j})(BW_{2j}^*)) + \beta_3((NBW_{1j})(BW_{1j}^*) - (NBW_{2j})(BW_{2j}^*)) + \phi(Z_{1j} - Z_{2j}) + (e_{1j} - e_{2j}). \quad (5)$$

Significance of the estimated coefficient for the low birth weight dummy will indicate a discontinuous jump in that outcome at 2,500 grams and indicate a threshold effect. Significance of the coefficient estimate for the birth weight interaction terms will indicate that additional birth weight in that birth weight group has an effect on that outcome. F-statistics are calculated to test if the two slopes are equal. Statistically different slopes would suggest that birth weight has a non-linear effect on that outcome.

Panel A in Table 2-6 presents the OLS and OLS with family fixed effects piecewise regression results for the four cognitive outcomes. The first two columns present the OLS and OLS with family fixed effects results for the motor and social development (MSD) score. The OLS coefficient estimate for the low birth weight is not significant but both birth weight interaction term are positive and highly significant. Additional weight at birth benefits both groups of children. The F-statistic suggests that the effect of birth weight on the MSD score is non-linear, benefiting those born weighing <2,500 grams to a greater extent than those 2,500+ grams. However, among the fixed effects estimates only the coefficient estimate for the normal birth weight interaction term remains significant. The estimate suggests that an additional 1000 grams of birth weight in the range above 2,500 grams will increase the MSD score by 2.6 points, more than 15% of a standard deviation. The F-statistic for these slope estimates is much lower and does not suggest the presence of non-linear effects.

The regression results for the PPVT scores show a similar pattern to the MSD estimates. The two birth weight interaction terms are positive and significant in the OLS model but only the interaction term for normal birth weight is significant after controlling for unobserved household factors. As with the MSD results, for children born weighing 2,500+ grams, a 1000-gram increase in weight at birth will increase the PPVT score by 2.6 points, more than 15% of a standard deviation.

Columns 5 and 6 of Panel A of Table 2-6 present the results for math scores as the dependent variable. Among the birth weight variables, only the estimated coefficient for the low birth weight dummy variable is significant in the OLS model. For the fixed effect estimates in column 6, only the coefficient estimate for the low birth weight interaction term is significant. The results suggest that an additional 1000 grams for low birth weight children is related to an increase in math scores equal to 0.3 of a standard deviation. The F-statistic suggests that the slopes for the two segments are not equal; indicating that additional birth weight only benefits those born weighing less than 2,500 grams. For the results with reading scores as the dependent variable, the OLS coefficient estimates in column 7 show that the low birth weight dummy variable is significant, suggesting that those weighing just under 2,500 grams at birth have reading scores that are lower than those weighing just over 2,500 grams. However, the relationship disappears after controlling for family fixed effects.

Panel B of Table 2-6 presents the results for the four behavioral outcomes for young children. In the hyperactivity OLS regressions, the estimate for the normal birth weight interaction term is significant. However, after family-level factors are controlled, none of the estimates for the birth weight coefficients are statistically significant. Among the coefficient estimates for the emotional disorder score, the normal birth weight interaction term is significant in both the OLS and OLS with fixed effects models. The fixed effects estimate suggest that an additional 1000 grams in the normal birth weight range is associated with a 0.23-point decrease in the emotional disorder score, which is almost 0.15 of a standard deviation. The results for pro-social behavior in Column 6 show that after taking into account unobserved household factors additional birth weight for those born with low birth weight is associated with higher pro-social behavior scores. A 1000-gram increase in birth weight in this range is related to a 0.56-point increase in the pro-social behavior score, a quarter of a standard deviation. The F-stat suggests that the benefit of additional birth weight on the pro-social behavior score is non-linear, only benefiting those born < 2,500 grams.

The coefficient estimates for the six behavioral outcomes for older children are shown in panels C and D of Table 2-6. For the hyperactivity, emotional disorder and conduct disorder regressions, the only significant coefficient estimate among the birth weight variables is the OLS estimate for the normal birth weight interaction term. The coefficient estimates for these three variables are not significant once controlling for household fixed effects. For the property offense regression estimates, the low birth weight interaction term is significant in the fixed effects model and suggests that a 1000-gram increase in birth weight for this group is associated with a decrease in the property offense score of 0.896 points, approximately three-quarters of a standard deviation. In column 1 of panel D of Table 2-6, the OLS results suggest the low birth weight dummy variable and the normal birth interaction term are negatively related to the indirect aggression score. However, the relationship does not hold in the fixed effects model. The pro-social behavior regression fixed effects results present two significant coefficient estimates. An increase in birth weight for low birth weight children is estimated to have a positive influence on the pro-social behavior score while additional weight for normal birth weight children has a negative relationship, and the relative sizes of their estimates are 0.8 and 0.2 of a standard deviation respectively. The F-statistics for both the property offense and pro-social behavior fixed effects models suggest that birth weight has a non-linear effect on these outcomes. In the case of the pro-social behavior score, additional birth weight benefits those with low birth weight but is estimated to be detrimental for with normal birth weight.

In several cases (reading in Table 2-3, MSD and PPVT in Table 2-6 Panel A, emotional disorder in Table 2-4 and Table 2-6 Panel B), the size of the statistically significant fixed effects estimate is larger than the statistically significant OLS counterpart. The larger fixed effects estimates are unexpected since family fixed effects control for omitted variables related to the household that are correlated with both birth weight and the outcomes and therefore should reduce the estimated effect. Currie *et al.* (2008) also find family fixed effects estimates that are larger than OLS estimates when regressing birth weight dummies on literacy scores and taking college-preparatory math courses.

Part of the increase from the OLS to the family fixed effects estimators may be explained by the samples. The samples used for the OLS models for each of the outcomes include both children with and without a sibling present in the sample. The samples used in the OLS with family fixed effects models include only those with a sibling. For all of the outcomes, more than half of the full sample is excluded when using the family fixed effects models. To determine if this may explain the larger fixed effects estimates (in results not shown), I re-estimate the OLS models using the sample of siblings for the concerned coefficient estimates mentioned above. When using the sample of siblings and the reading score as the outcome in Table 2-3, the OLS coefficient estimate for low birth weight is larger than the fixed effects estimate. For the emotional disorder score for children aged 2 to 6 in Table 2-4, the low birth weight OLS coefficient estimate is much larger when using the sibling sample than when using the full sample but it is still not quite as large as the fixed effects estimate. Similarly, the coefficient estimate of the normal birth weight interaction term in the MSD model in Table 2-6 Panel A is also larger than the full sample but not quite as large as the fixed effects estimate. The OLS coefficient estimate for the normal birth weight interaction term in the PPVT model in Table 2-6 Panel A is not significant when estimated with the sibling sample. The OLS coefficient estimate of the normal birth weight interaction term in the emotional disorder (for children aged 2 to 6) regression in Table 2-6 Panel B is larger than the fixed effects estimate in the sibling sample. Based on these results, I conclude that part of the reason some of the family fixed effects estimates are larger than the full sample OLS estimates is that the sibling sample used for the family fixed effects analysis produces larger OLS results.

A second possible explanation could be that the OLS estimates are biased downward. If additional birth weight is positively correlated with omitted factors that have a negative (positive) effect on child outcomes then these estimates will understate (overstate) the true effect of birth weight. For example, suppose women who work high hours of paid work have certain characteristics that make them more likely to have children with higher birth weight. As these women work high hours of paid work, on average their children spend more time in non-maternal childcare. If non-maternal childcare is of lesser quality than maternal childcare then these children may have poorer developmental outcomes. Another possibility could be that women who are very concerned with their child's wellbeing may be those who take proper pre-natal care and have children with higher birth weight. These women may also be more conscious of child behavior and more likely to notice and report poorer behavioral scores. Not accounting for such maternal characteristics would result in an under-estimation of the negative effects of lower birth weight in the OLS estimates. However, once such maternal characteristics are controlled for in the family fixed effects analysis, this bias would disappear.

2.8 Robustness checks

2.8.1 Additional controls

Parental investments in the prenatal or post-natal period are of concern for the analysis. Prenatal care by mothers may influence birth weight as well as developmental outcomes, thus potentially confounding the effect of birth weight on such outcomes. Also, parental post-natal investments may be a function of birth weight, therefore confounding the estimated effect of birth weight on developmental outcomes. One of the advantages of the NLSCY for this study is that it collects a wide range of prenatal and post-natal information on mothers and children. This section investigates whether prenatal or post-natal behavior may be affecting the estimates.

In terms of parents' post-natal investments, parents may engage in compensatory or reinforcing investments as a function of birth weight. Compensatory (reinforcing) investments would imply that the above estimated coefficients are underestimated (overestimated). Datar *et al.* (2010) examine whether parents make compensatory and reinforcing investments based on birth weight in terms of breastfeeding. Their mother fixed effects results suggest that an increase in birth weight is associated with an increase in the probability of being breastfed. Royer (2007) also investigated differing levels of breastfeeding for different birth weights. Using a sample of twins, Royer finds no evidence of a relationship between birth weight and mothers breastfeeding behavior. Both of these studies use data from the U.S. As Canada offers generous health insurance and a parental benefit program not available in the US, these results may not hold in the Canadian context.

Using the full sample of children with information on birth weight, breastfeeding and covariates, in results not shown, I estimate the effect of birth weight on probability of never being breastfed. The logit estimates suggest that lower birth weight is associated with a higher probability of never being breastfed. However, the relationship between birth weight and never being breastfed is not statistically significant in the logit with family fixed effects models. The lack of a significant relationship in the family fixed effects model may result from a lack of variation between breastfeeding behaviors across children of the same mother.

Despite the lack of a significant relationship between birth weight and being breastfed, I nonetheless provide further evidence that parental post-natal investments are not confounding earlier estimates by adding a dummy variable for never being breastfed to the cognitive and behavioral outcomes for young children piecewise regressions.[13] As premature birth is often highly correlated with low birth weight, I also include a dummy variable to identify children who were born prematurely, which is defined as having a gestational age less than 259 days (37 weeks). In panels A and B of Table 2-7, there are four columns for each outcome. The first and second columns show the estimates for the birth weight variables from the original piece-wise regression for the full sample and postnatal sample respectively.[14] The third column includes the regression results with the never breastfed and premature variables added but without any birth weight variables. The fourth column includes the birth weight variables and the post-natal variables. While the post-natal variables are significant in several of the regressions in Column 4 in Table 2-7, the birth weight coefficient estimates for all outcomes but the PPVT scores are very similar before and after the addition of the post-natal variables. With the post-natal variables included in the PPVT regressions, the coefficient estimates for the birth weight

[13] Outcomes for older children were not examined because data on being breastfed was not collected for those children.
[14] Due to the large number of children with non-response to questions on being breastfed, the sample size was too small to estimate the equivalent OLS regressions with FFEs.

interaction terms are insignificant and the low birth weight dummy coefficient estimate is negative and significant. This change however is not a result of the post-natal variables but rather the change in sample. Column 2 shows that the piecewise regression results using the sample with valid response to the post-natal variables but without including the post-natal variables in the regression. The results are similar to those after the variables are added. These results provide evidence that being born premature and parental investments through breastfeeding are not confounding the relationships between birth weight and these outcomes. This suggests that the findings in the main analysis do not suffer bias due to the exclusion of these variables.

Another possible source of endogeneity that is not often controlled for due to data limitations is whether the mother drank alcohol or smoked during pregnancy. The medical literature suggests that maternal smoking (Ward *et al.* 2007) and the consumption of alcohol (Jaddoe *et al.* 2007) during pregnancy are related to a higher risk of low birth weight. Huizink and Mulder (2006) provide a review of the medical literature that has examined the effect of maternal smoking and drinking on cognitive and neuro-behavioral outcomes. Despite some mixed findings, the overall conclusion is that drinking alcohol and smoking during pregnancy have adverse effects on child developmental outcomes. I also examine these relationships using the NLSCY. In results not shown, I estimate the effect of smoking and drinking during pregnancy on birth weight using the full sample of children with information on birth weight, prenatal smoking, prenatal drinking and covariates. Using dummy variables, I identify children whose mothers report drinking alcohol throughout their entire pregnancy (7 percent of children) and children whose mothers report smoking throughout their entire pregnancy (18 percent of children). For each prenatal behavior, I estimate separate OLS and OLS with family fixed effects models. While the OLS coefficient estimate suggests that prenatal smoking is associated with lower birth weight, the fixed effect coefficient is not significant. Neither the OLS nor the fixed effects estimate suggests that drinking during pregnancy has a statistically significant effect on birth weight.

I also add dummy variables identifying children whose mothers smoked and drank during pregnancy to the piecewise regressions. Panels A and B in Table 2-8 present the results for the cognitive and young behavioral outcomes respectively.[15] The results in column 4 of the two tables show that the coefficient estimates for mothers smoking and drinking during pregnancy are significant in several regressions but do not change the size or significance of the birth weight coefficient estimates when compared to the results in column 1 or 2. However, the results in the MSD regressions unexpectedly show that smoking during pregnancy is associated with an increase in MSD scores and the relationship is highly significant. Previous literature has shown that maternal smoking during pregnancy is negatively associated with birth weight and cognitive ability. Given this inconsistency, I do not emphasize this result. However, overall, the lack of change in the coefficient estimates for the birth weight variables in these regressions suggests that smoking and drinking during pregnancy are not confounding the results in the main analysis.

2.8.2 High birth weight

The fixed effects results for the normal birth weight interaction term for the MSD and PPVT regressions in Panel A of Table 2-6 suggest that additional weight for those born 2,500 grams or more is beneficial to cognitive ability. However, it is plausible that additional weight at higher birth weights may actually be detrimental to development. Unlike their low weight counterparts, very little work has looked at cognitive or behavioral outcomes for children born with high birth weight (> 4,500 grams or 9.9 pounds).

Higher birth weight has already been associated with gestational diabetes and maternal obesity during pregnancy (Eide 2005). Research from the medical-related disciplines has explored the link between high birth weight and health outcomes such as subsequent overweight/obesity and emergency visits during childhood (Eide 2005, Danielzik *et al.* 2004). Only Cesur and Kelly (2010) have examined the relationship between high birth

[15] As with the regressions using information on breastfeeding, due to the large number of children with non-response to questions on prenatal smoking and drinking, the sample size was too small to estimate the equivalent OLS regressions with FFEs.

weight and cognitive outcomes. They do not use fixed effects regression models but they control for a large set of confounding factors in their OLS regressions, and suggest that high birth weight is related to lower test scores in math and reading.

I investigate the effect of high birth weight on my results by re-estimating all the OLS and fixed effects piecewise regressions but with the inclusion of high birth weight variables. I add a dummy for high birth weight (birth weight > 4,500 grams) alone as well as interacted with birth weight, where birth weight for all interaction terms is centered at 2,500 grams. The base case is children born with normal birth weight, ranging from 2,500 to 4,500 grams.

Among the regression results for the cognitive outcomes in Panel A of Appendix Table 2-3, the birth weight variable estimates remain similar to the original results with only one exception. The estimate for the normal birth weight interaction term is less precise and is no longer highly significant in the PPVT fixed effect regression but still has a p-value of 0.13. In all the regressions for the cognitive outcomes neither the high birth weight dummy variable nor its interaction are statistically significant.

Panel B of Appendix Table 2-3 presents the regression results for the behavioral outcomes for young children. The coefficient estimates for the normal birth weight interaction term are less precise and are now insignificant by conventional standards in the OLS and fixed effects regression for the emotional disorders score as well as in the OLS regressions for pro-social behavior (the p-values become 0.125, 0.154 and 0.013 respectively). Both the high birth weight dummy and its interaction are significant in the hyperactivity and oppositional disorder OLS regressions. In both cases, the coefficient estimates for the dummy are negative while the estimates for the high birth weight interaction terms are positive. However, for both outcomes, the two estimated coefficients are insignificant in the fixed effects models.

When comparing to the results from regressions without high birth weight variables, the regression results in panels C and D of Appendix Table 2-3 for behavioral outcomes for older children, show that the coefficient estimates for the low birth weight dummy and its interaction with birth weight remain unchanged in terms of significance. However, the coefficient estimates for the normal birth weight interaction term in the OLS results for property offense and conduct disorder, and the fixed effect results for pro-social behavior change slightly in significance (the p-values become 0.043, 0.116 and 0.144 respectively). The coefficient estimates becomes more precise for the property offense outcome but less precise in the pro-social behavior and conduct disorder outcome. Only in the property offense regressions are the high birth weight terms significant. Both the OLS and fixed effect estimates are significant for the high birth weight dummy and the high birth weight interaction term. In both models, the estimate for the dummy variable is negative and the estimate for the interaction term is positive suggesting that additional birth weight above 4,500 grams is associated with a higher property offense score.

While there are a few changes in precision once the high birth weight terms are included, several of the fixed effects coefficient estimates for the birth weight interaction terms remain significant. The low birth weight interaction terms remain significant in the math, pro-social (for young and older children) and property offense regressions. The normal birth weight interaction term remains significant in the MSD regression. These results also show that for all but one outcome, property offense scores of older children, children born with high birth weight on average do not have outcomes any different than children born with normal birth weight. Overall the inclusion of a high birth weight dummy variable and interaction term causes little change in the significance of already significant coefficient estimates except the estimated coefficient for emotional disorders.

2.8.3 Inclusion of twins

The inclusion of twins increases the number of observations by 107 to 536 children (depending on the outcome variable) and increases the proportion of children born with low birth weight from a range of 4.8-5.5 percent to a range of 5.6-6.3 percent (again, depending on the outcome variable). I re-estimate all the regressions with twins included. In results not presented here, I find that for most of the outcomes the results remain very similar. In the cases where there are differences, the coefficient estimate has gone from being close to significant by traditional standards to significant at 10 percent. These results provide evidence of the conservativeness of the results in the main analysis, and are not emphasized since the sample does not accurately represent the sample of singleton births, which account for a vast majority of the population.

2.8.4 Sample Selection

As lower birth weight is associated with higher infant mortality, sample selection may be an issue in this analysis. That is, children born with lower birth weight are less likely to survive long enough to appear in the data and those with low birth weight that do survive have been shown to have poorer outcomes. Not accounting for those that do not survive could lead to biased result.

It is not possible to examine the bias due to mortality with the NLSCY since it is not possible to identify children who left the sample due to death. However, Black *et al.* (2007) were able to investigate this issue using a sample of twins and a rich dataset from Norway. Their dataset includes a five-minute APGAR score for all individuals including those that eventually attrite from the sample due to mortality. They estimate the effect of birth weight on APGAR scores for the full sample of twins as well as the sample of twins that survive and have responses to the adult outcomes. The estimated coefficient of log birth weight on APGAR scores in the full sample of twins is much larger (0.35) than in the subset of twins that live (0.19). They suggest that if this pattern holds for later outcomes then selection bias most likely leads to underestimation of the effect of birth weight on later outcomes. Conversely, Royer (2007) suggests that sample selection is not driving the results in her analysis. Royer (2007) suggests that if the effect of birth weight on the probability of being observed for adult outcomes varies across cohorts then in the presence of selection bias, the effect of birth weight on later outcome must also vary by cohort. Royer finds that the effect of birth weight on the probability of later observation varies across cohorts while the effect of birth weight on long-run outcomes does not. Based on these findings Royer (2007) concludes that sample selection bias is minimal.

The arguments and conclusions presented by Black *et al.* (2007) and Royer (2007) suggest that, if anything, sample selection due to higher infant mortality of low birth weight children would bias the estimated coefficients downward in the present analysis.

2.9 Discussion and Conclusion

Programs such as the Canada Prenatal Nutrition Program (CPNP) are established to promote proper prenatal care among vulnerable pregnant woman with the objective of encouraging healthy birth weight among infants. Each year, the CPNP serves more than 50,000 pregnant women, and in 2005-2006 cost more than $52 million. A similar program in the United States, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), served 9 million participants in 2008 with a total cost of over $6 billion. Both programs reduce the number of infants born with low birth weight as well as encourage heavier birth weight among infants who likely would have been born with normal birth weight even without a prenatal nutrition program. In order to justify the resources directed to such programs, additional birth weight must benefit children born with low birth weight as well as children born with normal birth weight. The results in this paper help provide that justification.

In this paper, I examine the effect of birth weight on several measures of child development using a large nationally representative sample of Canadian children. In particular, I investigate the effect of additional weight on cognitive and behavioral outcomes for children born weighing less than 2,500 grams (referred to as low birth weight) as well as children born weighing 2,500 grams or more. OLS estimates suggest that additional birth weight is related to many of the child outcomes. However, as many household factors may be confounding the estimated relationship between birth weight and child development, I use OLS with family fixed effects models and samples of siblings to factor out household heterogeneity. Among the family fixed effects results, I find that additional birth weight for children born with normal birth weight has a positive effect on motor and social development scores for children aged 0 to 3 and scores of verbal competence for children aged 4 to 6. I also find that additional birth weight for children born with low birth weight leads to higher math scores for children aged 7 to 13.

For behavioral outcomes, additional birth weight for those born with low birth weight increases scores of pro-social behavior (for children at younger and older ages) and decreases scores of property offense for older children.

These results have two policy implications. First, these findings provide further support for prenatal nutrition programs that reduce the incidence of low birth weight infants. Similarly, these results provide evidence that resources that promote additional birth weight among normal birth weight infants have benefits. Second, since the adverse effects of lower birth weight can be seen in the early years, resources can be directed towards children to reduce the continuation of such effects on human capital and labour market outcomes later in life.

Table 2-1: Summary of the Relevant Literature

Authors	Outcome variable(s)	Age	Country	Results
Oreopoulos, Stabile, Walld and Roos (2008)	Language arts scores	Grade 12 students	Canada	OLS: low birth weight is negative and significant. Family and twin FE: mainly insignificant.
Currie, Stabile, Manivong and Roos (2008)	Language arts scores and takes college prep. math	Grade 12 students	Canada	OLS: low birth weight is negative and significant. Family FE: smaller and less precise than regular OLS
Johnson and Schoeni (2007)	Woodcock-Johnson achievement (Passage comp., reading ability, math problem solving).	0 to 12	U.S.	Family FE: low birth weight is negative and significant.
Black, Devereux and Salvanes (2007)	IQ scores of military men	18 to 20	Norway	OLS: log birth weight is positive and significant. Family and twin FE: same as OLS.
Royer (2007)	Mental development score and motor skills score for 858 female twins	N/A	U.S.	OLS: birth weight is positive and significant. Twin FE: smaller and less precise than OLS.

Table 2-2: Means for outcome variables

	Low birth weight (1)	Normal birth weight (2)	Difference (2)-(1) (S.E. difference)
Cognitive Outcomes			
MSD	93.718	101.01	7.292***
	(17.062)	(14.726)	(0.878)
PPVT	94.803	99.469	4.666**
	(17.492)	(15.035)	(1.825)
Math	-0.245	-0.005	0.24***
	(1.031)	(1.020)	(0.092)
Reading	-0.213	-0.015	0.198**
	(1.039)	(1.032)	(0.090)
Behavioral Outcomes (2 to 6 year olds)			
Hyperactivity	4.407	4.071	-0.336**
	(2.881)	(2.984)	(0.162)
Emotional Disorder	1.522	1.292	-0.23**
	(1.630)	(1.629)	(0.093)
Pro-social Behavior	5.244	5.308	0.064
	(2.188)	(2.139)	(0.129)
Conduct Disorder	1.82	1.975	0.155*
	(1.590)	(1.642)	(0.092)
Behavioral Outcomes (7 to 11 year olds)			
Hyperactivity	5.043	4.434	-0.609*
	(4.078)	(3.609)	(0.323)
Emotional Disorder	3.143	2.724	-0.419**
	(2.812)	(2.649)	(0.210)
Property Offense	0.832	0.779	-0.053
	(1.189)	(1.170)	(0.089)
Indirect Aggression	1.208	1.282	0.074
	(1.655)	(1.706)	(0.115)
Pro-social Behavior	13.285	12.925	-0.36
	(3.769)	(3.724)	(0.295)
Conduct Disorder	1.232	1.339	0.107
	(1.850)	(1.843)	(0.138)

Source: NLSCY, Cycles 1-3 (only cycles 2 and 3 for Math and Reading)
Note: In columns 1 and 2, standard deviations are reported in parentheses. In column 3, bootstrapped standard errors of the difference are in parentheses. Significant differences in scores between low birth weight and normal birth weight children are represented by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2-3: OLS and OLS with FFE Results for MSD (ages 0-3), PPVT (ages 4-6) and Math and Reading (ages 7-13) Scores

	MSD (1)	MSD (2)	PPVT (3)	PPVT (4)	Math (5)	Math (6)	Read (7)	Read (8)
Low birth weight	**-7.541*****	-2.604	**-4.020****	-2.785	**-0.277*****	**-0.256**†	**-0.196*****	**-0.266***
	(0.852)	(2.346)	**(1.864)**	(3.730)	**(0.0577)**	**(0.157)**	**(0.0601)**	**(0.141)**
Mother's age at child's birth	-0.566*	2.607	1.664***	-0.255	0.0159	-0.268***	0.0363	-0.321**
	(0.308)	(1.839)	(0.606)	(2.690)	(0.0266)	(0.0874)	(0.0333)	(0.148)
Mother's age at child's birth sq'd	0.00569	-0.0736**	-0.0249**	0.00733	-0.0000525	-0.00238*	-0.000386	-0.000943
	(0.00529)	(0.0304)	(0.0106)	(0.0457)	(0.000475)	(0.00143)	(0.000578)	(0.00195)
Girl	3.972***	4.571***	1.054*	1.457	-0.0115	-0.0217	0.0879***	-0.0379
	(0.339)	(0.791)	(0.550)	(1.036)	(0.0241)	(0.0449)	(0.0305)	(0.0806)
Oldest child	2.357***	0.346	2.360***	-0.792	0.122***	0.0515	0.187***	0.0184
	(0.428)	(1.132)	(0.584)	(1.525)	(0.0276)	(0.0598)	(0.0303)	(0.130)
Child age	--	--	--	--	0.793***	--	0.925***	--
					(0.0670)		(0.0897)	
Child age sq'd	--	--	--	--	-0.0200***	--	-0.0292***	--
					(0.00347)		(0.00436)	
Lone parent	0.662	--	0.523	--	-0.103**	--	-0.0981**	--
	(0.738)		(0.984)		(0.0442)		(0.0495)	
Log equivalent income (2006$)	1.083***	--	4.031***	--	0.0680***	--	0.115***	--
	(0.336)		(0.682)		(0.0249)		(0.0264)	
Mother has less than high school	-1.568**	--	-3.432***	--	-0.114***	--	-0.231***	--
	(0.616)		(0.891)		(0.0396)		(0.0454)	
Mother has uni/college degree	-0.283	--	3.784***	--	0.139***	--	0.302***	--
	(0.438)		(0.880)		(0.0362)		(0.0443)	
Number of siblings	0.0357	--	-0.498	--	0.0327**	--	0.0581***	--
	(0.241)		(0.366)		(0.0132)		(0.0172)	
Rural residence	-0.469	--	0.192	--	-0.00345	--	-0.0145	--
	(0.388)		(0.580)		(0.0249)		(0.0288)	
Observations	18634	3708	10980	1244	6546	2712	6546	2712
R^2	0.050	0.650	0.097	0.726	0.655	0.857	0.519	0.807

Source: NLSCY, Cycles 1-3. Standard errors clustered at the household level in parentheses. Bootstrapped standard errors for regression estimates with no FFE. All OLS regressions without FFE also control for province of residence and survey cycle. *** $p < 0.01$, ** $p < 0.05$, , * $p < 0.10$, $^{\dagger}p < 0.11$.

Table 2-4: OLS and OLS with FFE Results for Behavioral Outcomes (ages 2-6)

	Hyper (1)	Hyper (2)	Emo. Dis. (3)	Emo. Dis. (4)	Pro-social (5)	Pro-social (6)	Opp. Dis. (7)	Opp. Dis. (8)
Low birth weight	**0.332****	0.644	**0.149**†	**0.408****	-0.172	-0.346	-0.0483	0.217
	(0.162)	(0.484)	**(0.0911)**	**(0.179)**	(0.118)	(0.221)	(0.0870)	(0.220)
Mother's age at child's birth	-0.106	0.0614	0.0664*	0.0378	-0.0312	-0.399*	-0.0392	0.433**
	(0.0701)	(0.254)	(0.0370)	(0.211)	(0.0482)	(0.209)	(0.0435)	(0.186)
Mother's age at child's birth sq'd	0.000925	-0.00194	-0.00125**	-0.00541	0.000230	0.000833	0.0000808	-0.00374
	(0.00119)	(0.00414)	(0.000622)	(0.00330)	(0.000825)	(0.00329)	(0.000763)	(0.00304)
Girl	-0.723***	-0.930***	-0.123***	-0.179*	0.679***	0.676***	-0.333***	-0.380***
	(0.0775)	(0.145)	(0.0451)	(0.104)	(0.0505)	(0.0869)	(0.0401)	(0.0857)
Oldest child	-0.266***	-0.682***	0.455***	0.406***	0.428***	0.547***	-0.483***	-0.0633
	(0.0899)	(0.201)	(0.0499)	(0.146)	(0.0623)	(0.133)	(0.0446)	(0.120)
Child age	-0.151	--	0.204*	--	0.730***	--	0.110	--
	(0.192)		(0.112)		(0.127)		(0.0954)	
Child age sq'd	0.00345	--	-0.00169	--	-0.0569***	--	-0.0283**	--
	(0.0251)		(0.0151)		(0.0161)		(0.0122)	
Lone parent	0.347***	--	0.223**	--	0.170*	--	0.192***	--
	(0.132)		(0.0914)		(0.0926)		(0.0691)	
Log equivalent income (2006$)	-0.152**	--	-0.162***	--	0.0819	--	-0.0311	--
	(0.0757)		(0.0496)		(0.0531)		(0.0410)	
Mother has less than high school	0.392***	--	0.0406	--	-0.132	--	0.0375	--
	(0.128)		(0.0772)		(0.0929)		(0.0694)	
Mother has uni/college degree	-0.463***	--	-0.000169	--	0.234***	--	0.0316	--
	(0.0952)		(0.0534)		(0.0778)		(0.0589)	
Number of siblings	-0.167***	--	0.0141	--	0.0649*	--	0.0982***	--
	(0.0491)		(0.0249)		(0.0335)		(0.0239)	
Rural residence	0.0358	--	0.00147	--	0.0783	--	0.0957**	--
	(0.0836)		(0.0440)		(0.0589)		(0.0437)	
Observations	17373	5448	17373	5448	17373	5448	17373	5448
R^2	0.053	0.659	0.067	0.697	0.126	0.733	0.064	0.685

Source: NLSCY, Cycles 1-3. Standard errors clustered at the household level in parentheses. Bootstrapped standard errors for regression estimates with no FFE. All OLS regressions without FFE also control for province of residence and survey cycle. *** $p < 0.01$, ** $p < 0.05$, , * $p < 0.10$, † $p < 0.11$

Table 2-5: OLS and OLS with FFE Results for Behavioral Outcomes (ages 7-11)

PANEL A:	Hyper (1)	Hyper (2)	Emo. Dis. (3)	Emo. Dis. (4)	Prop. Off. (5)	Prop. Off. (6)
Low birth weight	0.474 (0.312)	0.948 (0.758)	0.277 (0.203)	0.249 (0.634)	0.0338 (0.0901)	0.0912 (0.186)
Mother's age at child's birth	0.103 (0.118)	1.423** (0.555)	0.101 (0.0884)	0.383 (0.353)	-0.0160 (0.0405)	0.262 (0.170)
Mother's age at child's birth sq'd	-0.00278 (0.00205)	-0.0171* (0.00931)	-0.00232 (0.00156)	-0.0101* (0.00571)	-0.000122 (0.000717)	-0.00270 (0.00274)
Oldest child	-0.509*** (0.135)	0.331 (0.348)	0.437*** (0.102)	0.226 (0.226)	-0.140*** (0.0465)	0.0130 (0.105)
Girl	-1.314*** (0.117)	-1.799*** (0.209)	0.0415 (0.0954)	0.0416 (0.141)	-0.280*** (0.0434)	-0.259*** (0.0703)
Child age	1.074* (0.648)	--	-0.285 (0.478)	--	-0.00778 (0.206)	--
Child age sq'd	-0.0693* (0.0361)	--	0.0205 (0.0267)	--	-0.00287 (0.0114)	--
Lone parent	0.627*** (0.211)	--	0.681*** (0.170)	--	0.242*** (0.0814)	--
Log equivalent income (2006$)	-0.530*** (0.122)	--	-0.315*** (0.0930)	--	-0.159*** (0.0464)	--
Mother has less than high school	0.450** (0.177)	--	0.0289 (0.145)	--	0.0867 (0.0686)	--
Mother has uni/college degree	-0.449** (0.204)	--	-0.0241 (0.151)	--	-0.0721 (0.0595)	--
Number of siblings	-0.431*** (0.0677)	--	-0.0257 (0.0522)	--	-0.0223 (0.0235)	--
Rural residence	-0.00365 (0.132)	--	-0.0797 (0.103)	--	0.0234 (0.0467)	--
Observations	8557	3392	8557	3392	8557	3392
R^2	0.090	0.608	0.050	0.696	0.061	0.692

Continued…

Table 2-5 continued: OLS and OLS with FFE Results for Behavioral Outcomes (ages 7-11)

PANEL B:	Indirect Agg. (1)	Indirect Agg. (2)	Pro-social (3)	Pro-social (4)	Conduct (5)	Conduct (6)
Low birth weight	-0.135	0.389	0.305	-0.629	-0.0847	0.205
	(0.112)	(0.325)	(0.284)	(0.794)	(0.140)	(0.432)
Mother's age at child's birth	0.0588	-0.158	0.0318	-0.108	0.0709	-0.176
	(0.0557)	(0.175)	(0.119)	(0.462)	(0.0647)	(0.247)
Mother's age at child's birth sq'd	-0.00144	0.00232	-0.000499	-0.00457	-0.00169	0.00297
	(0.000993)	(0.00291)	(0.00210)	(0.00782)	(0.00114)	(0.00415)
Oldest child	-0.248***	-0.255**	0.0583	-0.117	-0.115	-0.193
	(0.0802)	(0.126)	(0.135)	(0.363)	(0.0822)	(0.189)
Girl	0.312***	0.547***	1.274***	1.762***	-0.506***	-0.470***
	(0.0648)	(0.0948)	(0.126)	(0.212)	(0.0685)	(0.123)
Child age	-0.243	--	0.393	--	-0.298	--
	(0.345)		(0.692)		(0.361)	
Child age sq'd	0.0141	--	-0.0128	--	0.0144	--
	(0.0196)		(0.0386)		(0.0206)	
Lone parent	0.464***	--	-0.192	--	0.339***	--
	(0.109)		(0.210)		(0.112)	
Log equivalent income (2006$)	-0.151**	--	0.186	--	-0.264***	--
	(0.0653)		(0.135)		(0.0630)	
Mother has less than high school	0.0357	--	-0.0708	--	-0.114	--
	(0.0997)		(0.214)		(0.102)	
Mother has uni/college degree	-0.0379	--	0.250	--	0.0119	--
	(0.114)		(0.245)		(0.0905)	
Number of siblings	-0.00726	--	-0.0770	--	0.114***	--
	(0.0353)		(0.0850)		(0.0410)	
Rural residence	0.161**	--	-0.149	--	0.173**	--
	(0.0726)		(0.162)		(0.0737)	
Observations	8557	3392	8557	3392	8557	3392
R^2	0.045	0.754	0.047	0.693	0.058	0.690

Source: NLSCY, Cycles 1-3. Standard errors clustered at the household level in parentheses. Bootstrapped standard errors for regression estimates with no FFE. All OLS regressions without FFE also control for province of residence and survey cycle. *** $p < 0.01$, ** $p < 0.05$, , * $p < 0.10$.

Table 2-6: OLS and OLS with FFE Piece-wise Regressions

Panel A: MSD Scores (ages 0 to 3), PPVT Scores (ages 4 to 6), and Math and Reading Scores (ages 7 to 13)

	MSD (1)	MSD (2)	PPVT (3)	PPVT (4)	Math (5)	Math (6)	Read (7)	Read (8)
Low birth weight	-1.389	2.817	0.0102	0.647	**-0.201****	-0.162	**-0.190***	-0.324
	(1.160)	(3.313)	(2.071)	(4.692)	**(0.087)**	(0.218)	**(0.098)**	(0.235)
LBW*(birth weight - 2.5kg)	**10.28*****	8.603	**7.040***	4.114	0.186	**0.246***	-0.0362	-0.145
	(1.727)	(6.156)	**(4.270)**	(3.987)	(0.132)	**(0.147)**	(0.201)	(0.486)
Not LBW*(birth weight - 2.5kg)	**1.709*****	**2.573****	**0.983***	**2.639***	-0.00181	-0.0494	0.0219	0.026
	(0.406)	**(1.148)**	**(0.548)**	**(1.483)**	(0.028)	(0.065)	(0.034)	(0.055)
Family fixed effects?	No	Yes	No	Yes	No	Yes	No	Yes
Number of children	18634	3708	10980	1244	6546	2712	6546	2712
F-stat of equal slopes	23.62	0.95	1.97	0.11	1.87	3.57	0.08	0.12
R^2	0.058	0.653	0.1	0.728	0.656	0.858	0.519	0.807

Panel B: Behavioral Outcomes for Younger Children (ages 2 to 6)

	Hyper (1)	Hyper (2)	Emo. Dis. (3)	Emo. Dis. (4)	Pro-social (5)	Pro-social (6)	Conduct (7)	Conduct (8)
Low birth weight	0.291	0.795	0.119	0.115	0.114	-0.159	-0.0644	0.303
	(0.239)	(0.741)	(0.142)	(0.272)	(0.147)	(0.275)	(0.126)	(0.318)
LBW*(birth weight - 2.5kg)	0.283	0.523	0.104	-0.314	0.316	**0.559***	-0.0249	0.296
	(0.323)	(0.632)	(0.238)	(0.394)	(0.259)	**(0.314)**	(0.225)	(0.326)
Not LBW*(birth weight - 2.5kg)	**-0.175****	-0.167	**-0.0807***	**-0.227**†	**0.152*****	-0.138	-0.00521	-0.0959
	(0.086)	(0.189)	**(0.043)**	**(0.138)**	**(0.054)**	(0.158)	(0.044)	(0.117)
Family fixed effects?	No	Yes	No	Yes	No	Yes	No	Yes
Number of children	17373	5448	17373	5448	17373	5448	17373	5448
F-stat of equal slopes	1.94	1.15	0.57	0.04	0.38	3.73	0.01	1.35
R^2	0.054	0.66	0.068	0.699	0.127	0.734	0.064	0.686

Continued…

Panel C: Behavioral Outcomes for Older Children (ages 7 to 11)

	Hyper (1)	Hyper (2)	Emo. Dis. (3)	Emo. Dis. (4)	Prop. Off. (5)	Prop. Off. (6)
Low birth weight	0.393	0.417	-0.0169	-0.464	0.0391	-0.267
	(0.429)	(0.853)	(0.292)	(0.755)	(0.126)	(0.204)
LBW*(birth weight - 2.5kg)	0.847	-1.11	-0.0186	-1.539	0.12	**-0.895****
	(0.897)	(1.782)	(0.662)	(1.319)	(0.200)	**(0.402)**
Not LBW*(birth weight - 2.5kg)	**-0.472*****	-0.164	**-0.300*****	-0.189	-0.0492	-0.0217
	(0.131)	(0.339)	**(0.094)**	(0.183)	(0.046)	(0.103)
Family fixed effects?	No	Yes	No	Yes	No	Yes
Number of children	8557	3392	8557	3392	8557	3392
F-stat of equal slopes	2.09	0.27	0.17	1.00	0.67	4.34
R^2	0.094	0.609	0.053	0.698	0.061	0.694

Panel D: Behavioral Outcomes for Older Children (ages 7 to 11) continued

	Indirect Agg. (7)	Indirect Agg. (8)	Pro-social (9)	Pro-social (10)	Conduct (11)	Conduct (12)
Low birth weight	**-0.289****	0.282	0.0306	0.131	-0.134	-0.0307
	(0.144)	(0.336)	(0.402)	(0.928)	(0.182)	(0.525)
LBW*(birth weight – 2.5kg)	-0.0797	-0.32	-0.133	**3.048****	0.116	-0.856
	(0.291)	(0.830)	(0.800)	**(1.511)**	(0.372)	(0.872)
Not LBW*(birth weight – 2.5kg)	**-0.125****	0.0244	-0.227	**-0.649**†	**-0.105***	0.147
	(0.061)	(0.130)	(0.147)	**(0.403)**	**(0.062)**	(0.158)
Family fixed effects?	No	Yes	No	Yes	No	Yes
Number of children	8557	3392	8557	3392	8557	3392
F-stat of equal slopes	0.03	0.17	0.01	5.58	0.35	1.28
R^2	0.046	0.754	0.048	0.698	0.058	0.691

Source: NLSCY, Cycles 1-3 (only Cycles 2-3 for math and reading). Standard errors clustered at the household level in parentheses. Bootstrapped standard errors for regression estimates with no FFE. All OLS regressions control for a quadratic for mother's age at birth, family structure, birth order, gender, mother's education, rural/urban residence, province of residence and survey cycle. All FFE regressions include a quadratic for mother's age at birth, birth order and gender. *** $p < 0.01$, ** $p < 0.05$, , * $p < 0.10$, † $p < 0.11$.

Table 2-7: OLS Estimates with Variables for Born Premature and Never Breastfed

	Full sample	Natal sample		
	(1)	(2)	(3)	(4)
Panel A: Cognitive Outcomes				
MSD				
Low birth weight	-1.389	-0.853	--	-0.0299
	(1.160)	(1.236)		(1.255)
LBW*(BW - 2.5kg)	**10.28*** **	**11.829*** **	--	**10.79*** **
	(1.727)	**(1.954)**		**(1.947)**
Not LBW*(BW - 2.5kg)	**1.709*** **	**1.936*** **	--	**1.562*** **
	(0.406)	**(0.503)**		**(0.512)**
Born premature (< 260 days)	--	--	**-5.747*** **	**-2.629*** **
			(0.702)	**(0.793)**
Never breast fed	--	--	**-0.907†**	-0.719
			(0.553)	(0.550)
Observations	18633	14135	14135	14135
R^2	0.058	0.056	0.046	0.058
PPVT				
Low birth weight	0.0102	**-6.700***	--	**-7.825***
	(2.071)	**(3.987)**		**(4.082)**
LBW*(BW - 2.5kg)	**7.040***	-5.081	--	-4.828
	(4.270)	(6.884)		(6.902)
Not LBW*(BW - 2.5kg)	**0.983***	-0.660	--	-0.396
	(0.548)	(1.265)		(1.281)
Born premature (< 260 days)	--	--	0.487	2.023
			(1.858)	(1.787)
Never breast fed	--	--	0.637	0.974
			(1.320)	(1.267)
Observations	10980	2261	2261	2261
R^2	0.10	0.084	0.08	0.086
Panel B: Behavioral Outcomes for Younger Children (ages 2 to 6)				
Hyperactivity/Inattention				
Low birth weight	0.291	-0.045	--	0.0115
	(0.239)	(0.360)		(0.357)
LBW*(BW - 2.5kg)	0.283	-0.300	--	-0.405
	(0.323)	(0.572)		(0.580)
Not LBW*(BW - 2.5kg)	**-0.175** **	**-0.294***	--	**-0.313*** **
	(0.086)	**(0.114)**		**(0.117)**
Born premature (< 260 days)	--	--	0.0345	-0.239
			(0.189)	(0.203)
Never breast fed	--	--	**0.249***	0.224
			(0.137)	(0.137)
Observations	17373	5925	5925	5925
R^2	0.054	0.047	0.045	0.048

	(1)	(2)	(3)	(4)
Emotional Disorder				
Low birth weight	0.119	0.132	--	0.15
	(0.142)	(0.179)		(0.183)
LBW*(BW - 2.5kg)	0.104	0.221	--	0.202
	(0.238)	(0.244)		(0.245)
Not LBW*(BW - 2.5kg)	**-0.0807***	**-0.103***	--	**-0.111***
	(0.043)	**0.057**		**(0.059)**
Born premature (< 260 days)	--	--	0.027	-0.055
			(0.084)	(0.099)
Never breast fed	--	--	0.011	0.000
			(0.070)	(0.070)
Observations	17373	5925	5925	5925
R^2	0.068	0.050	0.049	0.05

Pro-social Behavior				
Low birth weight	0.114	-0.216	--	-0.205
	(0.15)	(0.26)		(0.27)
LBW*(BW - 2.5kg)	0.316	-0.194	--	-0.156
	(0.26)	(0.53)		(0.54)
Not LBW*(BW - 2.5kg)	**0.152*****	**0.162***	--	**0.155***
	(0.05)	**(0.09)**		**(0.09)**
Born premature (< 260 days)	--	--	-0.0926	0.0436
			(0.16)	(0.20)
Never breast fed	--	--	**-0.257****	**-0.241****
			(0.10)	**(0.11)**
Observations	17373	5925	5925	5925
R^2	0.127	0.119	0.119	0.121

Opposition Disorder				
Low birth weight	-0.0644	-0.1514	--	-0.114
	(0.126)	(0.198)		(0.202)
LBW*(BW - 2.5kg)	-0.0249	-0.1505	--	-0.191
	(0.225)	(0.368)		(0.372)
Not LBW*(BW - 2.5kg)	-0.00521	-0.0104	--	-0.0247
	(0.044)	(0.067)		(0.067)
Born premature (< 260 days)	--	--	-0.100	-0.113
			(0.108)	(0.118)
Never breast fed	--	--	0.00841	0.00872
			(0.073)	(0.074)
Observations	17373	5925	5925	5925
R^2	0.064	0.081	0.081	0.081

Source: NLSCY, Cycles 1-3. Bootstrapped standard errors clustered at the household level in parentheses. All regressions include controls for mother's age at birth (and square), child age (and square), oldest child, gender, log equivalent income, mother's education, lone parent status, number of siblings, rural/urban residence, province of residence and survey cycle. *** significant at 1%, ** significant at 5%, , * significant at 10%, † significant at 11%.

Table 2-8: OLS Estimates with Variables on Prenatal Care

	Full sample		Natal sample	
	(1)	(2)	(3)	(4)
Panel A: Cognitive Outcomes				
MSD				
Low birth weight	-1.389	-0.853	--	-0.855
	(1.160)	(1.236)		(1.234)
LBW*(BW - 2.5kg)	**10.28*****	**11.829*****	--	**11.56*****
	(1.727)	**(1.954)**		**(1.955)**
Not LBW*(BW - 2.5kg)	**1.709*****	**1.936*****	--	**2.202*****
	(0.406)	**(0.503)**		**(0.501)**
Mom smoked during pregnancy	--	--	**1.705*****	**2.217*****
			(0.517)	**(0.504)**
Mom drank during pregnancy	--	--	0.615	0.351
			(0.755)	(0.753)
Observations	18633	14135	14135	14135
R^2	0.058	0.056	0.036	0.059
PPVT				
Low birth weight	0.0102	**-6.700***	--	**-6.663***
	(2.071)	**(3.987)**		**(3.969)**
LBW*(BW - 2.5kg)	**7.040***	-5.081	--	-5.351
	(4.270)	(6.884)		(6.894)
Not LBW*(BW - 2.5kg)	**0.983***	-0.660	--	-0.447
	(0.548)	(1.265)		(1.271)
Mom smoked during pregnancy	--	--	1.138	1.112
			(1.204)	(1.201)
Mom drank during pregnancy	--	--	1.926	1.982
			(1.569)	(1.562)
Observations	10980	2261	2261	2261
R^2	0.10	0.084	0.082	0.086
Panel B: Behavioral Outcomes for Younger Children (ages 2 to 6)				
Hyperactivity/Inattention				
Low birth weight	0.291	-0.045	--	-0.0412
	(0.239)	(0.360)		(0.358)
LBW*(BW - 2.5kg)	0.283	-0.300	--	-0.365
	(0.323)	(0.572)		(0.572)
Not LBW*(BW - 2.5kg)	**-0.175****	**-0.294***	--	**-0.250****
	(0.086)	**(0.114)**		**(0.114)**
Mom smoked during pregnancy	--	--	**0.409*****	**0.355****
			(0.151)	**(0.152)**
Mom drank during pregnancy	--	--	**0.474***	**0.495***
			(0.259)	**(0.259)**
Observations	17373	5925	5925	5925

R^2	0.054	0.047	0.049	0.051

	(1)	(2)	(3)	(4)
Emotional Disorder				
Low birth weight	0.119	0.132	--	0.124
	(0.142)	(0.179)		(0.180)
LBW*(BW - 2.5kg)	0.104	0.221		0.219
	(0.238)	(0.244)	--	(0.244)
Not LBW*(BW - 2.5kg)	**-0.0807***	**-0.103***		**-0.115***
	(0.043)	**0.057**	--	**(0.059)**
Mom smoked during pregnancy			-0.0383	-0.0662
	--	--	(0.069)	(0.072)
Mom drank during pregnancy			0.177	0.183
	--	--	(0.123)	(0.123)
Observations	17373	5925	5925	5925
R^2	0.068	0.050	0.049	0.051

Pro-social Behavior				
Low birth weight	0.114	-0.216		-0.198
	(0.15)	(0.26)	--	(0.255)
LBW*(BW - 2.5kg)	0.316	-0.194		-0.235
	(0.26)	(0.53)	--	(0.532)
Not LBW*(BW - 2.5kg)	**0.152*****	**0.162***	--	**0.217****
	(0.05)	**(0.09)**		**(0.089)**
Mom smoked during pregnancy			**0.342*****	**0.393*****
		--	**(0.099)**	**(0.100)**
Mom drank during pregnancy			-0.0376	-0.0519
		--	(0.151)	(0.151)
Observations	17373	5925	5925	5925
R^2	0.127	0.119	0.120	0.123

Opposition Disorder				
Low birth weight	-0.0644	-0.1514		-0.146
	(0.126)	(0.198)	--	(0.197)
LBW*(BW - 2.5kg)	-0.0249	-0.1505		-0.186
	(0.225)	(0.368)	--	(0.371)
Not LBW*(BW - 2.5kg)	-0.00521	-0.0104		0.0202
	(0.044)	(0.067)	--	(0.068)
Mom smoked during pregnancy			**0.229*****	**0.236*****
	--	--	**(0.087)**	**(0.089)**
Mom drank during pregnancy	--		0.183	0.182
		--	(0.122)	(0.122)
Observations	17373	5925	5925	5925
R^2	0.064	0.081	0.084	0.085

Source: NLSCY, Cycles 1-3. Standard errors in parentheses. Bootstrapped standard errors for OLS estimates. All regressions include controls for mother's age at birth (and square), child age (and square), oldest child, gender, log equivalent income, mother's education, lone parent status, number of siblings, rural/urban residence, province of residence and survey cycle. *** significant at 1%, ** significant at 5%, , * significant at 10%, † significant at 11%.

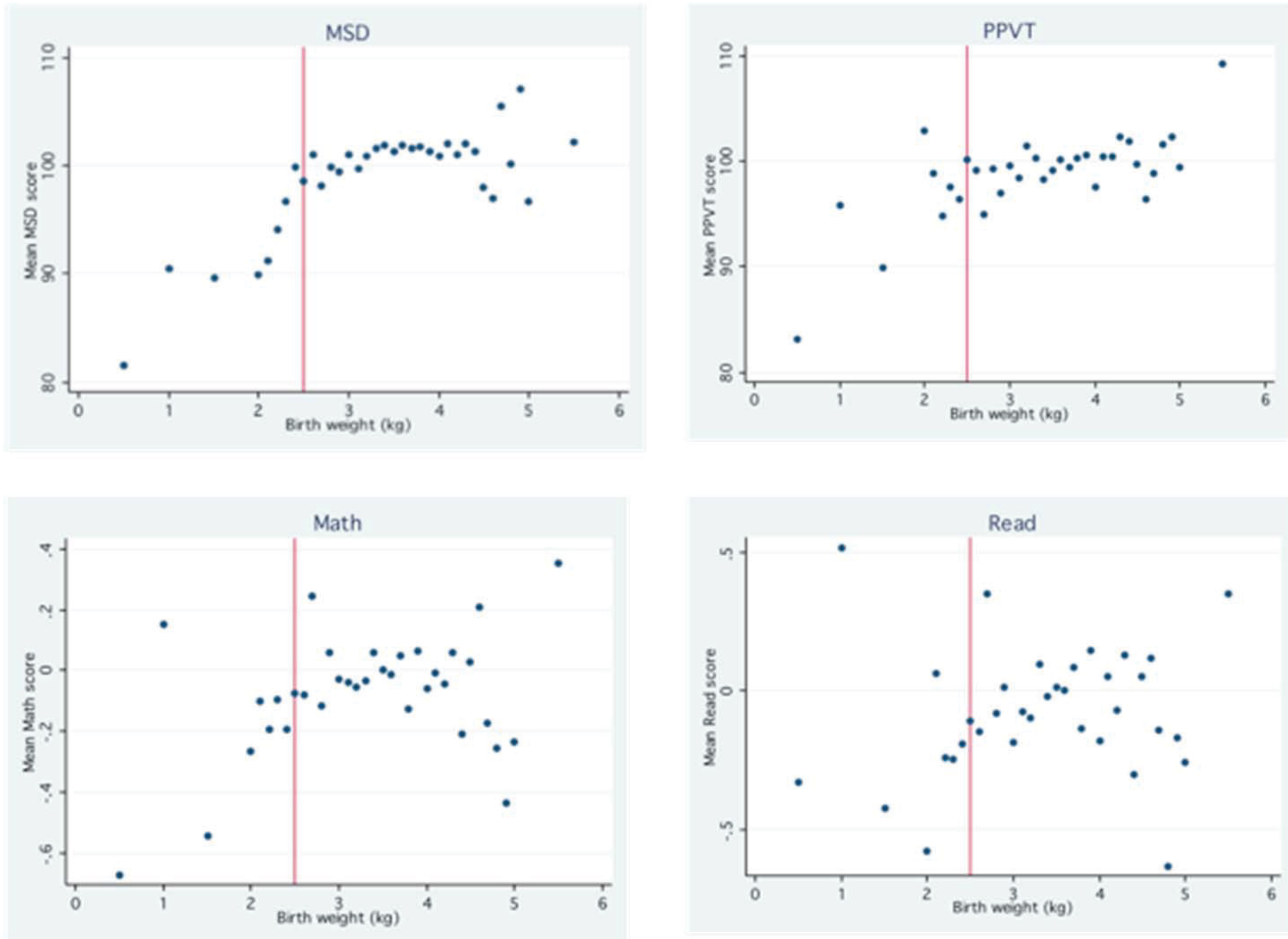

Figure 2-1: Cognitive outcomes by birth weight

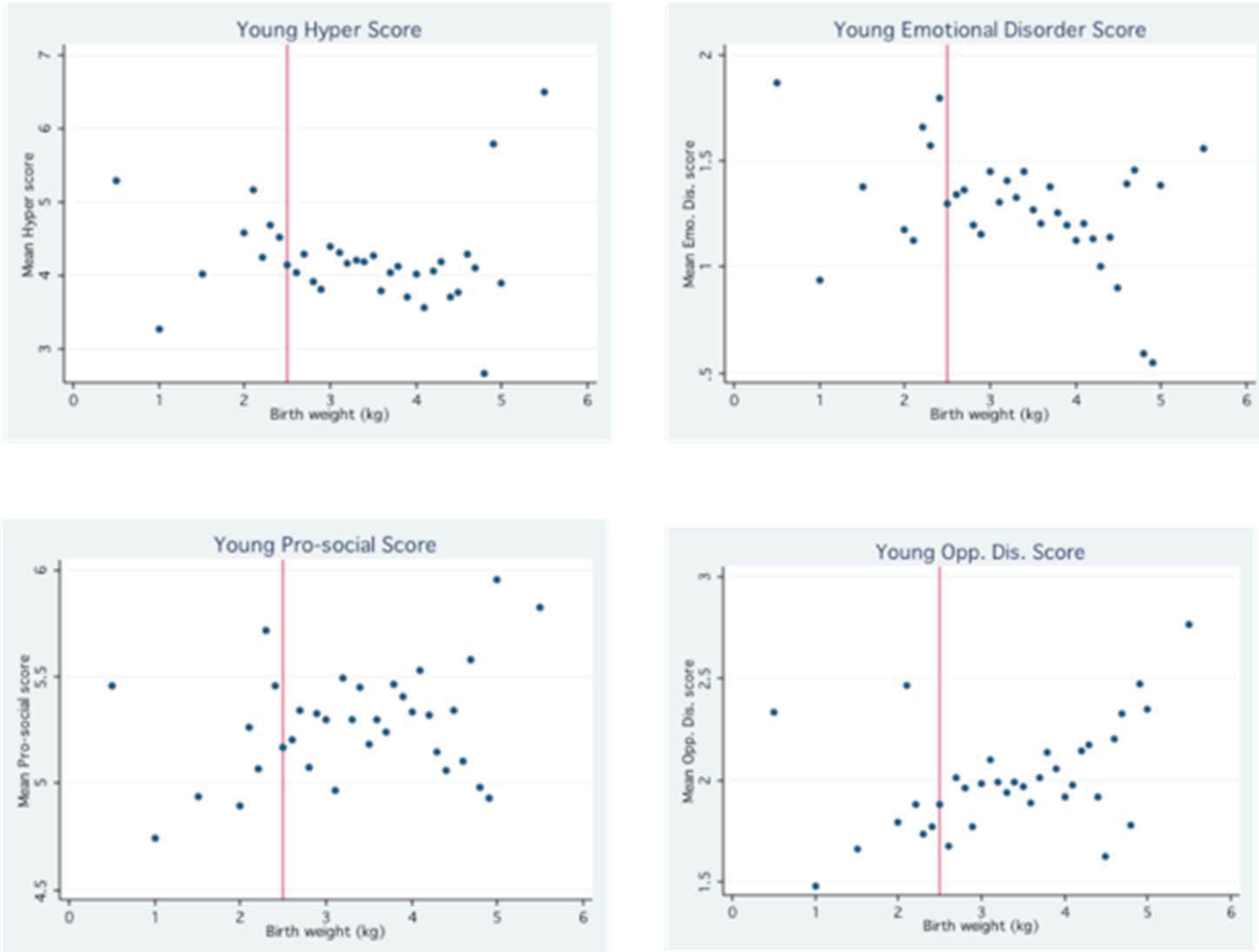

Figure 2-2: Behavioural outcomes for 2-6 year olds by birth weight

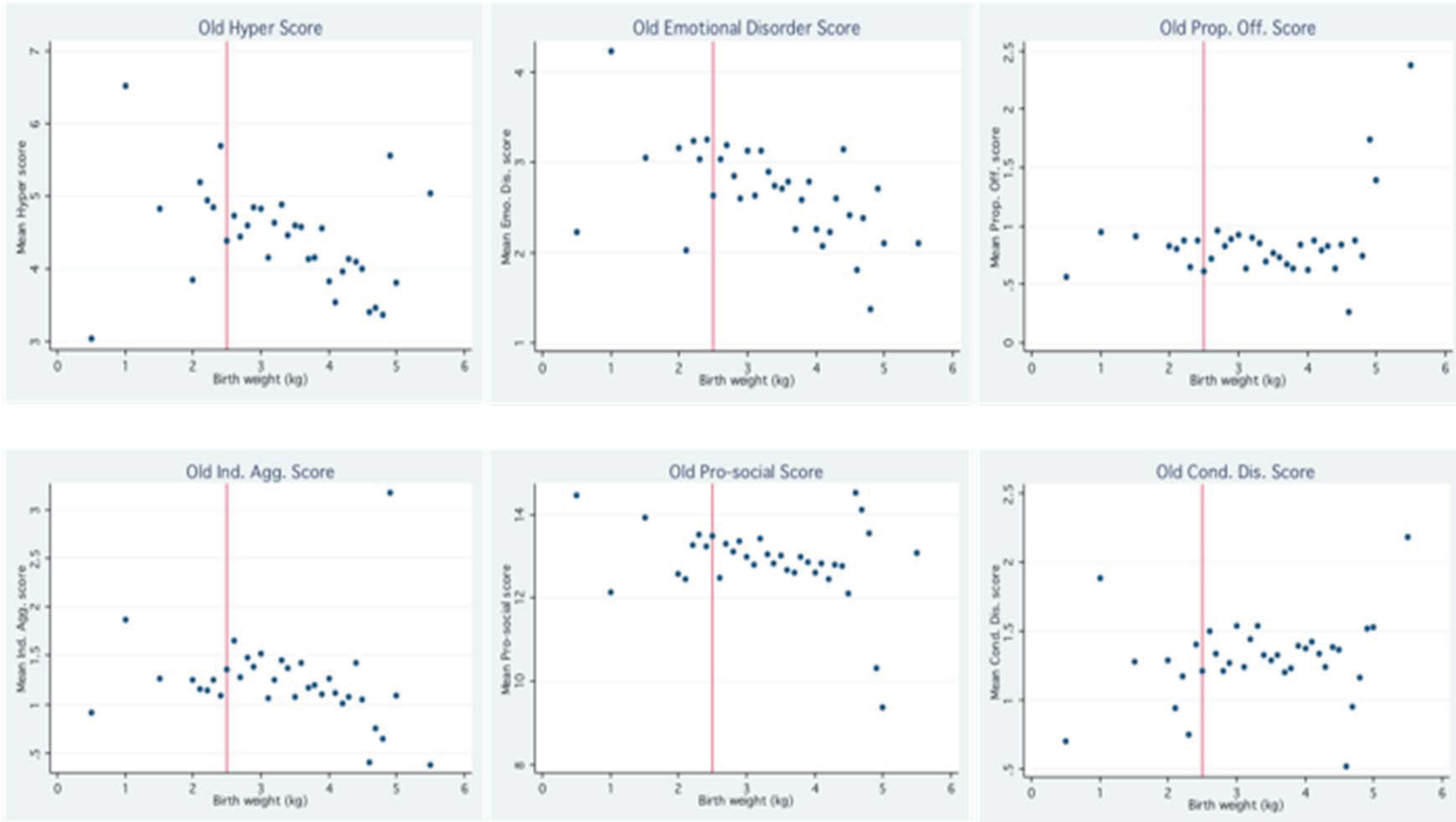

Figure 2-3: Behavioural outcomes 7 to 11 year olds by birth weight

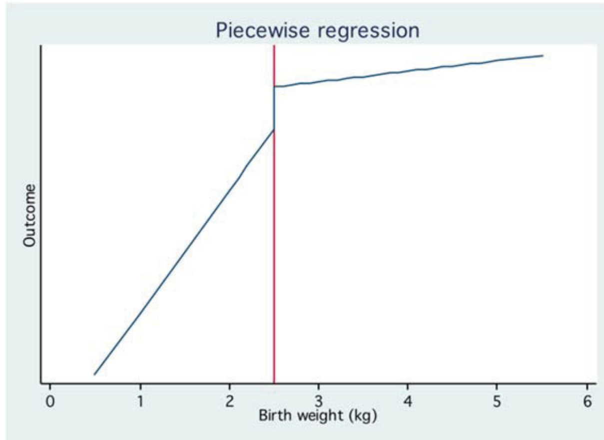

Figure 2-4: Example of Piecewise Regression with Knot at 2,500 gram

Appendix 2-1: Indices for Behavioral Outcomes (ages 2 to 6)

Outcome	Questions	Score range
Hyperactivity/inattention score	How often would you say that *"fname"*: • Can't sit still, is restless or hyperactive? • Is distracted, has trouble sticking to any activity? • Fidgets? • Can't concentrate/Can't pay attention? • Is impulsive, acts without thinking? • Cannot settle to anything for more than a few moments? • Is inattentive?	0-14, a higher score indicating the greater hyperactivity/ inattention
Emotional disorder/anxiety score	How often would you say that "*fname*": • Seems to be unhappy, sad or depressed? • Is not as happy as other children? • Is too fearful or anxious? • Is worried? • Is nervous, highstrung or tense? • Has trouble enjoying him/herself?	0-12, a higher score indicating a more behavior associated with emotional disorder
Pro-social behavior	How often would you say that *"fname"*: • Will try to help someone who has been hurt? • Offers to help other children (friend, brother, or sister) who are having difficulty with a task? • Comforts a child (friend, brother or sister) who is crying or upset? • Helps other children (friend, brother, or sister) who are feeling sick?	0-8, a higher score indicating more pro-social behavior
Physical aggression/opposition disorder score	How often would you say that *"fname"*: • Gets into many fights? • Kicks, bites, hits other children? • Has difficulty waiting for my turn in games or group activities? • When another child accidentally hurts him/her (such as by bumping into him/her), assumes that the other child meant to do it, and then reacts with anger and fighting?	0-8, higher scores indicating behaviors associated with conduct disorders and physical aggression

Appendix 2-2 Indices for Behavioral Outcomes (ages 7 to 11)

Outcome	Questions	Score range
Hyperactivity/inattention score	How often would you say that *"fname"*: • Can't sit still, is restless or hyperactive? • Is distracted, has trouble sticking to any activity? • Fidgets? • Can't concentrate/Can't pay attention? • Is impulsive, acts without thinking? • Has difficulty waiting for my turn in games or group activities? • Cannot settle to anything for more than a few moments? • Is inattentive?	0-16, a higher score indicating the greater hyperactivity/ inattention
Emotional disorder/anxiety score	How often would you say that "*fname*": • Seems to be unhappy, sad or depressed? • Is not as happy as other children? • Is too fearful or anxious? • Is worried? • Cries a lot? • Is miserable, unhappy, tearful, distressed? • Is nervous, highstrung or tense? • Has trouble enjoying him/herself?	0-16, a higher score indicating a more behavior associated with emotional disorder
Property offense score	How often would you say that *"fname"*: • Destroys his/her own things? • Steals at home? • Destroys things belonging to others? • Tells lies or cheats? • Vandalizes? • Steals outside the home?	0-12, a higher score indicating behaviors associated with property offences
Indirect aggression score	How often would you say that *"fname"*: • When mad at someone, tries get others to dislike him/her? • When mad at someone, becomes friends with another as revenge? • When mad at someone, says bad things behind his/her back? • When mad at someone, says to others: let's not be with him/her? • When mad at someone, tell that person's secrets to a third person?	0-10, a higher score indicating the greater presence of behaviors related to indirect aggression
Pro-social behavior	How often would you say that *"fname"*: • Shows sympathy to someone who has made a mistake? • Will try to help someone who has been hurt? • Volunteers to help clear up a mess someone else has made? • Offers to help other children (friend, brother, or sister) who are having difficulty with a task? • If there is a quarrel or dispute, will try to stop it? • Comforts a child • (friend, brother or sister) who is crying or upset? • Spontaneously helps pick up objects which someone else has dropped? • Will invite other children to join in a game?	0-20, a higher score indicating more pro-social behavior
Conduct disorder/physical aggression score	How often would you say that *"fname"*: • Gets into many fights? • Reacts with anger and fighting? • Physically attacks people? • Threatens people? • Is cruel, bullies or is mean to others? • Kicks, bites, hits other children?	0-12, higher scores indicating behaviors associated with conduct disorders and physical aggression

Appendix 2-3: Estimates with High Birth Weight Variables

Panel A: MSD Scores (ages 0 to 3), PPVT Scores (ages 4 to 6), and Math and Reading Scores (ages 7 to 13)

	MSD	MSD	PPVT	PPVT	Math	Math	Read	Read
Low birth weight	-1.064	2.862	0.141	0.584	**-0.195****	-0.154	**-0.184***	-0.324
	(1.168)	(3.333)	(2.079)	(4.719)	**(0.088)**	(0.219)	**(0.100)**	(0.236)
High birth weight	-1.964	-12.13	-10.9	18.5	0.292	0.802	0.245	0.867
	(9.597)	(19.590)	(10.110)	(18.350)	(0.326)	(0.718)	(0.514)	(0.973)
Birth weight for LBW	**10.28*****	8.588	**7.043***	4.069	0.186	**0.247***	-0.0362	-0.145
	(1.727)	(6.149)	**(4.270)**	(4.046)	(0.132)	**(0.147)**	(0.201)	(0.486)
Birth weight	**2.111*****	**2.630****	**1.150***	2.629	0.00507	-0.0312	0.0297	0.0314
	(0.436)	**(1.244)**	**(0.611)**	(1.739)	(0.031)	(0.073)	(0.038)	(0.061)
Birth weight for HBW	1.742	7.66	5.484	-5.048	-0.144	-0.42	-0.101	-0.351
	(4.115)	(8.899)	(4.302)	(7.247)	(0.138)	(0.317)	(0.228)	(0.424)
Family fixed effects?	No	Yes	No	Yes	No	Yes	No	Yes
Number of children	18634	3708	10980	1244	6546	2712	6546	2712
R^2	0.058	0.653	0.101	0.729	0.656	0.858	0.519	0.807

Panel B: Behavioral Outcomes for Younger Children (ages 2 to 6)

	Hyper	Hyper	Emo. Dis.	Emo. Dis.	Pro-social	Pro-social	Conduct	Conduct
Low birth weight	0.246	0.809	0.122	0.117	0.114	-0.112	-0.0597	0.303
	(0.241)	(0.742)	(0.144)	(0.275)	(0.149)	(0.275)	(0.128)	(0.320)
High birth weight	**-4.894***	1.328	-0.833	1.046	0.171	-1.709	**-2.641*****	-2.121
	(2.510)	(2.351)	(0.620)	(1.043)	(1.049)	(2.354)	**(0.847)**	(1.589)
Birth weight for LBW	0.284	0.517	0.104	-0.316	0.316	**0.545***	-0.0243	0.299
	(0.322)	(0.631)	(0.238)	(0.394)	(0.259)	**(0.319)**	(0.224)	(0.326)
Birth weight	**-0.228****	-0.139	-0.0764	-0.221	**0.152****	-0.0492	0.00193	-0.0975
	(0.091)	(0.203)	(0.050)	(0.155)	**(0.061)**	(0.170)	(0.050)	(0.128)
Birth weight for HBW	**2.052***	-0.804	0.272	-0.692	0.079	0.408	**1.125*****	0.826
	(1.138)	(1.066)	(0.276)	(0.441)	(0.446)	(1.027)	**(0.383)**	(0.702)
Family fixed effects?	No	Yes	No	Yes	No	Yes	No	Yes
Number of children	17373	5448	17373	5448	17373	5448	17373	5448
R^2	0.055	0.66	0.068	0.699	0.127	0.735	0.065	0.686

Panel C: Behavioral Outcomes for Older Children (ages 7 to 11)

	Hyper	Hyper	Emo. Dis.	Emo. Dis.	Prop. Off.	Prop. Off.
Low birth weight	0.403	0.364	-0.0142	-0.472	0.00244	-0.305
	(0.433)	(0.858)	(0.294)	(0.759)	(0.126)	(0.204)
High birth weight	-2.761	-2.097	-0.39	1.495	**-2.873****	**-2.925****
	(2.361)	(4.218)	(1.807)	(3.251)	**(1.351)**	**(1.151)**
Birth weight for LBW	0.847	-1.091	-0.0186	-1.534	0.121	**-0.884****
	(0.897)	(1.779)	(0.662)	(1.319)	(0.200)	**(0.399)**
Birth weight	**-0.457*****	-0.274	**-0.297*****	-0.208	**-0.0934****	-0.0991
	(0.147)	(0.382)	**(0.106)**	(0.197)	**(0.046)**	(0.103)
Birth weight for HBW	0.692	0.915	-0.138	-0.797	**1.280****	1.358***
	(1.059)	(1.858)	(0.795)	(1.345)	**(0.623)**	(0.526)
Family fixed effects?	No	Yes	No	Yes	No	Yes
Number of children	8557	3392	8557	3392	8557	3392
R^2	0.094	0.609	0.053	0.698	0.064	0.696

Panel D: Behavioral Outcomes for Older Children (ages 7 to 11) continued

	Indirect Agg.	Indirect Agg.	Pro-social	Pro-social	Conduct	Conduct
Low birth weight	**-0.282***	0.253	0.0133	0.147	-0.132	-0.0241
	(0.146)	(0.337)	(0.410)	(0.934)	(0.184)	(0.526)
High birth weight	-1.035	-0.81	3.515	4.891	-1.737	-2.564
	(1.012)	(1.779)	(3.383)	(6.644)	(1.571)	(1.961)
Birth weight for LBW	-0.0797	-0.309	-0.133	**3.050****	0.116	-0.863
	(0.291)	(0.830)	(0.800)	**(1.511)**	(0.372)	(0.872)
Birth weight	**-0.116***	-0.0349	-0.252	-0.623	-0.102	0.164
	(0.069)	(0.123)	(0.160)	(0.425)	(0.069)	(0.177)
Birth weight for HBW	0.304	0.468	-1.701	-2.787	0.64	1.218
	(0.474)	(0.915)	(1.493)	(3.184)	(0.720)	(0.791)
Family fixed effects?	No	Yes	No	Yes	No	Yes
Number of children	8557	3392	8557	3392	8557	3392
R^2	0.046	0.755	0.049	0.698	0.059	0.692

Source: NLSCY, Cycles 1-3 (only Cycles 2-3 for math and reading). Standard errors clustered at the household level in parentheses. Bootstrapped standard errors for regression estimates with no FFE. All OLS regressions control for a quadratic for mother's age at birth, family structure, birth order, gender, mother's education, rural/urban residence, province of residence and survey cycle. All FFE regressions include a quadratic for mother's age at birth, birth order and gender. *** $p < 0.01$, ** $p < 0.05$, , * $p < 0.10$, † $p < 0.11$.

Chapter 3

While the Cat's Away: Parental Work Schedules and Adolescents' Engagement in Risky Behaviours

3.1 Introduction

Parental investments of time and money are recognized as important determinants of child outcomes. While much of the empirical work on parental time investment and child outcomes has focused on the link with hours of work[16], the type of parental work schedules also matter but has received much less attention. In particular, little work has examined the relationship between parental work schedules and adolescents' involvement in risky behaviours.

The objective of this paper is to estimate the influence of standard and non-standard[17] parental work schedules on adolescents' engagement in stealing, fighting, drinking and illicit drugs using a representative sample of Canadian boys and girls aged 10 to 15 years old from dual-earner families in the National Survey of Children and Youth (NLSCY). Non-standard work schedules include: i) evening or night shifts, ii) rotating shifts, iii) irregular or split shifts, and iv) weekend shifts. Not only are risky behaviours during adolescence correlated with poorer school outcomes, early and risky sexual activity and other delinquent behaviours during youth (Fagan and Pabon 1990, Mensch and Kandel 1988, Maguin and Loeber 1996, Grossman and Markowitz 2002, Rashad and Kaestner 2004, Hirschfield and Gasper 2011) but they are also associated with poorer labour market outcomes, crime and substance abuse later in life (Moffitt 1993, Krohn *et al.* 1997, Healey *et al.* 2004, Merline *et al.* 2008). While participation in risky behaviours is undesirable at any age, the involvement of children aged 10 to 15 is particularly

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[16] Such as the relationship between parental work hours and: 1) child overweight and obesity (Anderson *et al.* 2003, Phipps *et al.* 2006, Ruhm 2008, Chia 2008), 2) cognitive development (Blau and Grossberg 1992, Han *et al.* 2001, Waldfogel *et al.* 2002, Ruhm 2004 and Ruhm 2008) and 3) risky behaviour (Aughinbaugh and Gittleman 2004).

[17] I use the terms non-standard work schedules, non-standard hours and shift work interchangeably.

unwelcomed. Evidence of underlying relationships will provide insight to direct future policies to reduce their engagement.

The framework for this analysis is based on the model of the family described in the seminal paper by Becker and Tomes (1986). Under this model, the family is viewed as a production unit with the objective of maximizing the well-being of family members. Parents derive utility from their children's well-being, and child outcomes are a function of two main types of inputs. Firstly, at birth, children inherit, through genetic endowment, ability from their natural parents. Second, parents decide the level of economic resources of the family through labour supply decisions, as well as how these resources will be used. Two important resources include income and time. Income can be used to purchase goods and services, while time can be used in the production of goods or services. Parents influence their children's attainments by directing resources towards improving their skills, health, and other attributes, and depend on several factors including parental preferences, income, and fertility. In earlier work on the theory of the family, Leibowitz (1974) also suggests that children's outcomes not only depend on the *quantity* of time and goods inputs but also the *quality* of these inputs.

One channel through which work schedules may influence children's engagement in risky behaviour is through parental time investment or, more generally, supervised care.[18] As children age, they are more likely to spend time unsupervised by an adult, often referred to as self-care, either on their own or with peers (Waldfogel 2007). While there is no evidence regarding the relationship between parental work schedules and self-care, Waldfogel (2007) finds that children of mothers that work enter self-care a year earlier than mothers who don't work. Other research shows that adolescents (aged 10 to 14) with adult supervision are less likely to skip school, use alcohol or marijuana, steal something or hurt someone (Aizer 2004).

[18] While there is a large literature on the difference between maternal versus non-maternal care, it often relates to care for pre-school aged children rather than those school-aged. However, Belsky *et al.* (2007) find that children who spent more time in centre-based care in early childhood had poorer outcomes in terms of externalizing problems/aggression at age 12.

At first glance, it may appear that non-standard work schedules would be negatively related to the adult supervision or quantity of parent's time input. For example, in addition to not being able to monitor children after school, a parent who works an evening shift may not be able to participate in important after-school activities such as helping with homework, eating dinner with the family[19] or driving the child to after-school activities. However, when the combination of mother and father work schedules is considered, the relationship becomes less clear. While evidence suggests that fathers, on average, contribute less to household duties (Marshall 1993) and childcare (Bianchi 2000) than mothers, Presser (1994) finds that in dual-earner families when mothers work full-time or their availability is limited due to their work schedule, fathers are more likely to participate in care-giving. Bianchi (2000) and Gauthier (2004) also provide evidence to suggest that father's involvement in childcare has increased over time. Bianchi (2000) suggests that father's increased time investment acts to offset any reduction in maternal care; failure to account for father's work schedules would ignore this offset. Furthermore, previous research suggests that fathers' time investment is associated with fewer behavioural problems (at school and at home) among children (Amato and Rivera 1999). Households with at least one parent who works a nonstandard schedule may be more able to coordinate so that the quantity of parental time devoted to the child is greater than when both parents work standard day shifts. This type of approach may ensure that one parent is always home when the child arrives home from school. Not accounting for the combination of mother-father schedules would mask part of the true relationship between work schedules and outcomes. Due to the possible offsetting relationships that may arise from shift work, the overall effect of parent's combined schedules is an empirical issue.

While parental work schedules will influence the quantity of parental time investment, in many cases it will affect the quality as well. Shields (2002) and Williams (2008) point to number of studies that find a positive association between the physical and mental health issues and shift work. This suggests that one of the plausible pathways from parental shift work to children's engagement in risky behaviours may be through poorer quality of time

[19] Eisenberg *et al.* (2004) find that the frequency of eating dinner as a family is negatively associated with substance use and unfavorable emotional-behavioural outcomes among adolescents.

inputs driven by parents' poorer health and increased stress. For example, parental shift work could mean more interrupted sleep, the lack of a routine, more time stress or extra effort to coordinate schedules, which may mean that parents are more easily irritated, have less patience or are physically less able to play or participate in activities with children.[20]

In order to accurately estimate and better understand the relationship between parents' shift work and adolescents' risky behaviour, I take several factors into account. Firstly, there may be self-selection issues, or in other words, factors that are correlated with both work schedules and risky behaviours that are driving the results. For example, Presser (2003) finds that mothers differ by work schedule in terms of race, income and education; such factors may also be related to child behavioural outcomes. To reduce the amount of possible bias, I control for a large number of potentially confounding variables. Although I considered child (and family) fixed effects to help further reduce bias, there is not enough variation in parents' work schedules over time to use either of these approaches.

Second, several studies show important gender differences in the prevalence (Rodham *et al.* 2005, Moffitt *et al.* 2001) and predictors (Hoeve *et al.* 2011, Moffitt *et al.* 2001) of risky behaviour, suggesting that results from analyses that combine both genders may conceal associations that are present for one gender and not the other.[21] Evidence from Datta Gupta and Simonsen (2010) suggests that young boys (aged 3), but not young girls, with mothers with low levels of education have poorer non-cognitive outcomes when placed in non-relative home day cares than in parental care. Due to such differences across genders, all analyses are conducted separately for boys and girls.

[20] However, the negative effect of these factors may be weaker if the shift work is voluntary and chosen for child-care or work-life balance reasons, since this presumably improves the overall quality or quantity of parental time inputs. Han (2008) points out that whether shift work is voluntary or involuntary often varies by occupation. This is an area for future research.

[21] The childhood development literature provides evidence that the determinants of other child outcomes also vary by child gender. For example, several studies find that the negative association between maternal employment and cognitive development is stronger for boys than girls (Desai *et al.* 1989, Brooks-Gunn *et al.* 2002, Ruhm 2008) while other research suggests either no difference by gender (Han *et al.* 2001) or a stronger effect for girls (Waldfogel *et al.* 2002).

Third, previous evidence suggests that context may influence the association between parental work schedules and child outcomes (Han 2008, Han *et al.* 2010). In the case of risky behaviours, for example, shift work among low-income families could have positive effects if it means higher household income than otherwise, or it may have negative effects if shift work involves greater stress for these families. In a similar sense, shift work may have little effect when parents work low to full-time hours but may have negative effects with high work hours. I investigate these two contexts separately by interacting variables for low-income and high work hours with the work schedule variables.

Finally, other studies have suggested that the influence of parental employment (either in terms of high hours of paid work or nonstandard shifts) on cognitive ability (Han 2005), overweight status (Phipps *et al.* 2006) and engagement in risky behaviours (Han *et al.* 2010) are compounded over time. In this context, such an effect would suggest that children whose parents work shift work for many years are more likely to engage in risky behaviour than those whose parents worked shift work in the contemporaneous period. Such a relationship may exist if these children increasingly feel a lack of closeness with parents, increasingly spend time with other youths engaging in risky behaviour or develop poor behaviours that accumulate over time. Given the longitudinal nature of the NLSCY and the large number of children with past information on parent work schedules, I can test this hypothesis.

The relationship between parental non-standard work schedules and child outcomes has only recently received attention. Among the work looking specifically at adolescents' risky behaviour, there are two studies, Han and Waldfogel (2007) and Han *et al.* (2010), both of which use the U.S. National Longitudinal Survey of Youth (NLSY). This paper adds to this literature in three ways. First, it is the only study to examine the association between parental work schedules and adolescents' risky behaviour using a nationally representative sample of Canadian children. As Canada offers more generous programs related to work-life balance and child development than the U.S., the relationship between work schedules and child outcomes may be different in the two countries. Canadian mothers and fathers appear to have more labour market flexibility due to more availability of part-time employment as well as longer paid leave and the legislative right to return to their jobs after a child's birth (Corak, Curtis and Phipps 2010). Research by Zhang (2009) suggests that American mothers' earlier return to work after childbirth explains why American teenagers are, on average, three times more likely to engage in fights than their Canadian counterparts. In addition, unlike the U.S. NLSY that has been used in previous studies, NLSCY data are fully representative of the child population under examination.[22] This paper also differs from other literature in this area in that, despite gender differences in the prevalence and predictors of risky behaviour, earlier research has not examined the relationship separately by sex, presumably because of small sample sizes. This is the first analysis to examine the relationship for boys and girls separately. Also, this paper is unique in that it estimates the relationship for combined mother-father work schedules, which, relative to separate indicators of maternal or paternal work schedules, better represent the resources available for total parental time investment, and as such provides better insight into the true relationship between work schedules and risky behaviours.

This paper is organized as follows: Section 3.2 provides a review of the relevant literature. Section 3.3 describes the data and the variables included in the model, and provides some descriptive statistics. Section 3.4 specifies the econometric model used for the analysis. Section 3.5 applies the model from 3.4 to extend the descriptive evidence from Section 3.3, giving probit results in terms of marginal effects for boys and girls separately. Section 3.6 provides several extensions to the regression model in Section 3.5. In Section 3.7, I conclude.

3.2 Literature Review

While much of the earlier literature on the relationship between parental employment on

[22] The sample of children in the NLSY is not random, rather they are the children of a random sample of women aged 14 to 21 in 1979, which results in samples that include a larger share of younger mothers than the full cross-section of children. Chase-Lansdale *et al.* (1991) find that these younger mothers have lower education and are more likely from minority groups than would be representative of the general population.

child outcomes focuses on hours of work[23], over the last few years, there has been an emerging body of research examining the influence of parental work schedules on children's behavioural outcomes (see summary in Table 3.1).[24]

Two empirical studies that have already examined the relationship between parental shift work and adolescent's engagement in risky behaviours are Han and Waldfogel (2007) and Han *et al.* (2010). Both studies use a sample of U.S. children from the U.S. NSLY. Han *et al.* (2010), however, is written more for a psychology audience, using techniques and terminology specific to that discipline. Han and Waldfogel (2007), using a sample of 10-14 year olds and disaggregated non-standard schedules for mothers and fathers separately, investigate how work schedules are related to family processes such as parental monitoring and parent-child closeness, as well as adolescent's engagement in risky behaviours related to substance abuse (with cigarettes, alcohol, marijuana and other drugs) and delinquent behaviour (disobedient behavior, criminal behavior, school-related trouble). They find that parental non-standard work schedules are associated with improved parental monitoring but poorer parent-child closeness. The results also show that the relationships between shift work and adolescents' engagement in risky behaviours are positive but are not statistically significant. They suggest that the findings on monitoring and closeness cancel out each other, and explain why non-standard work hours are not related to a higher incidence of risky behaviour among adolescents.

Han *et al.* (2010) extend the work of Han and Waldfogel (2007) to examine potential mediators of the same relationships. They find that years of maternal night shifts are negatively related to parent-child relations and lead to adolescents' increased engagement in risky behaviours. Consistent with Han and Waldfogel (2007), they also find that years of other types of shift work are associated with improved parental monitoring. Result from subgroup analyses show that these results were stronger among boys, children from

[23] For example, work on the relationship between parental work hours and: 1) child overweight and obesity (Anderson *et al.* 2003, Phipps *et al.* 2006, Ruhm 2008, Chia 2008), 2) cognitive development (Blau and Grossberg 1992, Han *et al.* 2001, Waldfogel *et al.* 2002, Ruhm 2004 and Ruhm 2008) and 3) risky behaviour (Aughinbaugh and Gittleman 2004).

[24] Other studies have looked at the impact of parents' work schedules on cognitive (Han 2005) and health outcomes (Miller and Han 2008).

low-income households and children whose mothers never worked as professionals.

Several other studies have looked at the relationship between parental work schedules and behavioural outcomes amoung younger children. Han (2008), using the NLSY and child fixed effects, finds that an increase in the number of years worked in non-day work schedules is associated with more behavioural problems (as measured by an index based on 6 dimensions: antisocial behavior, anxiousness/depression, headstrongness, hyperactivity, immaturity, and dependency) in children aged 4 to 10. The strongest associations were for children whose mothers worked non-standard shifts *and* worked more than 35 hours, worked in cashier or service occupations, had low family income, or were single. Two other studies, and the only studies in the work schedule literature using the NLSCY, Strazdins *et al.* (2004) and a follow-up paper examining mediators, Strazdins *et al.* (2006), find a strong, negative relationship between maternal (but not paternal) nonstandard work hours and a score of socio-emotional well-being (based on measures of: hyperactivity-inattention, indirect aggression, physical aggression-conduct disorder, property offence, emotional disorder-anxiety, and separation anxiety) for children aged 2 to 11.

Although not directly related to risky behaviour or other behavioural outcomes, within the parental work schedule and child development literature, there are also studies that have looked at cognitive and health outcomes. Han (2005) finds that non-standard maternal work schedules are negatively associated with cognitive development at young ages (15, 24 and 36 months) and Miller and Han (2008) find that many years of maternal shift work is associated with higher BMIs and a higher probability of being overweight among youths. The link with being overweight is particularly pronounced for families in the 2nd quartile (a group that is above but near the poverty line, and is not eligible for many public assistance programs).

The previous research regarding the relationship between shift work and risky behaviours is inconclusive (results of Han and Waldfogel (2007) lack statistical significance, whereas those of Han *et al.* (2010) don't). However, across other child outcomes, including behavioural outcomes for young children, the literature generally shows negative associations between parents' engagement in non-standard work hours and child well-being. These earlier studies also provide evidence that context matters. In particular, the negative relationship with outcomes is sometimes stronger for children from households with lower income or higher parental work hours. Some results also suggest that parental monitoring and parent-child closeness may mediate the channel from work schedules to outcomes.

3.3 Data, Variables and Descriptive Analysis

3.3.1 Data

This analysis uses data from cycles 2-7 of the master files and cycles 4-7 of the child self-reported files of the National Longitudinal Survey of Children and Youth (NLSCY). The NLSCY is a nationally representative sample of Canadian children, which in its first cycle in 1994-95 included 22,831 children aged 0 to 11.[25] Biennially since then, the NLSCY has conducted a follow-up survey with this sample. The NLSCY was designed to collect detailed information related to children's cognitive, emotional, physical and behavioural development over time. While the unit of analysis for the NLSCY is the child, the person-most-knowledgeable (PMK) of the child provides the information for each child for many of the variables. The PMK also provides personal and family information (including information on the spouse when present). In addition to information provided by the PMK, this analysis uses the self-report files for responses to questions on risky behaviours that are collected for children aged 10 to 17. Given the personal nature of some of the questions in the youth questionnaire, to increase the likelihood of honest and accurate answers from the children, the child completes the questionnaire in private, away from both parents and interviewers, and returns it in a sealed envelope directly to the interviewer during the visit (Statistics Canada 2001). While the questions regarding the

[25] The target population for the NLSCY is the non-institutionalized civilian population in Canada's 10 provinces. Therefore, the survey excludes children living on Indian reserves, residents of institutions, full-time members of the Canadian Armed Forces, and residents of the territories.

risky behaviour are only consistently asked across cycles 4 to 7, I use earlier cycles of the main files to create variables related to parent's work and income histories.

The sample for this analysis includes only the children who have valid responses to any of the outcomes and all the independent variables. Since all children in the data come from the original longitudinal sample, some children may appear in the sample more than once.[26] The sample also only includes children from married-couple households (either legal or common-law union) with dual-earners and with a PMK who is the biological mother. I chose to exclude children of lone-parent households since there would presumably be large differences between two-parent and lone-parents household in terms of parental time and resources available to children as well as potentially many other factors. Using dual-earner households allows for analysis of both mothers' and fathers' combined work schedules. It also avoids possible convoluting relationships (e.g. health, situational factors) that may arise when a parent, and particularly a father, does not work. I also limit the analysis to children whose PMK is their biological mother, which represents roughly 90% of the sample, to avoid special issues that may arise when the PMK is a father, step-parent or foster-parent.

Since I take advantage of the longitudinal nature of the data in the analysis using work schedule, work hour and income histories, I use longitudinal weights for all analyses.[27] I also use bootstrap weights, supplied by Statistics Canada, to take into account the complex survey design of the NSLCY. Also, as individuals may appear more than once and as there are siblings in the sample, the standard errors are clustered at the household level to account for possible correlations. Estimation is carried out using the software package Stata.

3.3.2 Outcome Variables

[26] While there are repeated observations for many children and siblings in this sample to allow for fixed effects analyses, there is not enough variation in parents' work schedules over time to identify relationships.
[27] The longitudinal weights correspond to the children aged 0 to 11 who entered the survey in 1994-95, and therefore the results should be interpreted as such.

The outcome variables are based on self-reported responses in the NLSCY child self-report files to questions on stealing, fighting, drinking alcohol, and illicit drug use. The coverage for stealing and fighting is children aged 10 to 15, whereas the responses on drinking and drugs use are for children aged 12 to 15. An indicator variable for stealing is coded as 1 if the child reports "sometimes" or "often" to stealing in or outside the home (10.5% of all boys, 8.5% of all girls). An indicator variable for fighting is coded as 1 if the child reports "sometimes" or "often" to the statement, "I get into many fights" (26.7% of boys, 18.9% of girls). The indicator variable for drinking alcohol is coded as 1 if the child describes his/her experience drinking alcohol as "about once or twice per month" or more (12.7% of boys, 13.9% of girls). The indicator variable for drugs is coded as 1 if the child answered having done illicit drugs in the past 12 months (17.5% of boys, 16.3% of girls).[28]

3.3.3 Independent Variables[29]

The main independent variables are four indicator variables related to the combination of standard and non-standard work schedules that are mainly worked by mothers and fathers in the 12 months prior to the interview. Standard work schedules are day shifts that are worked during the week (Monday to Friday). Non-standard work schedules include: 1) evening or night shifts, 2) rotating shifts, 3) irregular or split shifts, and 4) weekend shifts. The four indicator variables are: 1) both mother and father work standard shifts, 2) mother works standard shifts and father works non-standard shifts, 3) mother works non-standard shifts and father works standard shifts and 4) both mother and father work non-standard shifts. The PMK provides the information on her spouse's work schedule, which is used to create parents' combined work schedule variables.[30]

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[28] Illicit drugs include any of the following: 1) marijuana and cannabis products, 2) hallucinogens like LSD/acid, magic mushrooms, 3) glue or solvents, 4) drugs without a prescription or advice from a doctor: downers, uppers, tranquilizers, Ritalin, etc., or 5) crack, cocaine, heroin, speed or ecstasy, etc.

[29] All control variables are from the same period as the outcome unless otherwise stated.

[30] I also conducted analyses using variables that disaggregated non-standard work schedules for mothers and fathers separately (i.e. separately identifying those who work evening/night, rotating, irregular/split shifts and weekend shifts), however, these results are not shown nor described. These analyses involved small cell sizes for the cross tabs between the dependent variables and the work schedule variables, and this is an issue for two main reasons. First of all, it is often difficult to estimate precise relationships based on a small number of observations. Second, due to confidentiality reasons, Statistics Canada will not release results

To avoid the influence of correlates of work schedules confounding the results, I control for an extensive set of variables related to the parents, the child and the household. Mothers' hours of paid work vary by work schedule (Presser 2003), with shift-workers working part-time more often than those working standard shifts. However, while both Aughinbaugh and Gittleman (2004) and Ruhm (2008) find that maternal hours of work are correlated with risky behaviour, the associations lack statistical precision. Nonetheless, I control for mothers' and fathers' paid work hours (using their usual number of hours worked per week during the 12 months prior to the interview) to avoid possible bias in the results. As household income has been associated with several cognitive and behavioural outcomes among children (Dooley and Stewart 2004, Phipps and Lethbridge 2006, Zhang 2011), I include the natural logarithm of real household equivalent before-tax income[31] (in 2002 dollars) in all regressions.

Evidence suggests that birth order is directly related to risky behaviour among adolescents. Argys *et al.* (2006) find that adolescents who are later-born (higher ordered) are more likely to engage in risky behaviour (including substance use, sexual intercourse, stealing, destroying property and carrying a gun) than their first-born counterparts. Argys *et al.* (2006) suggests that the relationship may arise due to younger siblings' exposure to older siblings' risky behaviours that they then mimic or that younger siblings receive less parental supervision. Earlier research (Steelman *et al.* 2002) finds a positive relationship between family size and risky behaviours. Having more siblings may also encourage risky behaviour as it increases exposure to risky behaviour and increases opportunities for behaviours such as fighting. Both birth order and number of children in the household may also influence parents' employment decision, including whether to work standard or non-standard hours. To control for birth order, I use a dummy variable for being the first-born in the family; I also include a variable for the number of siblings for each child. As the outcome variables and mother's work schedules may both depend on child age, I

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based on cross tabs with small cell sizes.

[31] Equivalent income is a per capita income measure that is adjusted to take into account that individuals living in households benefit from economies of scale. Here, equivalent income is equal to real household income divided by the square root of the family size.

control for age in years using indicator variables. Research also shows that ethnicity has been associated with risky behaviour (Blum *et al.* 2000) therefore I include a dummy variable to indicate children who are non-white[32]. Since a child's activity limitation may influence their parents' work schedules as well as their involvement in risky behaviours, I include a dummy variable for the presence of a limitation. MacPhee (2013) finds a statistically significant relationship between being born with low birth weight (birth weight less than 5.5 pounds/2.5 kg) and higher scores of emotional disorders among young children age 2 and 6, and that low birth weight is correlated with scores of emotional disorder among 7 to 11 year olds (though the relationship is statistically significant). As symptoms of emotional disorder may be correlated with engagement in risky behaviours, I include a dummy variable to identify those children born with low birth weight.

Maternal age at child's birth has been associated with child behaviours (Levine *et al.*, 2001), and I control for this relationship using a variable for mother's age at birth. Evidence suggests that higher maternal education is related to better cognitive outcomes (Behrman and Rosenzweig 2002). If this association is driven by higher quality maternal investment then it seems likely that maternal education would also be related to children's engagement in risky behaviours. I control for maternal education using a dummy variable for mothers with less than a high school diploma and a dummy variable for mothers having a post-secondary degree or diploma. I also include a dummy variable to indicate if the child's mother is an immigrant.

Living in a rural area is hypothesized to decrease access to resources and therefore negatively influence developmental outcomes. However, in the case of risky behaviours, the effect of rural residence is not as clear. It may be that rural residences may reduce children's exposure to risky behaviour and access to resources that encourage risky activities. It is also possible that children living in more rural areas have less access to organized extra-curricular activities, providing more idle time to engage in mischievous

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[32] While it would be preferable to disaggregate non-white into different ethnicities, the incidence of some ethnicities for each outcome becomes too low, and results for such variables would be suppressed by Statistics Canada to protect respondents' confidentiality.

behaviour. Parents in rural areas may also face different labour market conditions that influence their employment opportunities and involvement in shift work. A dummy for rural residence is used to take such effects into account. I also include regional fixed effects[33] to control for cultural or regional differences in family policies that affect households' disposable incomes and accessibility to services such as childcare and after school programs. These dummy variables will also capture possible differences in preferences toward investment in children that may result in differences in curriculum and resources devoted to education that could ultimately affect the likelihood of engaging in risky behaviours. Regional fixed effects will also roughly account for differences across regions in prevalence of non-standard work schedules. Finally, cycle dummies are included to control for effects that are common to each cycle.

3.3.4 Descriptive Analysis

To provide a first glance at possible relationships between parental work schedules and adolescents' engagement in risky behaviour, Figure 3-1 presents means for the four outcomes by the four parental work schedule categories for boys and girls separately. There are two key points. Firstly, there is considerable variation in outcomes by parents' work schedules, and in most cases, the means for children with both parents working standard day shifts are the lowest or very near the lowest for all outcomes. Second, the only outcome with large differences in means between boys and girls is fighting. For each of the parental work schedules, boys appear, on average, more likely to report fighting than girls. This may be because boys tend to express their negative emotions outwardly and more aggressively (e.g. through fighting, vandalizing) while girls are more likely to internalize their feelings (e.g. have low self esteem, feel lonely, become depressed).

To provide more detail, I examine each outcome for boys and girls separately. For stealing, Figure 3-1 shows that there is little variation across work schedules for boys, with the means ranging from 9.8 to 11.2 percent. For girls, there is slightly more variation.

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[33] That is, I include regional dummies for the Atlantic region, Quebec, the Prairies and British Columbia – Ontario is the base.

Girls with mother's working non-standard schedules are more likely (10.1-10.8 percent) to steal than other girls (6.9-7.7 percent). Based on the overlapping standard error bars for all work schedules for boys and only a small gap for girls, the differences are likely not statistically significant for either. However, since Aizer (2004) finds a statistically significant relationship between stealing and adult supervision, I continue to include stealing as one of the outcomes in the following analysis.

From among all the outcomes, the means for fighting show the most variation by work schedule. Also, it appears that a higher incidence of fighting is related to the parent of the child's own gender working non-standard shift work. That is, for boys, those with a father working shift work appear to be more likely (28.2-30.7 percent) to fight than those with a father working standard day shifts (23.4-25.7 percent). However, the error bars suggest that the difference may only be statistically significant from boys with fathers working standard hours and mothers working standard shifts. For girls, 20.1 to 24.1 percent of those with a mother working a non-standard schedule report being in fights compared to 16.4-17.5 percent of girls with a mother working a standard schedule. The mean for girls with both parents working non-standard hours appears to be statistically significantly different from those with both parents working day shifts.

In terms of drinking, boys with one parent working a non-standard schedule (but not both) appear to be more likely (15.7-15.9 percent) to report drinking once or more per month than their counterparts with both parents working standard schedules (9.9 percent). While girls with both parents working standard hours have the lowest rate of drinking (11.2 percent versus 14.6-15.8 percent), the variation within work schedule group suggests that they are not significantly different.

For drugs, boys with mothers working non-standard hours (and fathers working standard hours) are more likely to have tried drugs in the year before the survey (21.9 percent) than those with both parents working standard hours (15.6 percent). The overlapping standard error bars for the means for girls suggests no difference by work schedule in the likelihood of girls doing drugs.

Figures 3-2 and 3-3 show the incidence of each outcome for boys and girls by income and hours of parental work. In particular, Figure 3-2 presents the frequency of outcome when both parents usually work more than 40 hours per week. Figure 3-3 provides frequencies for children from families with equivalent household income in the bottom quartile of the income distribution versus those in the top three-quarters. Figure 3-2 shows that, for all outcomes (except stealing for boys), adolescents with both parents working high hours are more likely to report participation in the risky behaviours than their peers. However, the differences in proportions for the two groups are small, and in all cases their standard error bars overlap or are very close to overlapping suggesting no statistical difference. In Figure 3-3, the relationship between low income and incidence in risky behaviours varies by outcome, and in some case (stealing and doing drugs among boys, and stealing, drinking and doing drugs for girls) there seems to be no statistical difference among those in the bottom quartile and those in the top 3 quartiles. The figure suggests that boys, and potentially girls, in families with low household income are more likely to fight. Interestingly, boys from higher-income households appear to be more likely to report drinking 1-2 times per month in the 12 months prior to the survey. Higher family income may increase the likelihood that adolescent boys can afford alcohol.

These figures provide some evidence of associations between risky behaviours among 10 to 15 year olds and parental work schedules, high hours of work and low income; however, variables correlated with these factors may be driving the results. A more robust investigation of the relationships requires regression analyses including those that examine whether the associations between work schedules and risky behaviour vary by work hours or income.

Tables 3-2 and 3-3 present the means or frequencies of all the variables included in the analysis for all boys and all girls respectively. With the exception of age, most of the variables are similar across the four outcomes for both boys and girls. Note that the frequency of having both parents working standard hours is 35 to 36 percent depending on the outcome. Roughly 24 percent of boys and 22 percent of girls have both parents working non-standard schedules. Having a father working shifts (but not mother) is reported for 24 percent of boys and 28 per cent of girls. The least common work schedule combination is the mother working nonstandard hours and the father working standard hours, which is reported for only 16 percent of boys and 15 percent of girls.

3.4 Model Specification

While some of the means in Figure 3-1 are suggestive of relationships between parents' shift work and adolescents' risky behaviours, there may be characteristics that are correlated with the work schedules and risky behaviours that are driving the results. To control for possible confounding factors and provide a more robust analysis, I use probit regression models to estimate the relationship. More specifically, for boys and girls separately, I regress the outcome variables for each of the risky behaviours on mothers' and fathers' combined contemporaneous work schedules, paid work hours and household income as well as an extensive set of covariates. Each of the outcome variables, Y_i, takes either a value 0 or 1 for individual *i*, and can be expressed in a probability distribution conditional on X_i as:

$$Pr(Y_i = 1|X_i) = F(\beta X_i + u_i) \quad (1)$$

where *F* is the standard normal cumulative distribution function (Wooldridge 2002). Taking the inverse of the cumulative normal distribution function produces the probit model:

$$Y^*_i = F^{-1}(X_i\beta + u_i) = \beta(X_i) + u_i \quad (2)$$

where Y^* is the latent variable of Y_i such that higher values of Y^* suggest that an individual is more likely to engage in a risky behaviour. Here, $X = (D_i, H_i)$, where D_i represents the vector of the main independent variables of interest, that is, dummy variables indicating the type of combined mother-father work schedules (both working standard work schedules is the base). *H* is a vector of covariates that represents characteristics of the child, the parents and the household in the year of the outcome. The child characteristics include dummy variables for child age in years, whether the child was the first-born, number of siblings, whether the child was born with low birth weight (less than 5.5 pounds or 2.5 kg), whether the child has a physical limitation and whether the child is non-white. Parental characteristics include mother and father hours of paid work, whether a step-father is present, maternal age at birth, whether the mother is an immigrant, whether the mother has less than a high school diploma and whether the mother has a post-secondary diploma or degree (mother with a high school diploma is the base). Household characteristics include logged real household equivalent before-tax income, whether the household resides in a rural area and region of residence (Ontario is the base). Dummy variables to control for cycle are also included.

3.5 Regression Results

Table 3-4 presents the estimation results for the probability of engaging in the four outcomes for boys. Rather than report the probit coefficient estimates, which are not directly meaningful, I present and discuss the estimated marginal effects (at the sample means), which provide the impact on the outcome variable from a one-unit increase in each explanatory variable. Overall in Table 3-4, the results suggest that, with the exception of stealing, parents' non-standard work schedules are positively associated with the probability of involvement in risky behaviour for boys. Compared to boys with both parents working standard hours, boys with just fathers working shifts (and mothers working standard shifts) are 5.6 percentage points more likely to fight. The probability that a boy reports drinking at least 1-2 times per month is 4.0 or 7.3 percentage points higher if either a father or a mother, respectively, works non-standard hours. Boys with mothers that work non-standard schedules are 6.9 percentage points more likely to have done drugs in the past year. These results point to one of the main findings of this study -- father's play an important role in caring for adolescents. Interestingly, for none of the outcomes does having both parents working non-standard shifts seem to be associated with boys' risky behaviour. This relationship may arise if non-standard hours allow parents more coordination between their schedules so that they can still monitor and remain close with their sons.

Among the remaining explanatory variables, there are no variables (except child age) that are statistically significantly for more than two outcomes. I first examine the results for some of the traditional labour market variables of interest. Interestingly, there is no statistically significant relationship between either mother or father's work hours and any of the outcomes. However, this is consistent with work by Aughinbaugh and Gittleman (2004) who find that adolescents' involvement in risky behaviours is not related to maternal hours of employment. The marginal effects for income and having a mother with a post-secondary degree or diploma are only statistically significant for boys' engagement in fighting. The results suggest that boys' probability of getting into many fights either 'sometimes' or 'often' decreases with increases in equivalent household income and if the boy's mother has completed post-secondary education.

The probability of stealing, drinking and doing drugs increases with child age while the probability of fighting decreases as boys get older. Boys that have a stepfather present are statistically significantly more likely to steal and to have done drugs. Mother's age at child's birth and being the oldest are both negatively related to the probability of adolescent boys doing drugs. Being a boy born with low birth weight increases the probability of fighting. Boys that report having an activity limitation are significantly less likely to report drinking. Both boys who are non-white or who have an immigrant mother report better outcomes in terms of drinking and doing drugs. Finally, there are several geographical differences among the outcomes. First of all, boys from rural areas are more likely to drink more than once a month. Also, compared to boys from Ontario, boys from the Atlantic region are less likely to report drinking. Boys from Quebec are less likely to report fighting but more likely to report doing drugs than their Ontarian counterparts.

The results for girls are presented in Table 3-5. While most of the estimates for the non-standard work schedule marginal effects are positive in sign for the four outcomes, all of them but one lacks statistical precision. Parents' non-standard work schedules are only significantly related to girls' involvement in fighting. More specifically, the marginal effects suggest that, girls with both parents engaged in shift work are 4.1 percentage points more likely to report fighting than girls with both parents working standard hours.

In general, the estimates suggest that, relative to boys, girls' engagement in risky behaviours seems to be less related to parents work schedules. As the results for girls are much more muted than boys, previous studies on adolescent's involvement in risky behaviors that combined both genders may have missed important relationships for boys.

For the remaining estimates for girls in Table 3-5, I first discuss those related to hours of work, income and education. Parental work hours only matter in that higher maternal hours are related to an increase in the probability of doing drugs. Similar to boys, higher income and having a mother with completed post-secondary education is negatively related to fighting for girls. Girls with mothers with a post-secondary education are 4.7 percentage points less likely to have done drugs in the 12 months prior to the survey.

Among the other estimates for girls in Table 3-5, similar to the case for boys, age is positively associated with reports of drinking and doing drugs but negatively related to fighting. Also, like boys, girls with a stepfather present are more likely to steal and do drugs. Maternal age at child's birth is related to a lower probability of stealing. For girls, having more siblings is positively related to the probability of getting into fights but is negatively associated with drinking. Girls who are the oldest child in the household are less likely to drink and do drugs. Being born with low birth weight is associated with lower probabilities of fighting and doing drugs. Unexpectedly, girls with an activity limitation are statistically more likely to report fighting. Compared to white girls, other girls are less likely to report drinking and doing drugs. When compared to their Ontarian peers, girls from the Atlantic region are less likely to fight and drink. Similar to the case with boys, girls from Quebec are less likely to steal and fight, but are more likely to report doing drugs than girls from Ontario. Girls from the Prairies are more likely to get into fights.

Note that due to possible endogeneity from omitted variables or reverse causality, all of the results provided are evidence of associations rather than causation. That is, despite the inclusion of wide range of control variables, there may still be other unobservable factors that I cannot take into account that might bias the results. For example, if mothers' nonstandard work schedules are positively correlated with omitted factors that also negatively (positively) affect child outcomes then the estimates on the shift work variables will overstate (understate) the true negative relationship. One approach to further control for confounding facts would be to use child or family fixed effects. However, while there are repeated observations for many children and siblings in this sample to allow for fixed effects analyses, there is not enough variation in parents' work schedules over time to identify relationships.

Endogeneity due to a feedback from risky behaviours to parents', and particularly mothers', work schedules is also a concern. For example, a mother who usually works evening and night shifts notices that her son is often getting into trouble, and she decides to switch to employment with standard work hours so that she can be home during evenings and weekends to better monitor and supervise her son. Such a relationship may lead to an underestimation of the effect of non-standard work hours. If it is the case that mothers and/or fathers change from standard work hours to non-standard shift work to better care for a problem child, then the effect may be overestimated.

3.6 Extensions

3.6.1 Associations By Context

Previous research provides evidence that the relationship between maternal work hours and child outcomes is not necessarily linear, and either becomes negative or more negative with a greater intensity of work (Ruhm 2004, Ruhm 2008). It seems reasonable that the impact of certain work schedules may also depend the number of work hours. For example, night shifts may not be detrimental on their own, but night shifts combined with high work hours may have a negative effect if it means further reductions in parents' energy, and ability to monitor or spend time with their children. To examine this relationship, I create a dummy variable that identifies families in which both parents usually work more than 40 paid hours per week and I interact this variable with the three work schedule dummy variables. The base case is boys and girls with both parents usually working 40 hours or less per week. The results related to stealing, fighting and doing drugs among boys in Panel A of Table 3-6 do not suggest that high parental hours change the relationship between work schedules and these outcomes. One exception is for boys' involvement in drinking. Relative to the base case, having both parents working more than 40 hours per week and a father working non-standard hours actually reduces boys' probability of drinking. The increased probability of drinking related to father's shift work alone (7.6 percentage points) is partially offset if both parents work more than 40 hours a week (5.4 percentage points), leaving such boys no more or less likely to drink than those whose parents work standard shifts and 40 hours or less per week. Among the results for girls in Panel B, there is only one statistically significant relationship among the interacted variables. Girls with mothers working non-standard hours, fathers working standard hours and both working high hours are 10.9 percentage points more likely to report fighting than girls with both parents working standard hours and 40 hours or less per week.

In terms of income, shift work among low-income families could have positive effects if it means the presence of additional household income. However, shift work combined with low household income may also have negative effects if it is more difficult to handle the stress that typically comes with such schedules. In this analysis, low-income households are those that fall within the bottom quartile of the income distribution of the full sample (that is, before any observations are excluded for non-response) in each year. This variable is interacted with each of the three work schedule dummy variables. Table 3-7 Panel A shows that boys from households with low income are more likely to report fighting. Unexpectedly, however, the two interactions that are statistically significant are negative rather than positive. As a boy, having a father working non-standard shifts and low income is related to an 8.5-percentage point decrease in the probability of fighting. This partially offsets the positive relationships between fighting and father's nonstandard work and low income. Boys with both parents working shift work and low income are 8.6 percentage points less likely to do drugs. This more than offsets the estimated increased probability of doing drugs when both parents work shifts (but do not have low income). The results for girls in Table 3-7 Panel B also unexpectedly show that the three interactions that are statistically significant are negative rather than positive. Girls from households with low income and either her mother or father (but not both) working shifts are less likely to have drank 2-3 times per month than girls in the base case whose parents work standard hours and have income in the top three-fourths of the income distribution. Girls from households with a shifting-working mother and low income are 8.5-percentage points less likely to use drugs in the 12 months prior to the survey than girls in the base case.

The negative marginal effects for the variables with non-standard work schedules interacted with income and hours are not expected.[34] In several cases, the negative association either partially offsets the relationship estimated on the non-standard work variables with no interaction or implies a lower probability than adolescences in the base case. These results may arise if parents working long hours try to compensate through increased monitoring and supervision. Also, these findings can be explained if mothers and fathers are more likely to coordinate when they have non-standard schedules and low-income.

3.6.2 Work and Income Histories

Other studies have suggested that cumulative parental time investments (Phipps *et al.* 2006, Han *et al.* 2010) may matter more for child outcomes than contemporaneous investments. Such a relationship in this analysis would suggest that adolescents whose parents work shift work for many years are more likely to engage in risky behaviours than those with parents working shifts only in the current period or not at all. This may arise if parents feel increasingly drained from working such schedules or if children increasingly feel a lack of closeness with parents, increasingly spending time with other adolescents engaging in risky behaviour or develop poor behaviours that increase over time.

[34] Han (2008) finds interactions of non-day shifts with high hours and low incomes to be positively associated with more behavioural problems.

Since the children in the self-reported files are part of the main longitudinal sample of the NLSCY, I have three observations for each child.[35] With data from the current and two previous cycles, I create measures of permanent maternal and paternal employment and permanent income. More specifically, the work schedule histories include the number of years worked in each of the different work schedules. The histories on both usual weekly work hours and household income are averaged over the three cycles. I use these work and income histories to replace the contemporaneous variables in the initial regressions in Tables 3-4 and 3-5. Only children with valid responses to the variables on both parents' work schedules, both parents' work hours and household income for three consecutive cycles are included in the analysis.

Panels A and B of Table 3-8 present the results for boys and girls respectively. The results in Panel A show that, for boys, compared to the work schedule estimates that are statistically significant in Table 3-4, their historical equivalents are smaller in magnitude and two are no longer statistically significant. This suggests that, in general, parents' contemporaneous work schedules are more important to boy's outcomes than the cumulative effect of non-standard work schedules. Conversely, Panel B shows that the cumulative effect seems stronger for girls. Two shift-work schedules that were not statistically significant contemporaneously in Table 3-5 are significant and positive when expressed cumulatively. A one-year increase in the number of years a girl's mother works non-standard hours is associated with being 2.2 percentage points more likely to engage in fights. Similarly, for every one-year increase in the number of years a girl's father or a girl's mother (but not both) works non-standard hours, the more likely she is to report doing drugs.

3.7 Conclusion

Using the Canadian National Longitudinal Survey of Children and Youth (NLSCY) and regression analyses, I investigate the relationship between parental work schedules and

[35] I have four cycles available but chose to use three cycles since four cycles prior, most of the children would have been pre-school aged. I want to exclude this information because the income and employment situations of mothers when children are young may be different than school-aged children. Nonetheless, I estimated the same regressions but with four-year histories and the results were essentially the same.

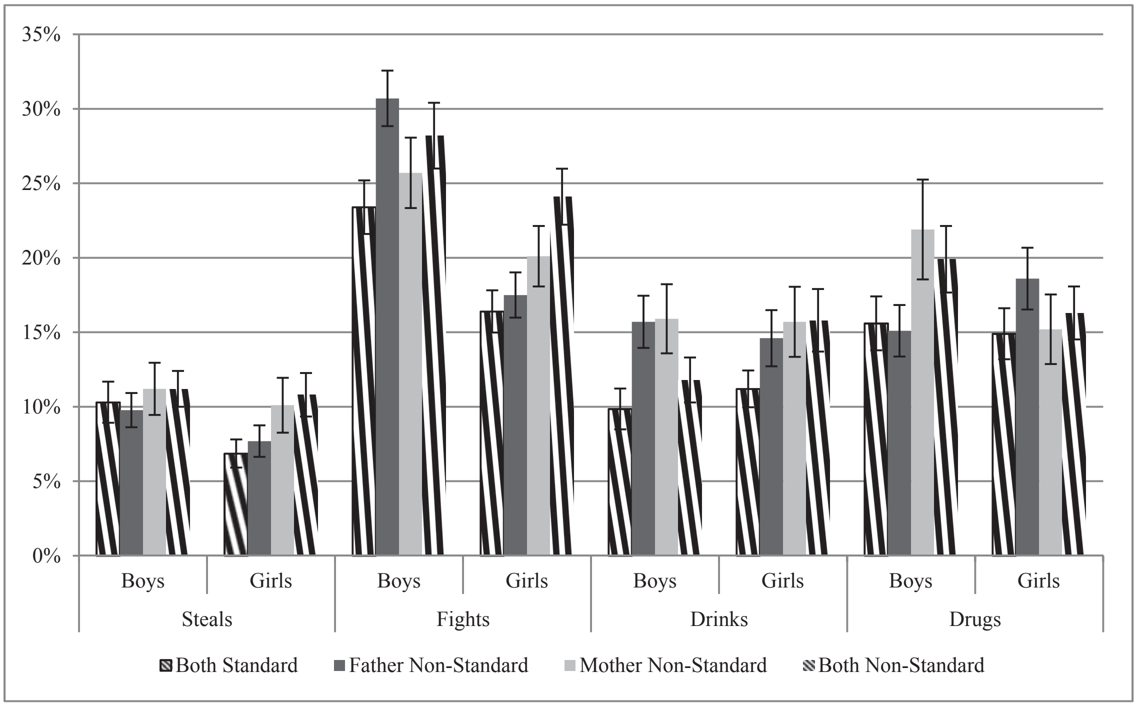
engagement in risky behaviours for young adolescents aged 10 to 15. While participation in risky behaviours is undesirable at any age, the involvement of young adolescents is particularly unwelcomed and uncovering the determinants of their involvement is important for future prevention. I find that parental work schedules play an important role in adolescents' involvement in risky behaviour, especially for boys. Non-standard parental work schedules are positively related to fighting, drinking and doing drugs among boys and fighting among girls. In particular, boys with shift-working fathers but mothers working standard shifts are 5.6 percentage points more likely to get into fights than boys with both parents working standard day shifts. Having a mother or a father (but not both) working non-standard hours is related to a 7.3 or 4.0 percentage point increase, respectively, in the probability a boy will drink 1-2 times per month or more. The probability of trying drugs in the 12 months prior to the survey increases by 6.9 percentage points if a boy's mother, but not his father, usually works a non-standard schedule. Girls with both parents working non-standard shifts are more likely to fight than other girls. These findings also provide evidence that fathers' work schedules matter, suggesting that fathers play an important role in parenting adolescents through monitoring and cultivating parent-child relationships.

When I examine the outcomes by context, the results unexpectedly suggest that non-standard schedules coupled with low-income or high work hours are related to a decrease in probability of engaging in certain risky behaviours. These results may arise if parents working long hours try to compensate by through increased monitoring and supervision. Also, these findings can be explained if mothers and fathers are be more likely to coordinate when they have non-standard schedules and low-income. Results from estimating the cumulative effects of work schedules on outcomes are weaker than the contemporaneous variables for boys but stronger for girls.

Given recent evidence on negative associations between shift work and individuals' physical and mental health (e.g., Shields 2002, Williams 2008), one of the pathways from parents' shift work to adolescents' risky behaviours may be through parents' poorer health and subsequent decreased ability to monitor children's activities and foster positive relationships. However, the size of this effect may depend on whether shift work is voluntary or involuntary. If shift work is chosen voluntarily and for child-care or work-life balance reasons, the satisfaction derived from better care may offset other negative factors. As the degree to which shift work is voluntary varies by occupation (Han 2008), future research examining the link between work schedule and adolescents' risky behaviour by occupation could provide valuable insights.

The estimated link between parental work schedules and adolescent's engagement in risky activities suggests that policies directed at supporting shift-working parents may be effective in improving adolescents' development. Examples of such policies include more high-quality after-school and weekend programs, and increased flexibility in arranging work schedules for shift workers.

Figure 3-1: Engagement in risky behaviours by parental work schedules

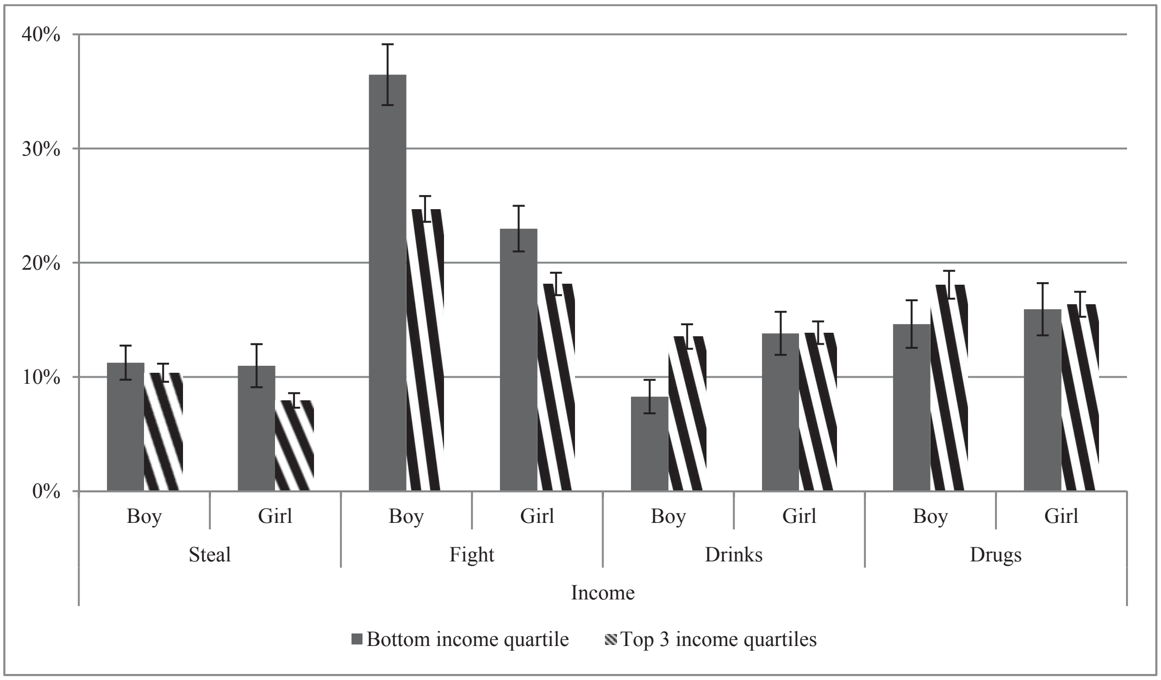


Error bars: ±1 SE

Figure 3-2: Engagement in risky behaviours by parents' hours of work

Error bars: ±1 SE

Figure 3-3: Engagement in risky behaviours by household income



Error bars: ±1 SE

Table 3-1: Summary of Relevant Literature

Authors	Outcome variables	Data Source (Country) and Empirical Strategy	Ages	Main Results
Han and Waldfogel (2007)	Risky behaviours: 1) ever smoked a cigarette, 2) ever drunk alcohol, 3) ever used marijuana, 4) ever used other drugs, 5) disobedient behavior, 6) criminal behavior, 7) school-related trouble	NLSY-CS (U.S.), OLS and logistic regressions	10 to 14	Parental shift work is associated with improved parental monitoring but poorer parent-child closeness. No statistically significant link to adolescents' risky behaviours.
Han, Miller and Waldfogel (2010)	Risky behaviours: 1) ever smoked a cigarette, 2) ever drunk alcohol, 3) ever used marijuana, 4) ever used other drugs, 5) number of delinquent behaviours, 6) ever had sexual intercourse	NLSY-CS (U.S.), OLS and logistic regressions	13 to 14	Maternal night shifts are negatively related to parent-child relations and positively related to risky behaviours. Years in other types of shift work are associated with improved parental monitoring
Han (2008)	Behavioral Problems Index based on 6 dimensions of behavior: antisocial behavior, anxiousness/ depression, headstrongness, hyperactivity, immaturity, and dependency	NLSY-CS (U.S.), OLS and OLS with child fixed effects regressions	4 to 10	Maternal non-day work schedules are associated with more behavioural problems and the associations were strongest for children: who lived in lone mother or low-income families, whose mothers worked in cashier or service occupations, and whose mothers worked non-day shifts full-time.
Strazdins et al. (2004)	Socio-emotional well-being: Measure of any difficulty based on scores related to: hyperactivity-inattention, indirect aggression, physical aggression-conduct disorder, property offence, emotional disorder-anxiety and separation anxiety.	NLSCY (Canada), logistic regressions	2 to 11	Negative relationship between maternal (but not paternal) nonstandard work hours and several measures of socio-emotional well-being.
Strazdins et al. (2006)	Socio-emotional well-being: Child difficulties measure based on scores related to: hyperactivity-inattention, indirect aggression, physical aggression-conduct disorder, property offence, emotional disorder-anxiety and separation anxiety.	NLSCY (Canada), OLS and hierarchical regressions	2 to 11	Parents that work nonstandard schedules report worse family functioning, more depressive symptoms, and less effective parenting. Negative relationship between maternal (but not paternal) nonstandard work hours and several measures of socio-emotional well-being.
Aizer (2004)	Risky behaviours: 1) skipping school, 2) alcohol use, 3) marijuana use, 4) stealing, 5) hurting others	NLSY-CS (U.S.), OLS and OLS with family fixed effects regressions	10 to 14	Adolescents with adult supervision are less likely to skip school, use alcohol or marijuana, steal something or hurt someone.

Table 3-2: Means or Frequencies for Boys

	Steals	Fights	Drinks	Drugs
Steals in or outside the home sometimes or often	10.5%	-	-	-
Gets in many fights sometimes or often	-	26.7%	-	-
Drinks 1-2 times/month or more	-	-	12.7%	-
Has done illicit drugs (e.g. marijuana, etc.) in the past 12 months	-	-	-	17.5%
Both parents work standard shifts	34.7%	34.8%	35.7%	35.8%
Both parents work non-standard shifts	23.6%	23.6%	23.6%	23.3%
Mom works standard, Dad works non-standard	24.8%	25.0%	23.8%	24.0%
Mom works non-standard, Dad works standard	16.7%	16.5%	16.7%	16.7%
Mother's hours of paid work	35.2	35.3	35.6	35.6
Father's hours of paid work	47.9	47.8	47.8	47.8
Log equivalent household income (2002$)	10.54	10.54	10.56	10.56
Stepfather present	11.9%	12.1%	11.9%	12.0%
Mother's age at birth	28.4	28.37	28.33	28.33
Age in years	12.7	12.7	13.5	13.5
Number of siblings	1.4	1.4	1.4	1.4
Oldest child in household	47.8%	48.0%	48.4%	48.2%
Child born with low birth weight (<2.5kg)	4.6%	4.6%	4.4%	4.4%
Child has an activity limitation	9.0%	9.0%	8.5%	8.7%
Child is non-white	7.8%	7.6%	7.9%	7.9%
Mother is an immigrant	15.3%	15.1%	15.5%	15.3%
Mother has less than high school diploma	8.9%	9.0%	9.7%	9.7%
Mother has high school but not post-sec degree	41.3%	41.2%	40.1%	40.3%
Mother has post-sec degree	49.8%	49.8%	50.2%	50.0%
Rural residence	14.0%	14.0%	14.1%	14.1%
Atlantic	7.4%	7.4%	7.2%	7.3%
Quebec	23.3%	23.3%	23.7%	23.7%
Ontario	39.0%	39.1%	39.2%	39.0%
Prairies	19.0%	19.0%	18.6%	18.8%
BC	11.4%	11.2%	11.3%	11.4%
Cycle 4	26.7%	26.5%	24.3%	24.3%
Cycle 5	26.1%	25.8%	24.1%	24.0%
Cycle 6	29.1%	29.3%	26.7%	26.8%
Cycle 7	18.1%	18.3%	24.9%	24.9%
Observations	5,606	5,520	3,799	3,819

Source: NLSCY, Cycles 4-7

Table 3-3: Means or Frequencies for Girls

	Steals	Fights	Drinks	Drugs
Steals in or outside the home sometimes or often	8.5%	-	-	-
Gets in many fights sometimes or often	-	18.9%	-	-
Drinks 1-2 times/month or more	-	-	13.9%	-
Has done illicit drugs (e.g. marijuana, etc.) in the past 12 months	-	-	-	16.3%
Both parents work standard shifts	34.5%	34.6%	34.7%	34.7%
Both parents work non-standard shifts	22.0%	21.9%	22.7%	22.6%
Mom works standard, Dad works non-standard	28.1%	28.1%	27.7%	27.7%
Mom works non-standard, Dad works standard	15.4%	15.4%	14.9%	15.0%
Mother's hours of paid work	35.3	35.2	35.6	35.7
Father's hours of paid work	47.7	47.7	47.7	47.7
Log equivalent household income (2002$)	10.54	10.54	10.56	10.56
Stepfather present	10.4%	10.4%	11.1%	11.2%
Mother's age at birth	28.47	28.48	28.45	28.43
Age	12.8	12.8	13.6	13.6
Number of siblings	1.5	1.5	1.5	1.5
Oldest child in household	46.7%	46.7%	47.2%	47.4%
Child born with low birth weight (<2.5kg)	5.8%	5.7%	5.5%	5.6%
Child has an activity limitation	6.6%	6.6%	7.1%	7.2%
Child is non-white	6.9%	6.9%	7.4%	7.5%
Mother is an immigrant	14.4%	14.3%	14.3%	14.2%
Mother has less than high school	8.4%	8.3%	8.6%	8.6%
Mother has high school	43.1%	43.2%	42.6%	42.5%
Mother has post-sec degree	48.5%	48.5%	48.8%	48.9%
Rural residence	13.3%	13.2%	13.4%	13.5%
Atlantic	7.6%	7.6%	7.5%	7.5%
Quebec	22.6%	22.6%	22.7%	22.8%
Ontario	38.5%	38.6%	39.1%	38.9%
Prairies	19.3%	19.2%	18.4%	18.6%
BC	12.0%	12.0%	12.3%	12.3%
Cycle 4	25.8%	25.9%	22.7%	22.8%
Cycle 5	25.2%	25.0%	23.0%	23.1%
Cycle 6	28.3%	28.3%	26.3%	26.1%
Cycle 7	20.8%	20.9%	28.0%	28.0%
Observations	5,673	5,610	3,889	3,906

Source: NLSCY, Cycles 4-7

Table 3-4: Marginal Effects, Base Case with Covariates, Boys

	Steals	Fights	Drinks	Drugs
Both parents work non-standard shifts	0.0000661	0.0160	0.0132	0.0386
	(0.0186)	(0.0303)	(0.0218)	(0.0266)
Mom works standard, Dad works non-standard	-0.00866	**0.0563****	**0.0397***	-0.00459
	(0.0197)	**(0.0265)**	**(0.0204)**	(0.0246)
Mom works non-standard, Dad works standard	0.0115	0.0123	**0.0726*****	**0.0686****
	(0.0222)	(0.0310)	**(0.0277)**	**(0.0343)**
Mother's work hrs	-0.000561	-0.0000140	0.00602	0.0100
	(0.00493)	(0.00850)	(0.00488)	(0.00662)
Father's work hrs	0.00943	0.00246	0.0128	0.0143
	(0.00931)	(0.0114)	(0.00832)	(0.0101)
Log equivalent household income (2002 $)	-0.0248	-0.0609**	0.00867	0.0215
	(0.0152)	(0.0273)	(0.0147)	(0.0206)
Stepfather present	0.0401*	0.0334	-0.00670	0.0670*
	(0.0237)	(0.0372)	(0.0184)	(0.0384)
Mother's age at birth	-0.000805	-0.00208	0.000135	-0.00515**
	(0.00177)	(0.00286)	(0.00166)	(0.00229)
Aged 11	0.00246	-0.0431	-	-
	(0.0242)	(0.0309)		
Aged 12	0.0312	-0.0796***	-	-
	(0.0263)	(0.0249)		
Aged 13	0.00489	-0.0519*	0.0837**	0.0881**
	(0.0227)	(0.0305)	(0.0359)	(0.0346)
Aged 14	0.0614**	-0.139***	0.206***	0.232***
	(0.0292)	(0.0246)	(0.0413)	(0.0379)
Aged 15-16	0.0743**	-0.148***	0.386***	0.358***
	(0.0303)	(0.0261)	(0.0447)	(0.0428)
Number of siblings	0.00851	0.00427	-0.00289	-0.0176
	(0.00786)	(0.0131)	(0.00794)	(0.0120)
Oldest child in household	-0.0226	-0.0302	-0.0153	-0.0513***
	(0.0146)	(0.0219)	(0.0142)	(0.0173)
Child born with low birth weight (<2.5kg)	-0.0219	0.109*	0.00972	-0.0349
	(0.0235)	(0.0570)	(0.0298)	(0.0318)
Child has an activity limitation	-0.0118	0.0165	-0.0567***	-0.0324
	(0.0203)	(0.0324)	(0.0129)	(0.0309)
Child is non-white	-0.0154	-0.0420	-0.0552**	-0.112***
	(0.0379)	(0.0644)	(0.0243)	(0.0253)
Mother is an immigrant	-0.0148	-0.0448	-0.0658***	-0.0739***
	(0.0240)	(0.0450)	(0.0163)	(0.0280)
Mother has less than high school	0.0223	0.0673	0.0316	0.0586
	(0.0244)	(0.0416)	(0.0346)	(0.0434)
Mother has post-sec degree	0.0109	-0.0586***	0.0161	0.0165
	(0.0149)	(0.0225)	(0.0136)	(0.0193)
Rural residence	-0.00952	-0.0166	0.0358**	-0.0266
	(0.0153)	(0.0225)	(0.0177)	(0.0220)
Atlantic	-0.00524	-0.0288	-0.0369**	-0.0307
	(0.0165)	(0.0265)	(0.0146)	(0.0226)
Quebec	-0.0139	-0.0601**	0.00957	0.0560*
	(0.0173)	(0.0296)	(0.0211)	(0.0289)
Prairies	0.00479	0.0396	0.00133	-0.0265
	(0.0181)	(0.0313)	(0.0168)	(0.0255)
BC	0.0182	0.0159	0.00202	0.0554
	(0.0270)	(0.0405)	(0.0271)	(0.0479)
Observations	5,606	5,520	3,799	3,819

Source: NLSCY, Cycles 4-7. Controls also include cycle fixed effects (excluded for space considerations). Bootstrapped standard errors clustered at the household level in parentheses.
* p<0.10, ** p<0.05, *** p<0.01

Table 3-5: Marginal Effects, Base Case with Covariates, Girls

	Steals	Fights	Drinks	Drugs
Both parents work non-standard shifts	0.0246	**0.0413***	0.0363	0.0159
	(0.0187)	**(0.0244)**	(0.0280)	(0.0239)
Mom works standard, Dad works non-standard	0.00189	-0.00504	0.0236	0.0301
	(0.0152)	(0.0215)	(0.0221)	(0.0227)
Mom works non-standard, Dad works standard	0.0239	0.0243	0.0315	-0.00154
	(0.0208)	(0.0255)	(0.0267)	(0.0265)
Mother's work hrs	-0.00320	0.00548	0.00459	**0.0129****
	(0.00463)	(0.00603)	(0.00548)	**(0.00600)**
Father's work hrs	0.00209	-0.00569	-0.00879	-0.000154
	(0.00533)	(0.00866)	(0.00919)	(0.00888)
Log equivalent household income (2002 $)	-0.0119	-0.0438**	-0.00943	0.0136
	(0.0136)	(0.0184)	(0.0154)	(0.0198)
Stepfather present	0.0474**	0.0309	0.0463	0.132***
	(0.0233)	(0.0304)	(0.0288)	(0.0394)
Mother's age at birth	-0.00248*	-0.00235	-0.00231	-0.00307
	(0.00131)	(0.00191)	(0.00211)	(0.00201)
Aged 11	0.00270	-0.0427*	-	-
	(0.0238)	(0.0248)		
Aged 12	-0.0169	-0.0615***	-	-
	(0.0204)	(0.0223)		
Aged 13	0.0124	-0.0607***	0.140***	0.135***
	(0.0235)	(0.0225)	(0.0519)	(0.0421)
Aged 14	0.0372	-0.0667***	0.279***	0.284***
	(0.0268)	(0.0233)	(0.0566)	(0.0448)
Aged 15-16	0.0331	-0.0414	0.390***	0.413***
	(0.0254)	(0.0266)	(0.0572)	(0.0448)
Number of siblings	0.0119	0.0175**	-0.0192**	-0.0101
	(0.00764)	(0.00885)	(0.00921)	(0.00984)
Oldest child in household	-0.0125	0.000644	-0.0480***	-0.0326*
	(0.0142)	(0.0199)	(0.0169)	(0.0178)
Child born with low birth weight (<2.5kg)	0.0440	-0.0504*	-0.0261	-0.0579**
	(0.0408)	(0.0301)	(0.0271)	(0.0242)
Child has an activity limitation	0.0295	0.120***	0.0390	0.0361
	(0.0288)	(0.0400)	(0.0366)	(0.0310)
Child is non-white	-0.00777	-0.000898	-0.0798***	-0.0954***
	(0.0290)	(0.0438)	(0.0173)	(0.0217)
Mother is an immigrant	0.0131	0.0158	-0.0314	-0.00229
	(0.0220)	(0.0332)	(0.0231)	(0.0324)
Mother has less than high school	-0.00519	0.0107	0.000346	0.0382
	(0.0207)	(0.0336)	(0.0250)	(0.0302)
Mother has post-sec degree	-0.0158	-0.0548***	-0.00131	-0.0467***
	(0.0129)	(0.0187)	(0.0152)	(0.0179)
Rural residence	-0.0172	-0.00854	0.0269	-0.0110
	(0.0125)	(0.0189)	(0.0193)	(0.0216)
Atlantic	-0.0206	-0.0389**	-0.0320*	-0.00497
	(0.0136)	(0.0189)	(0.0184)	(0.0213)
Quebec	-0.0371**	-0.148***	-0.0139	0.0916***
	(0.0146)	(0.0190)	(0.0212)	(0.0304)
Prairies	-0.00903	0.0425*	0.0162	-0.000272
	(0.0148)	(0.0217)	(0.0236)	(0.0229)
BC	-0.0192	-0.0358	0.0185	0.0101
	(0.0164)	(0.0259)	(0.0276)	(0.0320)
Observations	5,673	5,610	3,889	3,906

Source: NLSCY, Cycles 4-7. Controls also include cycle fixed effects (excluded for space considerations).
Bootstrapped standard errors clustered at the household level in parentheses.
* p<0.10, ** p<0.05, *** p<0.01

Table 3-6: Marginal Effects with Hour Interactions

	Steals	Fights	Drinks	Drugs
Panel A: Boys				
Both parents work non-standard shifts	0.00114	0.0306	0.0387	0.0559
	(0.0213)	(0.0358)	(0.0300)	(0.0355)
Mom works standard, Dad works non-standard	-0.00673	**0.0611****	**0.0757*****	-0.0129
	(0.0205)	**(0.0282)**	**(0.0274)**	(0.0288)
Mom works non-standard, Dad works standard	0.00664	0.00404	**0.0845****	**0.0765***
	(0.0279)	(0.0373)	**(0.0351)**	**(0.0407)**
Both parents work > 40 hrs	-0.0202	0.0285	0.0530	0.000954
	(0.0275)	(0.0488)	(0.0343)	(0.0384)
Both hrs > 40*Both non-std	0.0156	-0.0378	-0.0372	-0.0116
	(0.0418)	(0.0621)	(0.0273)	(0.0485)
Both Hrs > 40*Mom std, Dad non-std	0.0111	-0.00959	**-0.0538*****	0.0503
	(0.0393)	(0.0570)	**(0.0196)**	(0.0630)
Both Hrs > 40*Mom non-std, Dad std	0.0191	0.0248	-0.0230	-0.0133
	(0.0484)	(0.0739)	(0.0335)	(0.0620)
Observations	*5,606*	*5,520*	*3,799*	*3,819*
Panel B: Girls				
Both parents work non-standard shifts	0.0194	0.0320	0.0337	0.0163
	(0.0235)	(0.0292)	(0.0339)	(0.0280)
Mom works standard, Dad works non-standard	0.000185	-0.000706	0.0211	**0.0437***
	(0.0179)	(0.0244)	(0.0257)	**(0.0257)**
Mom works non-standard, Dad works standard	0.0293	-0.00461	0.0131	0.00508
	(0.0255)	(0.0291)	(0.0269)	(0.0310)
Both hrs > 40	-0.000196	-0.00260	0.0170	0.0412
	(0.0217)	(0.0284)	(0.0312)	(0.0352)
Both hrs > 40*Both non-std	0.0105	0.0189	-0.00691	-0.00699
	(0.0355)	(0.0468)	(0.0393)	(0.0416)
Both Hrs > 40*Mom std, Dad non-std	0.00740	-0.0227	-0.00453	-0.0350
	(0.0341)	(0.0408)	(0.0392)	(0.0351)
Both Hrs > 40*Mom non-std, Dad std	-0.0160	**0.109***	0.0540	-0.0199
	(0.0315)	**(0.0652)**	(0.0615)	(0.0495)
Observations	*5,673*	*5,610*	*3,889*	*3,906*

Source: NLSCY, Cycles 4-7.
Bootstrapped standard errors clustered at the household level in parentheses.
Each regression includes the full set of controls listed in Tables 3-4 and 3-5.
* p<0.10, ** p<0.05, *** p<0.01

Table 3-7: Marginal Effects with Income Interactions

	Steals	Fights	Drinks	Drugs
Panel A: Boys				
Both non-std	0.00913	-0.00645	0.0219	**0.0576***
	(0.0208)	(0.0332)	(0.0251)	**(0.0298)**
Mom std, Dad non-std	-0.00165	**0.0715****	**0.0399***	-0.00466
	(0.0214)	**(0.0287)**	**(0.0216)**	(0.0266)
Mom non-std, Dad std	0.0211	0.0295	**0.0762****	**0.0805****
	(0.0256)	(0.0345)	**(0.0296)**	**(0.0373)**
Bottom quartile	0.0413	**0.108****	-0.0142	0.0549
	(0.0416)	**(0.0479)**	(0.0348)	(0.0549)
Bottom quartile*Both non-std	-0.0353	0.0651	-0.0352	**-0.0855****
	(0.0338)	(0.0726)	(0.0304)	**(0.0333)**
Bottom quartile*Mom std, Dad	-0.0373	**-0.0849***	-0.00726	-0.0209
non-std	(0.0331)	**(0.0477)**	(0.0472)	(0.0568)
Bottom quartile*Mom non-std,	-0.0438	-0.0929	-0.0197	-0.0714
Dad std	(0.0313)	(0.0584)	(0.0520)	(0.0540)
Observations	*5,606*	*5,520*	*3,799*	*3,819*
Panel B: Girls				
Both non-std	0.0204	**0.0516***	0.0316	0.0192
	(0.0196)	**(0.0275)**	(0.0306)	(0.0259)
Mom std, Dad non-std	0.00217	-0.00854	0.0340	0.0350
	(0.0162)	(0.0236)	(0.0243)	(0.0239)
Mom non-std, Dad std	0.00407	0.0326	0.0502	0.0213
	(0.0190)	(0.0261)	(0.0306)	(0.0286)
Bottom quartile	-0.0312	0.0156	0.0403	0.00657
	(0.0241)	(0.0447)	(0.0477)	(0.0459)
Bottom quartile*Both non-std	0.0554	-0.0163	-0.0000873	-0.0254
	(0.0608)	(0.0511)	(0.0529)	(0.0466)
Bottom quartile*Mom std, Dad	0.0220	0.0400	**-0.0561****	-0.0330
non-std	(0.0490)	(0.0625)	**(0.0274)**	(0.0463)
Bottom quartile*Mom non-std,	0.164	-0.0279	**-0.0687*****	**-0.0850*****
Dad std	(0.120)	(0.0629)	**(0.0255)**	**(0.0281)**
Observations	*5,673*	*5,610*	*3,889*	*3,906*

Source: NLSCY, Cycles 4-7.
Bootstrapped standard errors clustered at the household level in parentheses.
Each regression includes the full set of controls listed in Tables 3-4 and 3-5.
* p<0.10, ** p<0.05, *** p<0.01

Table 3-8: Marginal Effects using 3-Cycle History

	Steals	Fights	Drinks	Drugs
Panel A: Boys				
Years both non-std	-0.00866	0.00403	0.0145	0.0132
	(0.00973)	(0.0156)	(0.0127)	(0.0126)
Years Mom std, Dad non-std	-0.00260	0.0192	**0.0206****	0.0109
	(0.0122)	(0.0124)	**(0.00915)**	(0.0144)
Years Mom non-std, Dad std	0.00171	-0.0184	**0.0250****	0.0226
	(0.0119)	(0.0153)	**(0.0114)**	(0.0152)
Observations	*3,831*	*3,778*	*2,642*	*2,659*
Panel B: Girls				
Years both non-std	0.00596	0.0156	0.0101	0.0167
	(0.00710)	(0.0105)	(0.0108)	(0.0124)
Years Mom std, Dad non-std	0.00796	0.00955	0.0149	**0.0229****
	(0.00736)	(0.0106)	(0.0111)	**(0.0112)**
Years Mom non-std, Dad std	0.0111	**0.0215***	0.0137	**0.0203***
	(0.00809)	**(0.0120)**	(0.0104)	**(0.0119)**
Observations	*3,886*	*3,842*	*2,678*	*2,690*

Source: NLSCY, Cycles 4-7.
Bootstrapped standard errors clustered at the household level in parentheses.
Each regression includes the full set of controls listed in Tables 3-4 and 3-5 except the controls for hours and income are the averages over the last 3 cycles.
* p<0.10, ** p<0.05, *** p<0.01

Chapter 4

Ants in the Pants: The Relationship between Child Hyperactive-Inattentive Behaviour and Time Spent Reading To Young Canadian Children

4.1 Introduction

Economic theory of the family (Becker and Tomes 1986) suggests that parents invest time and money into their children to maximize their outcomes. All else equal, children who receive more parental time investment are better off. While a large empirical literature has focused on understanding the relationship between parental time investments and child outcomes,[36] much less attention has been paid to the determinants of parental time investments.

In this paper, I investigate whether children's hyperactive-inattentive behaviour influence the amount of time they are read to by parents or other adults. For example, if a child can't sit still or can't pay attention for long, it may be difficult for parents or other caregivers to read to the child – are such children read to less often? Almost all parents know that it good to read to their children, especially when they are young, and the results reflect this. Using the National Survey of Children and Youth (NLSCY), I find that a majority of children aged 3 to 4 (66 percent) are read to at least once daily. However, for some parents it may be too difficult to read to their children as often as desired – the amount of time devoted to reading to children is not necessarily a choice. Roughly 10 percent of 3 to 4 year olds examined are read to once per week or less. The amount of time children are read to will depend on a number of factors including family structure, parental labour supply, household income, parental education as well as

[36] For example, in terms of: 1) cognitive outcomes: Leibowitz (1977), Blau and Grossberg (1992), Lefebvre and Merrigan (1998), Han *et al.* (2001), Zick *et al.* (2001), Waldfogel *et al.* (2002), Brooks-Gunn et al. (2002), Gagné (2003), Baum (2003), Ruhm (2004) and (2008), Baker and Milligan (2010), Price (2010); 2) child overweight status and child obesity, see Anderson *et al.* (2003), Phipps *et al.* (2006), Ruhm (2008), Chia (2008); and 3) behavioural outcomes, see Aughinbaugh and Gittleman (2004).

characteristics of the child. Attention deficit-hyperactivity disorder (ADHD)[37], the clinical level of hyperactivity-inattentive behaviour that is used in this analysis, is estimated to be the most prevalent mental disorder among children with a worldwide incidence rate of 5.3 percent (Polanczyk *et al.* 2007). Previous research shows that hyperactive-inattentive behaviour is negatively related to achievement test scores, school-related outcomes and academic motivation (Currie and Stabile 2006, Chen *et al.* 2011, Chen *et al.* 2012). This analysis examines whether there is a relationship between hyperactivity-inattention and the amount of time children are read to.[38]

This analysis focuses on reading time since several studies show that children who are read to more often have higher standardized tests scores and school grades (Price 2010, Zick *et al.* 2001, and Leibowitz 1977). While prior studies (Currie and Stabile 2006, Chen *et al.* 2011, Chen *et al.* 2012) show that hyperactivity-inattention is associated with human capital accumulation and school-related outcomes for school-aged children, evidence of a relationship between hyperactivity-inattention and reading among 3 to 4 year olds would suggest that such symptoms of mental health problems affect the accumulation of human capital at a very young age. Also, given the estimated higher rate of diagnosis of ADHD among children in the U.S. than in Canada[39], uncovering a relationship between hyperactivity-inattention and reading time may help explain why roughly two-thirds of Canadian children are read to daily compared to only 46 percent in the U.S. (Corak *et al.* 2010).

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[37] ADHD is a disorder of the nervous system. As noted in Daley and Birchwood (2010) and Currie and Stabile (2006), according to the American Psychiatric Association (APA) 1994 guidelines, in order to be diagnosed with ADHD, a child must exhibit a number of inattentive, impulsive and hyperactive behaviours over a period of 6 months, before the age of 7 and in at least two or more settings (usually home and school).

[38] I also explored relationships between time devoted to reading to children and several other measures: 1) being born with low birth weight, 2) having an activity limitation and 3) being in poor or fair health. However, none of the results are strong enough to provide sufficient evidence of a statistically significant relationship.

[39] Using data from the NLSCY, Brault and Lacourse (2012) find that only roughly 1 percent of preschoolers (children aged 3 to 5) in Canada were diagnosed with ADHD in both 2000 and 2007. The prevalence among school-aged children (aged 6 to 9) is slightly higher, and increased from 1.7 in 2000 to 2.6 percent in 2007. The CDC (2012) estimates that in 2011 8.4 percent of children aged 3-17 in the U.S. had ever been diagnosed with ADHD or ADD (Attention Deficit Disorder).

Note that this analysis uses responses to several questions related to hyperactivity and inattention. It does not use a measure of being diagnosed with ADHD, and therefore the results should not be interpreted as such. For brevity, I will refer to hyperactivity-inattentiveness as hyperactivity hereafter.

The analysis begins by estimating the relationship between hyperactivity and reading time using OLS and logit regression analyses, and a representative sample of Canadian children aged 3 to 4 from two-child households from the NLSCY. Despite using an extensive set of explanatory variables, unobserved heterogeneity may remain and bias the results. For example, variables related to genetics, parenting style or home environment may influence both children's hyperactivity scores as well as the amount of child reading time but may be omitted because they are unobservable. Family fixed effects models using sibling pairs will control for unobserved heterogeneity that would be common to households.

While OLS and logit models with family fixed effects may provide improvement, bias may still remain due to spillover effects from siblings. For example, if the high hyperactivity of one sibling has a negative effect on reading to another sibling, then the difference between the two siblings will provide an underestimate of the relationship between hyperactive behaviour and reading time.[40] In order to investigate this effect, using a sample of sibling pairs, the amount of reading time for each child is regressed on the child's own hyperactivity as well as the sibling's hyperactivity. Given the literature on the effects of birth order on parental time investment (Price 2008), this analysis is performed separately for older and younger siblings in each sibling pair.

Two measures of hyperactivity are used in the regression analyses. One measure is a continuous hyperactivity score ranging from 0 to 14, and the other is an indicator variable identifying the children with a hyperactivity score of 7 or more out of 14 (which is

[40] Family fixed effects results may also be biased because they do not control for unobserved individual level factors, like motivation or discipline, which might be correlated with hyperactivity and how often others read to them. However, as will be discussed in Section 6, this source of bias is not examined due to lack of variation in children's hyperactivity scores.

roughly the top 25 percent of the distribution). Both show significant results suggesting that it's not only high hyperactivity that matters. This is consistent with evidence from Currie and Stabile (2006) and Chen *et al.* (2012) who find negative effects on school outcomes for hyperactivity scores that would be considered below the level needed for a child to be diagnosed with ADHD.

The rest of the paper is organized as follows: Section 4.2 provides a review of related research in this area. Section 4.3 describes the dataset, variables and sample used in the analysis. Section 4.4 presents descriptive statistics to provide preliminary evidence that hyperactivity is related to lower reading time for children aged 3 to 4. Section 4.5 describes the OLS and OLS with fixed effects regression model specifications, and Section 4.6 presents the corresponding results for the relationship between hyperactivity and reading time. Section 4.7 provides results regarding the effect of siblings' hyperactivity on reading time. In Section 4.8, I conclude.

4.2 Literature Review

While this is the first paper to look at the relationship between child behaviour and parental time investments, several earlier studies have examined the influence of other child characteristics on parental time investments. Two recent studies in this area include Datar, Kilburn and Loughran (2010) and Hsin (2012), both of which look at the relationship between birth weight and different measures of parental time investment. Datar *et al*. (2010) finds that children born with normal birth weight are more likely to be breastfed, have well-baby visits, receive immunizations and attend preschool than their low birth weight siblings. Hsin (2012) examines the relationship between birth weight and total time investment as well as educational time investment (time spent reading, helping with homework) by maternal education. The results show little relationship between the main birth weight variable and either total time or educational time, however the estimates for the interaction terms (birth weight interacted with years of maternal education) suggest that the relationship varies by maternal education. In particular, lower-educated mothers invest more in the children with higher birth weight, while higher-educated mothers invest more in children with lower birth weight. The relationship for higher-educated mothers is much stronger than the influence of the lower-educated mothers.

Fletcher and Wolfe (2008) look at the effect of own and sibling's high hyperactivity on school outcomes, and find that siblings' hyperactivity is negatively related with children's school outcomes. An unpublished paper by Fletcher, Hair and Wolfe (2012) uses cousin fixed effects to look at the relationship between own health and sibling's health on cognitive outcomes (Woodcock-Johnson test, grade repetition). They find that both own health and sibling health has a negative effect on one's own outcomes. There are also differences by gender and birth order. Sisters of siblings with developmental disability are more negatively affected than brothers. Younger siblings are more negatively affected by externalizing behaviour than older siblings.

4.3 Data, Variables and Sample

4.3.1 Data

This analysis uses data from cycles 1-3 of the master files of the National Longitudinal Survey of Children and Youth (NLSCY). The NLSCY is a nationally representative sample of Canadian children, which in its first cycle in 1994-95 included 22,831 children aged 0 to 11.[41] Biennially since then, the NLSCY has conducted a follow-up survey with this sample. The NLSCY was designed to collect detailed information related to children's cognitive, emotional, physical and behavioural development over time. While the unit of analysis for the NLSCY is the child, the person most knowledgeable (PMK) of the child provides the information for each child for many of the variables.[42] The PMK also provides personal and family information (including information on the spouse, when present). For this analysis, I pool the children from cycles 1 to 3 since these are the

[41] The target population for the NLSCY is the non-institutionalized civilian population in Canada's 10 provinces. Therefore, the survey excludes children living on Indian reserves, residents of institutions, full-time members of the Canadian Armed Forces, and residents of the territories.
[42] For approximately 95% of the children in the sample, the PMK is the biological mother.

cycles in which responses to the questions on hyperactivity and child reading time were collected for the children with siblings and the age groups of interest.[43]

4.3.2 Outcome Variable

The outcome variable relates to time spent reading to children. More specifically, I use the valid responses given by PMKs to the question, "Currently, how often do you or another adult read to him/her (also include if child reads/pretends to read/attempts to read to adult)?" "Another adult" may be the spouse, a relative such as a grandparent, or a non-relative caregiver. The five possible responses and their assigned values are: 'never/rarely/once a month or less' (=1); 'once a week' (=4), 'a few times a week' (=12), 'daily' (=30) and 'many times each day' (=60). Categories are rescaled to represent the frequency of reading per month (in parentheses).[44] I also constructed and use a binary variable to identify children who are read to daily or more.

4.3.3 Main Independent Variable

The hyperactivity score is based on the PMKs responses to a series of seven questions.[45] More specifically, the PMK is asked, "How often would you say that [child's name]…:

- Can't sit still, is restless or hyperactive?
- Is distractible, has trouble sticking to any activity?
- Fidgets?
- Can't concentrate, can't pay attention for long?
- Is impulsive, acts without thinking?
- Cannot settle to anything for more than a few moments?

[43] Additional cross-sections of children are added to the NLSCY starting in cycle 2. However, for such cross-sections, only one child is interviewed per household, which naturally precludes the observation from the family fixed effects analysis in Section 4.5 and the sibling effects analysis in Section 4.6.

[44] For cycles 1 to 3, there are actually eight possible responses to the question on the amount of time devoted to reading to the child. However, due to very few responses in some categories (especially in the very bottom categories), several categories were collapsed.

[45] The NLSCY includes an already aggregated hyperactivity score based on these questions for children aged 2 to 3 (out of 14) and children aged 4 to 11 (out of 16). The score for those aged 4 to 11 includes an additional question ('Has difficulty awaiting turn in games or groups?'). To be consistent across age groups, I reconstruct the score using the questions common to both.

- Is inattentive?

The possible responses include: ‘never or not true’ (=0), ‘sometimes or somewhat true’ (=1) and ‘often or very true’ (=2). The responses to each question are added together to give a score out of 14. A higher score suggests a higher level of hyperactivity. I also generate a binary variable to identify children who have high hyperactivity, which I define as having a hyperactivity score of 7 or more out of 14. Using this cut-off, roughly 24 percent of all children are identified as having high hyperactivity.[46] Figure 4-1 presents the distribution of the hyperactivity score for the full sample of children in the analysis.

4.3.4 Control Variables[47]

A number of studies show that boys are more likely to have symptoms of hyperactivity and inattention, and be diagnosed with ADHD than girls (Brault and Lacourse 2012, CDC 2004, Szatmari *et al.* 1989). Other research (Currie and Stabile 2006), finds that the negative effects of hyperactivity on the risk of being placed into special education, and math and reading scores are confined to boys. Given such relationships, I include a dummy variable to identify boy children. To capture any systematic variation in the hyperactivity scores and being read to by age, I include child age in months in all regressions. Some research suggests that, at a given point in time, parents invest the same amount of time, including reading time, into each child regardless of birth order (Price 2008). However, those findings are based on older children (aged 4-13), and in this analysis, I don’t always observe the children in the same cycle – if they are not in the same cycle, the second-born children will always be observed in a later cycle than the first-borns. Reported symptoms of hyperactivity may also vary by birth order. To account for these possible correlations, I include a dummy variable to identify the oldest in the household.

[46] I also tried a cut-off of the 80th percentile and above. However, since the distribution of the hyperactivity score varies by cycle, the cut-off was 7 in cycles 1 and 2 but 6 in cycle 3. Given the cut-off of 6 in cycle, nearly 40 percent of children in that cycle would have been identified with high hyperactivity.

[47] All control variables are from the same cycle as the outcome.

I also control for children who have a PMK who is an immigrant since reading time and reports of hyperactivity may differ by PMK immigrant status. Maternal age at child's birth has been associated with measures of child development (Levine *et al.* 2001). Since maternal age may also be related to both children's reported symptoms of hyperactivity and time investment in reading, I account for these relationships using mother's age at birth. Also, as younger mothers may, in particular, lack experience and be less mature than their older counterparts, I control for young mothers using a dummy variable to identify mothers younger than 21 years old at child's birth. Labour supply will also influence parental time available.

I control for the PMK's time spent in paid work using dummy variables to identify PMKs who work part-time in paid employment (less than 30 hours per week) and PMKs who work full-time in paid employment (30 hours per week or more) -- PMKs who do not work outside the home are the base. Several studies, including Behrman and Rosenzweig (2002), have found that children of better-educated mothers have better cognitive outcomes due to intergenerational transfers of endowments as well as higher quality maternal investment. Furthermore, Gauthier (2004) and Guryan *et al.* (2008) find that parents with higher education spend more direct time with their children than their less-educated counterparts.[48] Parental education may also be a factor in reports of symptoms of hyperactivity. To avoid bias due to such relationships, I use a dummy variable to identify PMKs with a high school diploma or less (including those with some post-secondary education but no degree or diploma). PMKs that have completed postsecondary education (PSE), that is they have either a post-secondary degree or a diploma, are the base.[49]

Family structure may also affect outcomes and be correlated with reports of hyperactivity. Relative to lone parent households, the presence of two parents in the home

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[48] Some argue that these findings suggest that higher-educated parents view time investment in certain activities as more important for child development than lower-educated parents (Burton and Phipps 2007, Guryan *et al.* 2008).

[49] Equivalent variables related education and labour supply for the spouse are not included since not all children have two parents. Also, including a variable for combined hours of paid work for the PMK and spouse, which would only include spouse information when present, and would confound the lone parent variable.

increases parental time and financial resources available to children. To control for this, I identify children from lone-parent households. Household income has been associated with child development (Milligan and Stabile 2011, Dahl and Lochner 2012, Dooley and Stewart 2004, 2007), and Guryan *et al.* (2008) find that income is positively related to time spent with children. Income may also be correlated with measures of child hyperactivity. To address these correlations, I also include logged real household equivalent before-tax income (in 2002 dollars) in all regressions.[50] Living in a rural area is often hypothesized to decrease access to resources (e.g, libraries, recreation centres, centre-based day cares), which could influence reading time. Children from rural areas may also differ in reports of hyperactivity. A dummy for rural residence is used to control for this effect. I also include a set of dummy variables for the five Canadian regions (Atlantic, Quebec, Prairies, British Columbia – Ontario is base) to take into account differences in policies that affect households' disposable incomes, accessibility to childcare and resources devoted to early childhood education as well as differences in attitudes or perceptions regarding hyperactivity. Cycle dummies are included to control for cycle effects.

4.3.5 Sample

This analysis pools the children aged 3 to 4 from cycles 1 to 3 of the NLSCY. The sample contains only children from two-child families with valid responses to all the included dependent and independent variables described above. More specifically, each child in the sample has his/her other sibling also in the sample. Note that the total number of children in the household is two, and not just that there are two children currently present in the household. This is important since younger or older children, though not currently present, may influence the amount of parental time investment for the two children in the sample. Twins were excluded because they are a special subsample of sibling pairs that are not representative of the general population. Given the narrow age range for the analysis, no children are observed more than once across the three cycles.

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[50] Equivalent income is per capita income that is adjusted to take into account that individuals living in households benefit from economies of scale. I use the Luxembourg Income Study (LIS) equivalence scale where equivalent income is equal to real household income divided by the square root of the family size.

All analyses use cross-sectional sampling weights. Also, as there are always two children per household in the regression analyses, standard errors are clustered at the household level to account for non-independence between such observations. Estimation is carried out using the software package Stata.

4.4 Descriptive Statistics

The means or frequencies, as relevant, for all the variables included in the analysis are presented in Table 4-1 for the full sample, and for the those with low hyperactivity (score of 6 or lower out of 14) and high hyperactivity (score of 7 or more out of 14) separately as well as their differences. The results show that children with higher levels of hyperactivity are read to less frequently and are less likely to be read to daily than children with low hyperactivity, and the differences are statistically significant. Roughly 68 percent of children that are reported to have few symptoms of hyperactivity are read to daily or more, compared to 59 percent of children with high hyperactivity. Children with high hyperactivity are also statistically significantly more likely to be a boy, the second-born child in the household, from a lone-parent household, have a young mother at birth, and have a PMK with less than a completed post-secondary education (PSE) than those with lower scores of hyperactivity. Those with high hyperactivity are also less likely to be from Quebec. As these characteristics are related to hyperactivity and may also influence the amount children are read to, they are included in all relevant regression specifications.

Figure 4-2 graphically presents an alternative perspective of some of these results. It shows that the percentage of children identified with high hyperactivity overall as well as by PMK education, gender and birth order. Overall, 24 per cent of the full sample is identified as having high hyperactivity. When the sample is disaggregated by PMK education, 28 percent of children of PMKs with less than completed PSE and 21 percent of children of PMKs with completed PSE are reported to have high scores for the measure of hyperactivity. Boys are also more likely (28 percent) to be reported as having high hyperactivity than girls (20 percent). Only 21 percent of the first-born children but 27 per cent of the second-born children are reported to have high hyperactivity. These large differences as well as a sizable gap between standard error bars suggest that these differences may be statistically significant.

Figure 4-3 provides the average frequency of reading to children aged 3 to 4 for the full sample as well as for children with low and high levels of hyperactivity separately. The figure shows that a large majority of children (66 percent) are read to daily or more. This is not unexpected, almost all parents know that it is good to read to their children and make efforts to do so. However, for some parents it may be too difficult to read to their children as often as desired – the amount of time devoted to reading to children is not necessarily a choice. Figure 4-3 shows that roughly only 10 percent of 3 to 4 year olds are read to once per week or less. As described in the previous section, the amount of time children are read to will depend on a number of factors including family structure, income, parental education as well as characteristics of the child. While there is some variation in the bottom categories by degree of hyperactivity, most of the variation is in the proportion of the two groups read to daily. 57 percent of children with low hyperactivity are read to daily compared to only 51 percent of children with high hyperactivity scores. The difference between the two average frequencies is relatively large but there is also a lot of variation within each group.

Figures 4-4 and 4-5 are similar to Figure 4-3 but show the distribution of reading frequency for children by maternal education. Among children with a PMK with less than completed PSE, Figure 4-4 shows that those with high hyperactivity are much less likely to be read to daily than those considered to have low hyperactivity. The sizable gap between the standard error bars suggests that the difference may be statistically significant. Figure 4-5 provides the same disaggregation but for children that have a PMK with a completed post-secondary degree or diploma. For these children, there is almost no difference in frequency of reading by degree of hyperactivity. Figures 4-4 and 4-5 suggest that most of the variation in reading time by hyperactivity is among children that have a PMK without a completed post-secondary degree or diploma.

Figure 4-6 examines the differences in the proportion of children aged 3 to 4 who are read to daily or more by degree of hyperactivity for the full sample as well as by PMK education, gender and birth order. As suggested by the means in Table 4-1, Figure 4-6 show that for the full sample, those with high hyperactivity are less likely to be read to at least once daily than their peers with low hyperactivity.

When the children are disaggregated by PMK's education, there are two main results to point out. Firstly, children with PMKs who have completed PSE are more likely to be read to at least once a day than children of PMKs with less education. This is consistent with evidence from Guryan *et al.* (2008) who find that higher educated parents devote more time to their children than lower educated parents. Second, while there is little variation in being read to daily or more by hyperactivity level if the child's PMK has a post-secondary degree or diploma, if the PMK has not graduated from post-secondary education, there is a large difference. Children with high hyperactivity scores and a PMK with less than a completed PSE are 12 percentage points less likely to be read to at least once daily than their less hyperactive counterparts (64 percent versus 52 percent). There is a similar pattern by gender. Girls are more likely to be read to daily or more than boys. While there is no variation in reading time by hyperactivity for girls, the difference by hyperactivity for boys is large. Hyperactive boys are 16 percentage points less likely to be read to daily or more than less hyperactive boys of the same age (69 versus 53 percent). Finally, when reading is examined by birth order, Figure 4-6 suggests that the second-born is less likely to be read to at least once daily than the first-born. For both the first and second-born, having a high hyperactivity score is related to being read to less frequently than those less hyperactive. The difference by degree of hyperactivity is larger for second-born children. These large differences as well as a sizable gap between standard error bars suggest that these differences may be statistically significant. The differences in reading by subgroup not only suggest that such characteristics need to be controlled for in regression analyses but that the interaction between these factors and hyperactivity may also be instructive.

4.5 Estimation Strategy

While some of the summary statistics in Section 4.4 show an association between hyperactivity and child-reading time, there are other factors that may be correlated with hyperactivity and reading time, and those factors may be driving the results. To account for such possible influences, in the baseline model, I regress time devoted to reading to children on hyperactivity as well as an extensive set of covariates. The regression specification that is used can be described as:

$$Read_i = F(\beta Hyper_i + \phi X_i + u_i) \quad (1)$$

where $Read_i$ represents either the pseudo-continuous variable regarding how often child *i* is read to (ranging from 1-60 times per month) or the binary variable of being read to at least once daily. I use ordinary least squares (OLS) for the regressions with the pseudo-continuous reading measure and a logit regression model for the binary measure. $Hyper_i$ provides the measure of hyperactivity for child *i* (either the continuous measure from 0 to 14 or the binary variable for high hyperactivity scores of 7 or more out of 14), and *X* is a vector of covariates that represent characteristics of the child, the parents and the household in the cycle of the outcome. The child characteristics include a dummy variable to identify boys and age in months at the time of the survey. I control for parental characteristics using a dummy variable to identify PMKs who are immigrants, maternal age at birth, a dummy variable for young mothers (younger than 21 years old at birth), and a dummy variable for PMKs with less than a post-secondary degree/diploma. To capture available parental time in the household, I use a dummy variable to identify lone-parent households and the work status of the PMK (full-time and part-time; not-working outside the home is the base). Household characteristics include logged real household equivalent before-tax income as well as rural residence and region of residence (Ontario is the base). Indicator variables to control for cycle effects are also included.

While the above model controls for many factors that may be correlated with hyperactivity and time spent reading to children, bias may still arise due to unobserved heterogeneity. One source of omitted variables is at the family level. For example, characteristics such as genetics, parenting styles, family background and home environment may not only influence a child's level of hyperactivity but also how often the child is read to. To control for household-level influences, family fixed effects models with for sibling pairs are used. The OLS model with the addition of family fixed effects can be described as:

$$Read_{ij} = \alpha + \beta Hyper_{ij} + \phi X_{ij} + H_j + u_{ij} \qquad (2)$$

where j indexes each family and i represents each child in the household. X_{ij} is similar to X_i above but will cancel out any observable factors that are common to both siblings. For example, observable parental or household characteristics, such as PMK education, will be excluded.[51] In the cases where the matched siblings are not found in the same cycle but certain characteristics do not change, such as province of residence, they will cancel out for that pair. H_j will capture all unobservable characteristics that may be common to both siblings in the periods of their outcomes such as genetic similarities, parenting styles, family background and home environment. An OLS model with family fixed effects estimates the differences among siblings in the household and therefore removes any unobservable influences common to the household that would be included in H_j:

$$Read_{1j} - Read_{2j} = \beta(Hyper_{1j} - Hyper_{2j}) + \phi(X_{1j} - X_{2j}) + (u_{1j} - u_{2j}) \qquad (3)$$

Comparison of the coefficient estimates of hyperactivity on reading time from the OLS regressions against the OLS with family fixed effects results will indicate if unobserved factors common to the household are driving the results.

Given the differences in reading frequency across PMK and child characteristics by level of hyperactivity as presented in Figure 4-6, I also estimate if the effects of hyperactivity differ by PMK education, child gender and birth order. To do this, equation (2) is extended to include an interaction between each characteristic and the hyperactivity

[51] This will only necessarily be the case if the household or parental characteristic is taken from the same cycle for both siblings. Since the siblings may come from different cycles, this will not always apply.

measure. For example, with gender:

$$Read_{ij} = \alpha + \beta Hyper_{ij} + \rho Hyper_{ij} * Girl_i + \gamma Girl_i + \phi X_{ij} + H_j + u_{ij} \qquad (4)$$

The family fixed effects model is estimated by taking the differences among siblings as described in (3).

While OLS with family fixed effects models may improve on the OLS model, bias may still remain for two reasons. Firstly, family fixed effects models do not control for unobserved child level factors, like motivation or discipline, which might be correlated with how often others read to them and their scores of hyperactivity. While child-level fixed effects would remove such characteristics, since scores of hyperactivity do not vary much over time (except in cases of diagnosis of ADHD with treatment, which are presumed to be few[52]), this strategy will not work. Secondly, if it is the case that the high hyperactivity of one sibling has a negative effect on how often the other sibling is read to then the difference between the two siblings will provide an underestimate of the influence of hyperactivity.[53] I investigate these spillover effects in Section 4.7.

4.6 Empirical Results

Table 4-2 presents the OLS regression results of the relationship between measures of reading to 3 and 4 year olds and measures of hyperactivity. The measure of parent-child reading includes the pseudo-continuous reading frequency ranging from 1 to 60 times per month and a binary variable to identify children that are read to at least once a day. The measures of hyperactivity include the continuous hyperactivity score ranging from 0 to

[52] There are no questions regarding diagnosis of ADHD in cycles 1 to 3. However, in the sample for this analysis, only 2 boys and 1 girl report being treated with Ritalin (a medication commonly prescribed for the treatment of ADHD). Also, using later cycles of the NLSCY, Brault and Lacourse (2012) find that only roughly 1 percent of preschoolers (children aged 3 to 5) in Canada were diagnosed with ADHD in both 2000 and 2007.

[53] Another potential issue would arise if many children were being treated for hyperactivity, and treatment lowered their symptoms of hyperactivity but had no effect on the frequency of being read to. This would bias the estimates downward. This is not an issue since there are only 2 boys and 1 girl that are reported to be taking Ritalin.

14 and a binary variable to identify children with a high hyperactivity score of 7 or more out of 14. Regardless of the measure used for either variable, the results indicate that children with higher hyperactivity are read to less often. To gain a better idea of the size of the results (coefficient estimates for OLS results and odds ratios for the logit results), it is useful to compare associations between reading frequency and the estimates for the dummy variables for PMKs who haven't completed PSE, which are also consistently statistically significant. Using the logit results expressed as odds ratios on being read to at least once daily in Column 4, compared to children whose PMK has a post-secondary degree or diploma, the odds of being read to at least once daily decreases by 32 percent for children with a PMK without PSE. Similarly, a child with a high hyperactivity score of 7 or more out of 14 is 36 percent less likely than a child with low hyperactivity to be read to daily or more. The association between having high hyperactivity (versus low hyperactivity) and reading is similar in size to having a PMK who hasn't completed post-secondary education (versus a PMK who has completed PSE).

Several other variables have statistically significant associations across all specifications. Being the oldest child in the household is positively related to being read to. Mother's age at birth is also positively associated with the frequency with which children are read to. There are also regional differences. Relative to children living in Ontario, children from Quebec are read to less often. Children living in rural areas are more likely to be read to once a day or more than children from urban areas (but there is no significant relationship in terms of frequency of reading per month).

Table 4-3 presents the family fixed effects estimates to examine the robustness of the results in Table 4-2.[54] Panel A of Table 4-3 reproduces the estimates from Table 4-2 regarding the relationship between children's hyperactivity scores and parent-child reading time and Panel B presents the corresponding fixed effects estimates. When using the continuous hyperactivity score, the fixed effect results are very similar to the

[54] The NLSCY includes one set of sampling weights per child. In order to estimate the fixed effects regression in Stata, only one weight can be applied for each unit of analysis, which here is the sibling pair. As there are only small differences in weights between the children from the same household, the average of their weights was applied.

estimates in Table 4-2 suggesting that unobserved household characteristics common to siblings are not driving those results. The lack of change in the estimates after controlling for unobserved household heterogeneity suggests that it is less likely that unobserved individual heterogeneity is biasing the estimates. While the fixed effects estimates when using the high hyperactivity measure continue to suggest a negative relationship between hyperactivity and reading time, both coefficient estimates decrease in terms of magnitude or precision (or both for the OLS estimate), and are no longer statistically significant.

Panels C, D and E of Table 4-3 present the regression estimates with interactions for PMK education, gender and birth order respectively. In Panel C, each hyperactivity measure is interacted with a dummy variable for children with a PMK with less than completed PSE. According to these results, only children of lower educated PMKs are read to less often. These findings suggest that lower educated PMKs may not have the same ability as their higher-educated peers to deal with children that are more hyperactive.

Panel D provides estimates regarding the difference in the effect of hyperactivity on reading time by gender. None of the interaction terms are statistically significant suggesting that hyperactivity has the same influence on being read to for both boys and girls. Also, none of the main estimates are statistically significant, either because of a decrease in terms of magnitude or precision or both. However, more boys will be affected since more boys are hyperactive.

Finally, Panel E asks whether effects of hyperactivity on reading differ by birth order. In all four regressions estimates, none of the interaction estimates are statistically significant. The only significant relationship is between the pseudo-continuous hyperactivity score and reading at least once daily – and is similar to the original fixed effects results in Panel B. As in the case of gender, these results suggest that the influence of hyperactivity on reading does not differ by birth order.

In results not shown, I drop all the children with high hyperactivity and estimate the regressions with the continuous hyperactivity score and the two measures of reading. The results are very similar to those in Table 4-3 and suggest that it is not just children with high levels of hyperactivity that suffer detrimental effects. Currie and Stabile (2006) and Chen *et al.* (2012) also find relationships with school outcomes and low levels of symptoms of hyperactivity.

4.7 Sibling Effects

As discussed in Section 4.5, one concern with family fixed effects estimates in this context is the possibility of sibling spillover effects. To address this, I estimate OLS and logit regressions similar to equation (1) but including a variable to capture siblings' hyperactivity:

$$Read_i = \alpha + \beta Hyper_i + \beta SibHyper_i + \phi X_i + u_i \qquad (5)$$

where $SibHyper_i$ denotes the measure of hyperactivity for child *i*'s sibling. As this analysis is estimating the influence of sibling's hyperactivity on a child being read to, it is important that the information for both siblings is from the same period. The sample for these regressions still only includes children from two-child households but they are seen during the same cycle rather than that at the same age. Naturally, as in the preceding sample, the sample includes both the oldest and second-born child for each household. To have a large enough sample to allow for analyses, the sample is extended to include children aged 2 to 4 years old.

Panels A, B and C of Table 4-4 presents the OLS results for all children, the first-borns and second-borns respectively.[55] When the continuous hyperactivity measure is used both the OLS and logit coefficient estimates for own and sibling's hyperactivity show a negative relationship and are statistically significant. When the high hyperactivity measure is used only the sibling effect is significant. These results suggest that family

[55] While recent research (Price 2008) suggests that, on average, parents spend roughly the same amount of time with each child at any given point in time, the influence of hyperactivity on reading time may vary between children in the same period.

fixed effects results will be underestimated – a sibling's high hyperactivity may reduce the reading time of the other child regardless their own level of hyperactivity. When examining human capital outcomes, Fletcher and Wolfe (2008) also find that siblings' hyperactivity is negatively related to the outcomes of the other child.

Previous research suggests that the influence of siblings may depend on birth order (Buckles and Munnich 2012).[56] Panel B presents the results for the same regressions in Panel A but only for the first-born children. For all regressions, the younger sibling's hyperactivity has a negative and statistically significant association with the older sibling's reading time. Interestingly, while the regression estimates for the older child's own hyperactivity suggest a negative relationship with reading time, none are statistically significant. Conversely, the results in Panel C for the younger sibling suggest that both higher hyperactivity for the older sibling and for one's self is related to less reading time. These results suggest that one's own hyperactivity does not have the same effect on reading time among first born children as second-born children.

I take this analysis of sibling effects further in Tables 4-5 and 4-6 by examining the relationship between own and sibling hyperactivity and reading after dropping children who themselves have high hyperactivity and then dropping those whose sibling has high hyperactivity. Table 4-5 presents the results for the first-born children. The first four columns present the estimates when the oldest children who are considered as having high hyperactivity have been dropped. Similar to the results in Table 4-4, own hyperactivity is not statistically significant but higher hyperactivity for his/her sibling is negatively and significantly associated with reading time. The last four columns present

[56] Buckles and Munnich (2012) examine the influence of spacing on cognitive outcomes separately for the older and younger children in sibling pairs. They find that having a sibling less than 2 years younger has a negative effect on test scores but that having a sibling who is less than 2 years older has no effect on the younger sibling's test scores.

the estimates after siblings with high hyperactivity have dropped. Neither own nor sibling's hyperactivity is associated with the oldest reading time.

Table 4-6 presents the results for the second-born children. The first four columns show that, after dropping the second-born children with high hyperactivity, higher hyperactivity for their sibling is associated with less reading time. Interesting, low levels of symptoms of own hyperactivity remain negatively and statistically related to own reading. In the last four columns, after dropping the first-born children with high hyperactivity, own hyperactivity continues to have a negative influence but sibling hyperactivity is no longer related to the second child's reading time.

Overall the estimates from Table 4-5 and 4-6 suggest that when the second-born has higher hyperactivity, both the first-born and second-born are read to less. However, when the first-born has high hyperactivity, the second-born is read to less but the first-born is unaffected. This could be because parents establish stronger reading practices with the first-born prior to the second child's birth, and these practices continue into later years regardless the child's level of hyperactivity.

4.8 Conclusion

Using a sample of children aged 2 to 4 years old from the Canadian National Longitudinal Survey of Children and Youth and regression analyses, I explore relationships between children's symptoms of hyperactive behaviour and time spent being read to. There are several key findings. First, family fixed effects estimates suggest that children who have higher hyperactivity are read to less. However, results from regressions with interactions suggest that this relationship is only present when the PMK (usually the biological mother) has less than a completed post-secondary degree or diploma. Interactions of hyperactivity and first-born, and hyperactivity and a boy dummy variable do not show statistically significant differences suggesting that associations between hyperactivity and reading time do not differ by birth order or gender.

The second main finding is based on regression estimates for reading time that include a measure of own and sibling hyperactivity. Both own hyperactivity and sibling's hyperactivity negatively influence the amount of time devoted to reading to the child. This suggests that family fixed effect estimates of hyperactivity on reading time may be underestimated.

Finally, when these regressions for reading time that control for sibling's and own hyperactivity are examined for first-born and second-born children, interesting differences arise. The results for first-born children show that increases in sibling, but not own, hyperactivity are negatively related to reading time. The same is not true for the younger sibling. Reading time for second-born children decreases for higher levels of own or sibling hyperactivity. One explanation for this result is that parents establish stronger reading practices with the first-born prior to the second child's birth, potentially despite more symptoms of high hyperactivity, and this foundation continues into later years.

Taken together these findings suggest that additional support to parents (usually mothers) with children with higher symptoms of hyperactivity may be beneficial. This may be particularly true for children of lower educated parents. Not only will the child with higher hyperactivity benefit but possibly also his or her sibling. This analysis also provides some evidence to support the establishment of strong reading practices in the early years, as it may help to develop routines, regardless the level of hyperactivity, that encourage development at later ages.

Figure 4-1: Distribution of hyperactivity score

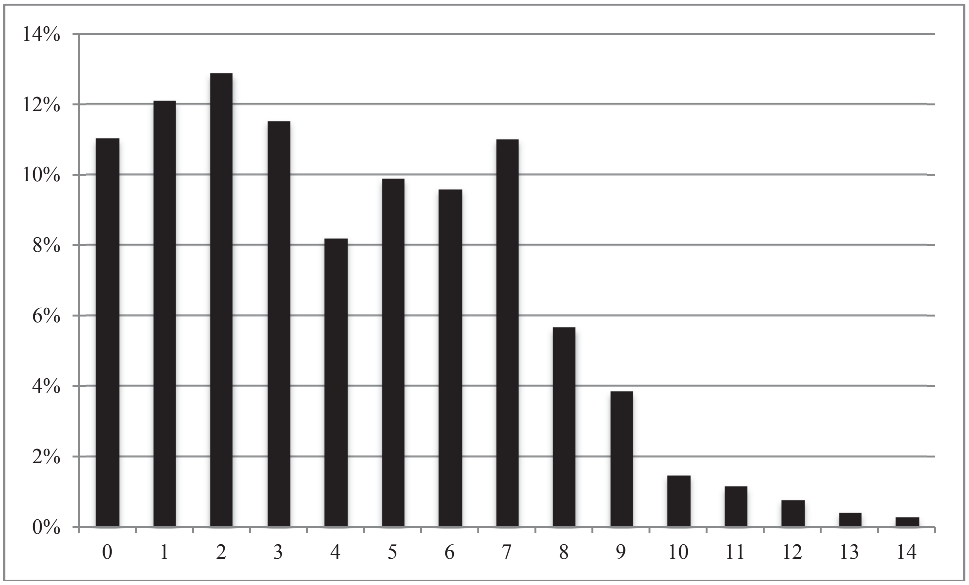
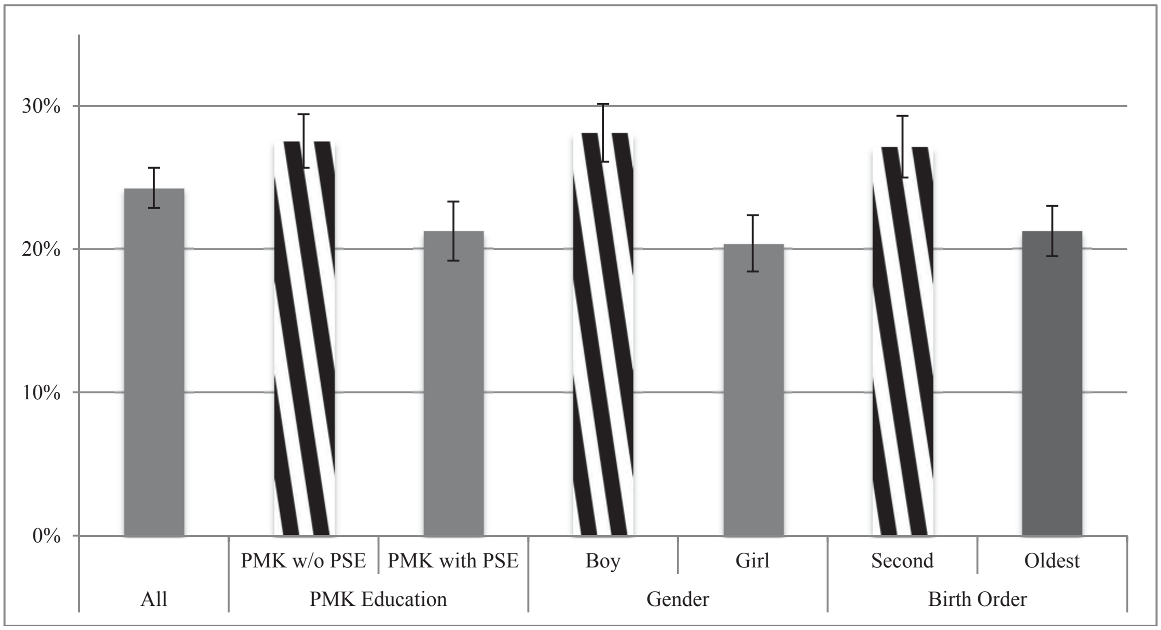
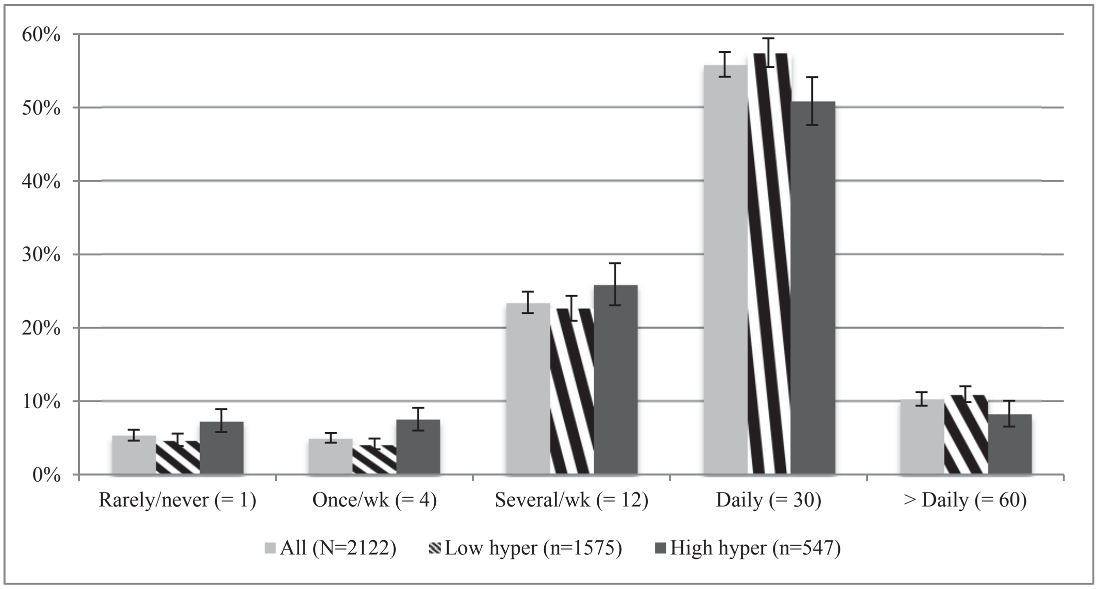


Figure 4-2: Incidence of high hyperactivity (≥ 7 out of 14)



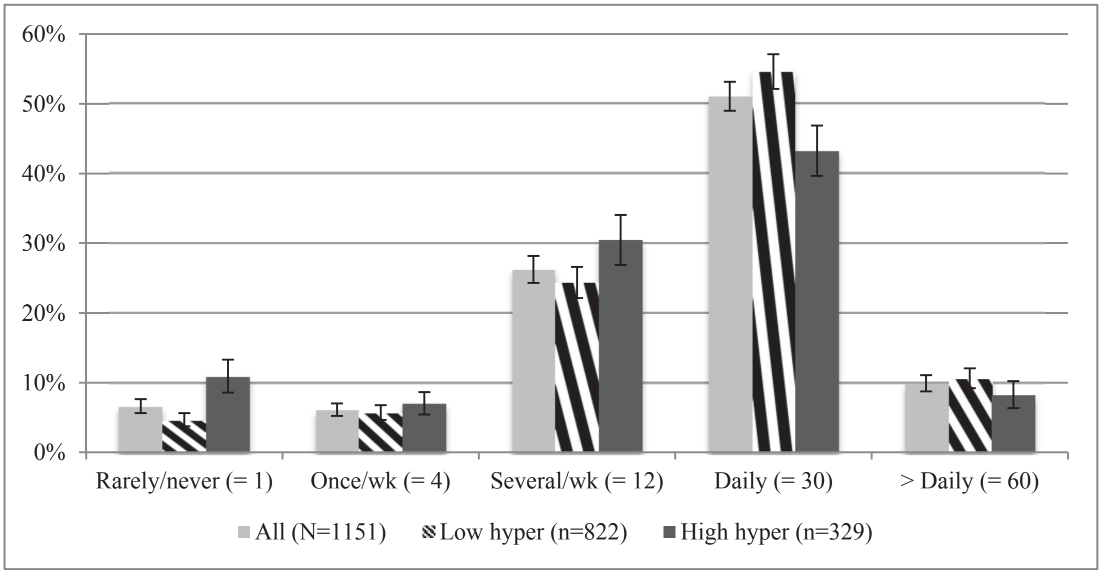
Error bars: ±1 SE

Figure 4-3: Frequency of reading to children, ages 3 to 4



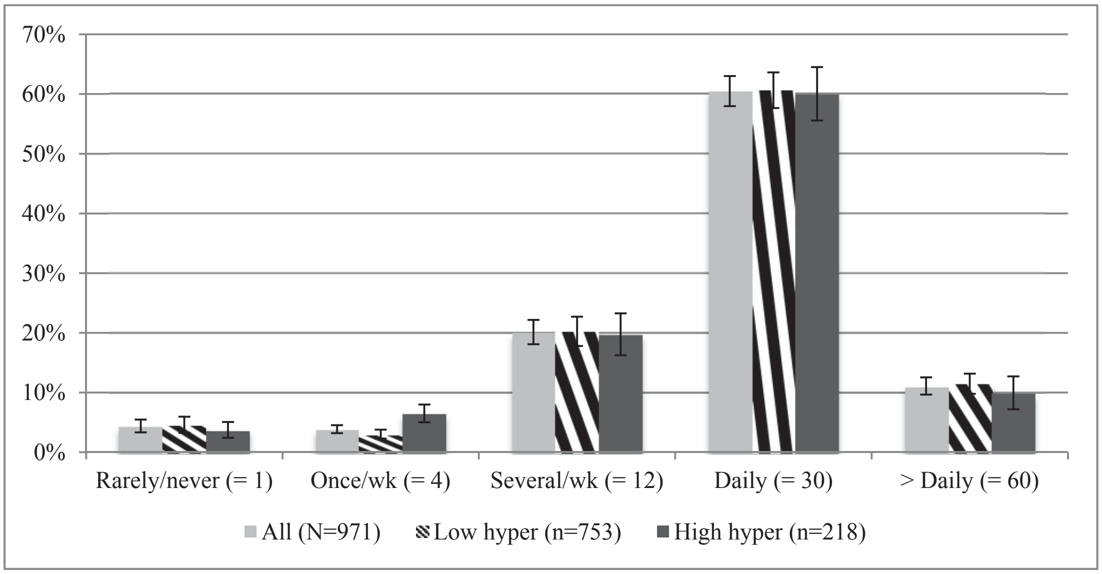
Error bars: ±1 SE

Figure 4-4: Frequency of reading to children ages 3-4, PMK without PSE



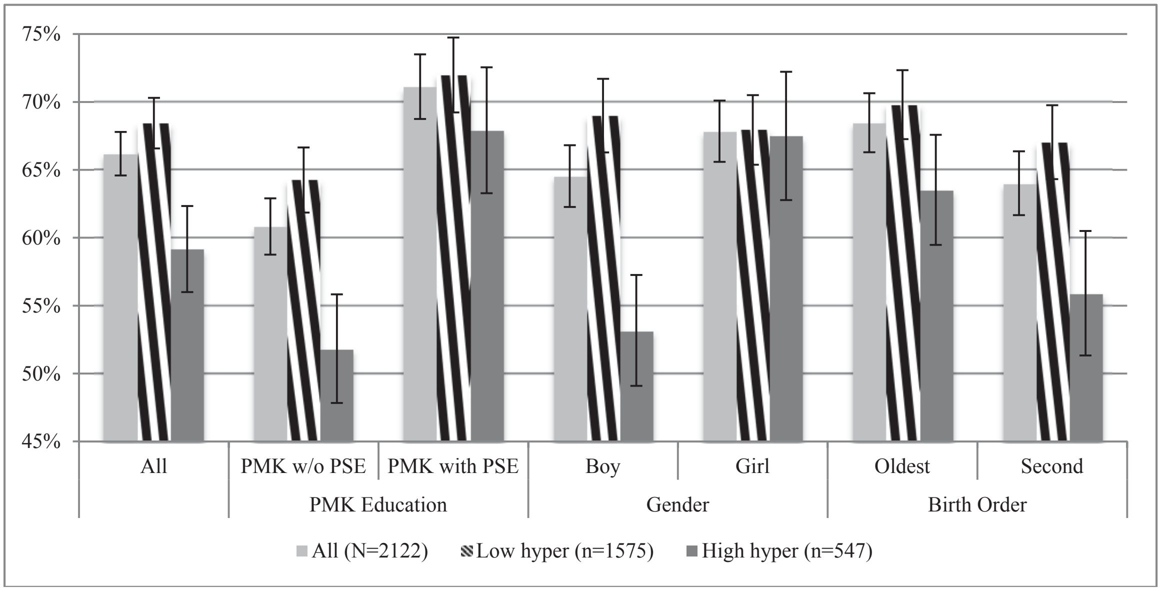
Error bars: ±1 SE

Figure 4-5: Frequency of reading to children ages 3-4, PMK with PSE



Error bars: ±1 SE

Figure 4-6: Daily or more reading by hyperactivity, ages 3-4



Error bars: ±1 SE

Table 4-1: Means of key variables for full sample and by hyperactivity (high hyperactivity score: ≥ 7 out of 14)

	All	Low hyperactivity	High hyperactivity	Diff
Frequency of reading to children aged 3 to 4 (1-60)	26.0	26.8	23.7	-3.0***
Daily or more reading to children aged 3 to 4	66.2%	68.4%	59.2%	-9.3%**
High hyperactivity score (≥ 7 out of 14)	24.3%	-	-	-
Oldest child in household	48.9%	50.8%	42.8%	-8.0%**
Boy	50.2%	47.6%	58.1%	10.5%***
Child age in months	48.7	48.8	48.4	-0.4
PMK is immigrant	12.4%	13.0%	10.6%	-2.4%
PMK is lone parent	9.8%	8.3%	14.6%	6.3%*
Mother's age at birth	28.5	28.8	27.7	-1.1
Mother under 21 at birth	4.9%	4.2%	7.0%	2.9%**
Log equivalent household income (2002 $)	10.2	10.2	10.1	-0.1
PMK works part-time	23.9%	24.5%	22.2%	-2.3%
PMK works full-time	48.9%	48.6%	49.9%	1.3%
PMK doesn't have completed PSE	47.9%	45.8%	54.4%	8.5%**
Rural residence	19.6%	19.9%	18.6%	-1.3%
Atlantic	7.3%	7.2%	7.7%	0.5%
Quebec	25.8%	27.5%	20.3%	-7.2%**
Prairies	18.0%	17.3%	20.2%	2.8%
BC	11.4%	11.8%	10.0%	-1.8%
Cycle 2	45.4%	46.3%	42.6%	-3.8%
Cycle 3	28.2%	28.3%	28.0%	-0.2%
Number of observations	2122	1575	547	2122

Source: NLSCY, Cycles 1-3

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4-2:OLS results of reading to children ages 3-4 on hyperactivity score

	OLS – Reading per month (1-60)		Logit - Daily reading†	
Hyperactivity score (0-14)	-0.536***	-	0.908***	-
	(0.143)		(0.0220)	
High hyperactivity score (≥ 7 out of 14)	-	-2.877***	-	0.636***
		(0.960)		(0.104)
Oldest child in household	2.506**	2.609**	1.467*	1.501**
	(1.137)	(1.128)	(0.292)	(0.294)
Boy	-1.146	-1.304	0.921	0.892
	(0.939)	(0.937)	(0.151)	(0.146)
Child age in months	-0.122*	-0.115	0.994	0.996
	(0.0702)	(0.0702)	(0.0106)	(0.0106)
PMK is immigrant	-2.593	-2.473	0.673	0.686
	(1.816)	(1.847)	(0.252)	(0.259)
PMK is lone parent	-1.221	-1.359	0.839	0.820
	(1.520)	(1.531)	(0.218)	(0.210)
Mother's age at birth	0.197*	0.211*	1.078***	1.079***
	(0.116)	(0.113)	(0.0238)	(0.0236)
Mother under 21 at birth	0.255	0.254	0.956	0.950
	(2.118)	(2.104)	(0.326)	(0.318)
Log equivalent household income (2002 $)	1.489	1.431	0.977	0.966
	(0.990)	(0.982)	(0.195)	(0.191)
PMK works part-time	-0.231	-0.380	0.976	0.945
	(1.402)	(1.390)	(0.245)	(0.237)
PMK works full-time	-1.710	-1.825	0.736	0.723
	(1.277)	(1.273)	(0.181)	(0.177)
PMK doesn't have completed PSE	-1.377	-1.545	0.697**	0.676**
	(1.007)	(1.008)	(0.126)	(0.121)
Rural residence	1.476	1.473	1.394*	1.386*
	(1.283)	(1.305)	(0.271)	(0.274)
Atlantic	2.272*	2.182*	1.555*	1.518*
	(1.295)	(1.301)	(0.353)	(0.343)
Quebec	-9.700***	-9.632***	0.181***	0.188***
	(1.185)	(1.204)	(0.0379)	(0.0394)
Prairies	0.826	0.732	1.081	1.065
	(1.305)	(1.299)	(0.256)	(0.251)
BC	3.748**	3.802**	1.254	1.272
	(1.753)	(1.768)	(0.355)	(0.361)
Cycle 2	-0.679	-0.580	0.971	0.994
	(1.244)	(1.233)	(0.193)	(0.196)
Cycle 3	-0.865	-0.751	0.916	0.940
	(1.558)	(1.532)	(0.252)	(0.253)
Constant	16.75	15.18	-	-
	(10.50)	(10.33)		
Observations	2122	2122	2122	2122
R^2	0.141	0.137	0.143	0.137

Source: NLSCY, Cycles 1-3
† Logit regression results expressed as odds ratios.
Robust standard errors clustered at the household level in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4-3: Robustness of effects of hyperactivity score on reading to children, ages 3-4

	OLS - Reading per month (1-60)		Logit - Daily reading†	
A) OLS results				
Hyperactivity score (0-14)	-0.536***	-	0.908***	-
	(0.143)		(0.0220)	
High hyperactivity score (≥ 7 out of 14)	-	-2.877***	-	0.636***
		(0.960)		(0.104)
Family fixed effects	No	No	No	No
B) OLS with FE results				
Hyperactivity score (0-14)	-0.331*		0.881**	
	(0.182)		(0.0461)	
High hyperactivity score (≥ 7 out of 14)		-0.477		0.650
		(1.170)		(0.203)
Family fixed effects	Yes	Yes	Yes	Yes
C) PMK education interaction				
Hyperactivity score (0-14)	0.0391	-	1.046	-
	(0.218)		(0.0780)	
Hyper score*PMK doesn't have completed PSE	-0.716**	-	0.697***	-
	(0.332)		(0.0877)	
High hyperactivity score (≥ 7 out of 14)	-	1.007	-	1.730
		(1.350)		(0.934)
High hyper*PMK doesn't have completed PSE	-	-2.741	-	0.186**
		(2.171)		(0.125)
Family fixed effects	Yes	Yes	Yes	Yes
D) Gender interaction				
Hyperactivity score (0-14)	-0.158	-	0.900	-
	(0.318)		(0.0619)	
Hyper score*Boy	-0.323	-	0.955	-
	(0.422)		(0.0767)	
High hyperactivity score (≥ 7 out of 14)	-	1.307	-	0.895
		(1.834)		(0.370)
High hyper*Boy	-	-3.286	-	0.558
		(2.805)		(0.295)
Family fixed effects	Yes	Yes	Yes	Yes
E) Birth order interaction				
Hyperactivity score (0-14)	-0.419	-	0.865**	-
	(0.257)		(0.0583)	
Hyper score*Oldest child in household	0.188	-	1.038	-
	(0.382)		(0.0870)	
High hyperactivity score (≥ 7 out of 14)	-	-1.811	-	0.526
		(1.653)		(0.220)
High hyper*Oldest child in household	-	2.851	-	1.515
		(2.583)		(0.875)
Family fixed effects	Yes	Yes	Yes	Yes
Observations	2122	2122	508	508
Number of pairs	1061	1061	254	254

Source: NLSCY, Cycles 1-3. The OLS results in Panel A are repeated from Table 4-2. The results in Panels B-E include controls for: child birth order, child gender, child age in months, PMK's immigrant status, PMK is lone parent, young mother at birth, household income, PMK labour supply, PMK education, rural residence and region of residence.
† Logit regression results expressed as odds ratios.
Robust standard errors clustered at the household level in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4-4: OLS results with sibling effects on reading to children, ages 2-4

	OLS - Reading per month (1-60)		Logit - Daily reading†	
A) All (N = 1612)				
Hyperactivity score (0-14)	-0.378** (0.151)	-	0.944** (0.0238)	-
Sibling's hyper score	-0.487*** (0.143)	-	0.889*** (0.0217)	-
High hyperactivity score (≥ 7 out of 14)	-	-1.698 (1.168)	-	0.773 (0.139)
Sibling's high hyper	-	-3.340*** (1.123)	-	0.492*** (0.0850)
R^2/McFadden R^2	0.170	0.164	0.172	0.162
B) First-born (N = 806)				
Hyperactivity score (0-14)	-0.0692 (0.218)	-	0.955 (0.0393)	-
Sibling's hyper score	-0.570*** (0.215)	-	0.888*** (0.0371)	-
High hyperactivity score (≥ 7 out of 14)	-	-2.002 (1.534)	-	0.725 (0.193)
Sibling's high hyper	-	-4.297*** (1.412)	-	0.426*** (0.110)
R^2/McFadden R^2	0.194	0.199	0.205	0.204
C) Second-born (N = 806)				
Hyperactivity score (0-14)	-0.632** (0.260)	-	0.934* (0.0374)	-
Sibling's hyper score	-0.438* (0.256)	-	0.889*** (0.0345)	-
High hyperactivity score (≥ 7 out of 14)	-	-1.578 (1.871)	-	0.781 (0.200)
Sibling's high hyper	-	-2.128 (2.036)	-	0.577** (0.149)
R^2/McFadden R^2	0.162	0.143	0.161	0.143

Source: NLSCY, Cycles 1-3. The results controls for: child birth order, child gender, child age in months, PMK's immigrant status, PMK is lone parent, young mother at birth, household income, PMK labour supply, PMK education, rural residence and region of residence.

† Logit regression results expressed as odds ratios.

Robust standard errors in parentheses, which in Panel A are clustered at the household level.

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 4-5: Regressions for oldest child after dropping those with high hyperactivity score

	Reading per month (1-60)		Daily reading		Reading per month (1-60)		Daily reading	
	OLS	OLS	Logit	Logit	OLS	OLS	Logit	Logit
	Sibling effect when own high hyper dropped				Own effect when sibling with high hyper dropped			
Hyper	0.367	-	0.946	-	0.0106	-	0.978	-
	(0.375)		(0.0673)		(0.269)		(0.0490)	
HyperSib	-0.574**	-	0.909**	-	-0.230	-	0.922	-
	(0.251)		(0.0432)		(0.392)		(0.0680)	
HighHyper	-	-	-	-	-	-1.143	-	0.956
						(1.958)		(0.334)
HighHyperSib	-	-3.455**	-	0.565*	-	-	-	-
		(1.734)		(0.177)				
Observations	631	631	631	631	568	568	568	568
R^2	0.194	0.191	0.218	0.212	0.220	0.220	0.210	0.206

Robust standard errors in parentheses
Source: NLSCY, Cycles 1-3
The results controls for: child gender, child age in months, PMK's immigrant status, PMK is lone parent, young mother at birth, household income, PMK labour supply, PMK education, rural residence and region of residence.
† Logit regression results expressed as odds ratios.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4-6: Regressions for second-born child after dropping those with high hyperactivity score

	Reading per month (1-60)		Daily reading		Reading per month (1-60)		Daily reading	
	OLS	OLS	Logit	Logit	OLS	OLS	Logit	Logit
	Sibling effect when own high hyper dropped				Own effect when high sibling dropped			
Hyper	-1.165**	-	0.865**	-	-0.661**	-	0.928*	-
	(0.451)		(0.0617)		(0.290)		(0.0403)	
HyperSib	-0.509*	-	0.870***	-	-0.587	-	0.867**	-
	(0.302)		(0.0422)		(0.416)		(0.0593)	
HighHyper	-	-	-		-	-2.219	-	0.750
						(2.116)		(0.228)
HighHyperSib	-	-3.840*	-	0.490**	-	-	-	-
		(2.122)		(0.156)				
Observations	568	568	568	568	631	631	631	631
R^2	0.214	0.185	0.205	0.176	0.164	0.143	0.155	0.135

Robust standard errors in parentheses
Source: NLSCY, Cycles 1-3
The results controls for: child gender, child age in months, PMK's immigrant status, PMK is lone parent, young mother at birth, household income, PMK labour supply, PMK education, rural residence and region of residence.
† Logit regression results expressed as odds ratios.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Chapter 5 Conclusion

There are large existing literatures showing the consequences associated with improvements in cognitive outcomes, behavioural outcomes, reading investment and involvement in risky behaviours among children. The purpose of this dissertation is to provide further insights into the determinants of these developmental outcomes that may influence future policies related to child well-being. The analyses for all three essays included in this dissertation take advantage of the wealth of information provided by the Canadian National Longitudinal Survey of Children and Youth (NLSCY).

The first essay provides evidence that additional birth weight is beneficial for cognitive and behavioural outcomes among children. These results have two policy implications. First, these findings provide support for programs such as the Canada Prenatal Nutrition Program (CPNP) and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in the US, both of which promote proper prenatal care with the objective of encouraging healthy birth weight among infants. Second, since the adverse effects of lower birth weight can already be seen in the early years, resources can be directed towards children to reduce the continuation of such effects on human capital and labour market outcomes later in life.

In the second essay, I find that parental work schedules play an important role in adolescents' involvement in risky behaviour, especially for boys. Non-standard parental work schedules are positively related to fighting, drinking and doing drugs among boys and fighting among girls. The estimated link between parental work schedules and adolescent's engagement in risky activities suggests that policies directed at supporting shift-working parents may be effective in improving adolescents' development. Examples of such policies include more high-quality after-school and weekend programs, and increased flexibility in arranging work schedules for shift workers. This analysis also provides evidence that fathers' work schedules matter, suggesting that fathers play an important role in parenting adolescents. Additional policies that promote father's involvement in caring for children, akin to the parental leave benefits available to fathers in the first year of a child's life, may have short-term as well as long-term consequences that benefit children across a variety of outcomes.

Finally, in the third essay, I present estimates that suggest that children aged 3 to 4 who have higher hyperactivity are read to less by parents or other adults. However, interactions results suggest that this relationship is only present when the person most knowledgeable of the child (usually the biological mother) has less than a completed post-secondary degree or diploma. I also provide evidence that siblings' level of hyperactivity also negatively influences time spent reading to the other child. Such findings may imply that family fixed effect estimates of hyperactivity on reading time may be underestimated. Overall, these findings suggest that additional support to parents with children with higher symptoms of hyperactivity may be beneficial, and this may be particularly true for children of lower educated parents. Not only will the child with higher hyperactivity benefit but possibly also his or her sibling. This analysis also provides some evidence to support the establishment of strong reading practices in the early years and at school, as it may help to develop routines, regardless the level of hyperactivity, that encourage development at later ages.

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