# Child Mental Health and Human Capital Accumulation:

# The Case of ADHD

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**Abstract:**

We examine U.S. and Canadian children with symptoms of Attention Deficit Hyperactivity Disorder (ADHD), the most common child mental health problem. Our work offers a number of innovations. First we use large national samples and focus on an ADHD screener that was administered to all children rather than on small samples of diagnosed cases. Second, we address omitted variables bias by estimating sibling-fixed effects models as well as instrumenting for possible measurement error in reports of ADHD symptoms. Third, we examine a range of outcomes and compare the effects of ADHD to the effects of physical health conditions. Fourth, we ask how the effects of ADHD and treatment for ADHD are mediated by income.

We find that ADHD has large negative effects on test scores and schooling attainment and the effects are much worse than those of physical health problems. The results are qualitatively similar in the U.S. and Canada, and are robust to many changes in specification. The test scores of higher income children suffer as much from ADHD as those of lower income children, though high income children are less likely to be retained in grade. Surprisingly, there appears to be little effect of income on the probability of treatment conditional on hyperactivity scores. A third finding is that even children with relatively low levels of symptoms suffer negative effects. The severity of the effects and the pervasiveness of the symptoms suggest that efforts to find better ways to teach the relatively small number of children diagnosed with ADHD could have a larger payoff in terms of improving the academic outcomes of large numbers of children with milder symptoms.

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Adult mental health problems are a major cause of lost work time and health care costs. For example, Ettner, Frank and Kessler (1997) show that psychiatric disorders reduce employment and earnings among both men and women. Currie and Madrian (1999) conclude that the labor market consequences of mental health problems are large relative to the consequences of physical health problems, since the former are more likely than the latter to afflict those of working age. Many adult mental health conditions have their origins in childhood, so that in addition to direct effects, mental health problems may reduce adult earnings and employment indirectly by inhibiting the child's accumulation of human capital. While the economics literature recognizes that physical health problems can impede children's human capital accumulation (c.f. Grossman and Kaestner, 1997), the link between mental health problems and human capital accumulation has received little attention.

This paper examines the experience of U.S. and Canadian children with symptoms of Attention Deficit Hyperactivity Disorder (ADHD), the most common chronic mental health problem among young children. It is difficult to find definitive estimates of differences in the prevalence of ADHD. Most studies are based on diagnosed cases and there is considerable controversy about whether ADHD is over (or under) diagnosed. Jensen et al. (1999) estimate that 5.1 percent of American children met diagnostic criteria for ADHD while Cuffe et al. (2003) estimate that 4.19 percent of children have "clinically significant" symptoms.

There are few longitudinal studies examining the effects of ADHD on child outcomes, but those that exist indicate that ADHD is associated with significantly worse outcomes. But it is possible that poorer outcomes reflect other problems suffered by children with ADHD. For example, in the U.S., estimated prevalence rates are almost twice as high in families with income less than $20,000 compared to families of higher income (Cuffe et al. 2003). Poor children with

ADHD may also receive less effective treatment than other children, and thus be at "double jeopardy" for ill effects.

We investigate these issues using data from the Canadian National Longitudinal Survey of Children and Youth, and the American National Longitudinal Survey of Youth. Our work offers a number of new contributions. First, we focus on an ADHD screener that was administered to all of the children in two large national data sets rather than only on diagnosed cases. Second, we address the possibility of omitted variables bias by estimating sibling-fixed effects models as well as instrumenting for possible measurement error in reports of ADHD symptoms. Third, we examine a range of outcomes and compare the effects of ADHD to the effects of physical health conditions. Fourth, we ask how the effects of ADHD and treatment for ADHD are mediated by income.

We show that ADHD symptoms increase the probability of grade repetition and special education and reduce future reading and mathematics test scores. The effects are large relative to those of physical health problems such as chronic conditions: A score at the $90^{th}$ percentile of the hyperactivity score increases the probability of grade repetition by 6 percentage points in Canada, and by 7 percentage points in the U.S., while having been diagnosed with a chronic condition such as asthma does not have a significant effect. Higher income children suffer as much as lower income children in terms of effects on reading and mathematics test scores, though they are less likely to be retained in grade. Surprisingly, there is also little difference in probability of treatment conditional on hyperactivity scores between high and low income children. We find negative effects even among children whose relatively low levels of symptoms make it unlikely that they would ever be diagnosed or treated for ADHD. This

finding suggests that if better ways could be found to teach the relatively small number of children diagnosed with ADHD many other children with low levels of symptoms might benefit.

## II. Background and Previous Literature

The prevalence and importance of child mental health problems have been increasingly recognized in recent years. For example, the 1999 U.S. Surgeon General's Report (U.S. DHHS, 1999) states that approximately one in five children and adolescents in the U.S. exhibit the signs or symptoms of mental or behavioral disorders. Similarly, Offord et al. (1987) report that in the Canadian province of Ontario, 18% of children have moderate to severe emotional or behavioral problems.

ADHD is the most common chronic mental health problem among young children, and the disorder is diagnosed in more than half of all child mental health referrals (Mannuzza and Klein, 2000). It is characterized by an inability to pay attention (inattention) and/or hyperactivity. The main diagnostic criteria for ADHD are laid out in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (American Psychiatric Association, 1994). They are: that six or more symptoms of inattention, or six or more symptoms of hyperactivity have persisted for at least six months to a degree that is maladaptive and inconsistent with developmental level; that some of the symptoms were present before seven years of age; and that impairment from the symptom is present in two or more settings (such as home and school). The symptoms are laid out in Appendix Table 1.

The measures available in our surveys, as in most surveys, correspond to the first diagnostic criteria. That is, parents and/or teachers are asked questions about symptoms. We do not have direct information about whether the symptoms are causing impairment in various

settings, and we do not know if children have actually been diagnosed with ADHD. In recent years, concern has been expressed about the over-diagnosis of ADHD, and about the increasing use of stimulants such as Ritalin to regulate the behavior of these children. Given that the diagnosis of ADHD depends on a subjective evaluation of whether or not the child's symptoms are causing impairment, we believe that it is preferable to examine the extent to which children exhibit symptoms, as we do below.[1]

Treatment for ADHD generally consists of drug treatment (with stimulants such as methylphenidate or amphetamine), psychiatric counseling for parents and children aimed at behavioral modification, or both. Drug therapy is effective in improving behavior for approximately 70 to 80 percent of children, though in some cases side effects (such as insomnia and loss of appetite) can make drugs difficult to use. However, in their review of the literature, Swanson et al. (1991) indicate that there is little evidence that drug treatment consistently improves academic performance.

They point to two reasons for mixed results of drug therapy. First, drug doses that are too high may impair cognitive functioning. For simple tasks, the performance of ADHD children improves linearly with dose, while for tasks that require mental effort performance improves at low doses and then declines. They conclude that the doses administered to control behavior may be higher than optimal for improving academic performance.[2] Second, there are children whose

[1]Most of the literature focuses on children who have been diagnosed with ADHD. However, in a large sample of English children Merrell and Tymms (2001) show that symptomatic children who have not been diagnosed have lower reading and math scores than other children.

[2] A large-scale controlled trial compared four treatments for ADHD: 1) Medication alone, where dose was carefully calibrated to achieve optimal results; 2) Behavioral therapy alone; 3) A combination of the first two; 4) A group which received the normal treatments available in the community—two thirds of this group got drug treatment. Results of 1) and 3) were similar and superior to the other treatments in terms of effects on behavior, though 3) achieved the same effect with lower drug doses (Wigal, 1999). The relatively poor performance of 4) suggests that the drug treatment that many children receive in their communities is suboptimal.

performance on cognitive tests does not improve with drug therapy at all, and may even be impaired. Some studies suggest that up to 40 percent of children treated with stimulant drugs do not have any favorable cognitive response.

A third possibility is related to the fact that children with ADHD also suffer from a higher than normal incidence of learning disorders, conduct disorders, and anxiety/depression. It is possible that conventional ADHD treatment addresses behavioral problems without addressing other, related, learning disabilities. It is even possible that successful treatment of behavioral symptoms makes it less likely that children with other learning problems will receive help for those problems (though we are not aware of any evidence on this point).

A fourth factor that complicates research on the effects of ADHD and research on the effectiveness of treatment is that, as discussed above, the prevalence of ADHD is related to income. This finding has been demonstrated in both of the data sets we use here (in the NLSY by Korenman, Miller and Sjaastad , 1995 and McLeod and Shanahan, 1993 and the NLSCY by Dooley et al., 1998; Dooley and Stewart, 2003; Phipps and Curtis, 2003) and in other data sets.[3] For example, Lipman et al. (1994) find that the incidence of hyperactivity is three times higher for poor children than for non-poor children in Ontario, Canada. However, Dooley et al. (1998) argue using the NLSCY data that lone motherhood is actually a more important predictor of ADHD than poverty, suggesting that it is also important to control for family structure and other potential confounders when investigating the effects of ADHD.

Mannuzza and Klein (2000) review three studies of the long-term outcomes of children with ADHD from the literature in medicine and psychology. In one study, children diagnosed

[3] Rather than using the hyperactivity scales, Phipps and Curtis focus on a single question: "How often would you say that (your child) can't sit still, is restless, or hyperactive". They treat a second question about trouble

with ADHD were matched to controls from the same school who had never exhibited any behavior problems or failed a grade; in a second study, controls were recruited at the 9-year follow up from non-psychiatric patients in the same medical center who had never had behavior problems; and in a third study, ADHD children sampled from a range of San Francisco schools were compared to non-ADHD children from the same group of schools.

These comparisons consistently show that the ADHD children had worse outcomes in adolescence and young adulthood than the control children. For example, they had completed less schooling and were more likely to have continuing mental health problems. However, studies that exclude children with any behavior problems from the control groups may overstate the causal effects of ADHD. These studies do not address the possibility that the negative outcomes might be caused by other factors related to ADHD, such as poverty. And these studies do not ask whether outcomes were better for ADHD children who were treated—in fact, there appears to be virtually no research examining the longer-term effects of treatment on achievement (Wigal et al., 1999).

There is also a literature in sociology and economics looking at the longer term consequences of a broader set of behavior problems in larger samples than are typically used in psychology. For example, Farmer (1993, 1995) uses data from the British National Child Development Survey (the NCDS) which follows the cohort of all British children born in a single week in March 1958, to examine the consequences of childhood "externalizing" behavioral problems on men's outcomes at age 23. She finds that children who fell into the top decile of an aggregate behavior problems score at ages 7, 11, or 16 had lower educational

concentrating as an additional domain of child well being.

attainment, earnings and probabilities of employment at age 23.[4] Gregg and Machin (1998) use the NCDS data and find that behavioral problems at age 7 are related to poorer educational attainment at age 16, which in turn is associated with poor labor market outcomes at ages 23 and 33. A similar study of a cohort of all New Zealand children born between 1971 and 1973 in Dunedin found that those with behavior problems at age 7 to 9 were more likely to be unemployed at age 15 to 21 (Caspe et al., 1998).[5]

Besides our focus on North America, our work differs from the previous work with these cohort data sets in several respects. First, we estimate sibling fixed-effects models to control for omitted variables bias. Fixed effects methods offer a powerful way to control for unobserved or imperfectly measured characteristics of households that might be associated both with a higher probability of ADHD and with outcomes. Second, these previous papers focus on behavior problems as measured by the sum of responses to a wide variety of questions about children's behavior, and do not attempt to focus on any specific syndrome that might be amenable to mental health treatment.[6] Third, the NCDS has no data on family income during childhood, so it is not possible to examine the relationships between mental health problems, treatment, income, and outcomes.

[4] Her regressions control for parent's aspirations for the child, the type of school attended, the ability group of the child, and whether they are in special education. Hence, her analysis attempts to measure the effects of externalizing behavior over and above its effects on these determinants of educational attainment.

[5] Other psychological studies have examined the longer term impact of different types of behavior, such as aggression (see Richard Tremblay's many studies of a cohort of Montreal school boys). However, a survey of this literature is beyond the scope of this paper.

[6] A limited amount of work has examined the consequences of specific mental health problems in adolescents. Mullahy and Sindelar (1989) examine the impact of adolescent alcoholism on earnings and employment, and conclude that the onset of alcoholism before age 18 reduces earnings and employment through its effect on schooling attainment. Cuellar, Markowitz, and Libby (2003) show that adolescents in the Colorado state foster care program who received treatment for their mental health problems were less likely to engage in crime.

Another set of issues for all of these papers are the problems involved in using parental reports of children's mental health disorders. Previous research has shown that socioeconomic characteristics and parents' mental health conditions are correlated with parents' perceptions of the mental health of their children, which suggests that there may be systematic measurement error in these reports (c.f. Offord et al., 1988; Garrett, 1996; Glied et al, 1997).

Measurement error can pose significant problems for studies using fixed effects models. Since the Canadian data asks identical questions about the mental health of the child of both teachers and parents, we use parent reports as instruments for teacher reports in order to correct for measurement error. The identifying assumption is that, conditional on the teacher report and on the family fixed effect included in the model, the parent report has no independent effect on the child's test scores and other outcomes.

**3. Data**

We use data from the Canadian National Longitudinal Survey of Children and Youth (NLSCY) and from the American NLSY. The NLSCY is a national longitudinal data set which surveyed 22,831 children ages 0 to 11 and their families beginning in 1994.[7] Follow up surveys were conducted in 1996 and 1998. We restrict our sample to those children surveyed in all three cycles for an initial sample of 14,226 children. We further restrict the sample to those children who were between the ages of 4 and 11 in 1994, which yields 8,332 children. Finally, we keep only those children whose teachers were given the ADHD screener in 1994, which yields a

[7] Both surveys included siblings, though we have not used this feature of the data in our analyses.

sample of just under 4,000 children[8]. For analyses that use math and reading test scores we have a smaller sample (not all children's test scores were recorded and we discuss this further below) of approximately 2,200. We use the NLSCY data to ask how the hyperactivity score in 1994 affects treatment in 1994 and outcomes in 1998.

The NLSY began in 1979 with a survey of approximately 6,000 young men and 6,000 young women between the ages of 14 and 21. These young people have been followed up every year up to the present. In 1986, the NLSY began assessing the children of the female NLSY respondents at two year intervals. Given the differences in the design of the two studies, and the large amounts of missing data in the NLSY, we use the NLSY data to see how the average hyperactivity score measured over the 1990 to 1994 period affects the average outcomes of children in the 1998 and 2000 waves.

This procedure yields a maximum sample of 5,348 children. We restrict the age range of the NLSY children to be greater than 4 and less than 12 years of age in 1994. This restriction makes the Canadian and U.S. samples more comparable. It also improves our ability to compare across outcome measures in the NLSY. The reason is that test scores are available only for children aged 5 to 14, while measures of delinquency are available for much older children. However, estimating our models for the full available sample for each outcome measure in the NLSY yielded estimates qualitatively similar to those discussed below.[9]

[8] The questionnaire was mailed out to teachers of the NLSCY respondents. Sample sizes are reduced for the teacher questionnaire as some children were not yet attending school, some parents did not consent to having the survey contact the school, and some schools did not return completed questionnaires. We discuss the possible biases caused by this missing information, and the work Statistics Canada has done to investigate this, in our discussion of test scores later in this section. We also replicate our results using the parent reported score as the ADHD variable, which does not suffer from the lower response rate, and find similar results.

[9] The main exception is that in models similar to those in Table 8, the interaction between income and hyperactivity scores is positive in OLS using the full U.S. sample. In other words, in the sample of older NLSY children, there IS a positive relationship between income and probability of treatment conditional on hyperactivity scores.

The NLSCY offers a number of advantages over the NLSY for our analysis. First, the NLSCY began with a nationally representative sample of children in 1994. In contrast, the parents of the NLSY children represented a nationally representative cohort of teens in 1978. Since women of lower socioeconomic status tend to have children at younger ages, the NLSY sample of children is disadvantaged relative to a nationally representative cross section of children, although this is less of a problem after we have deleted the oldest children. Second, the NLSCY has better measures of physical health than the NLSY, as discussed further below. Third, the NLSCY has both parent and teacher reports of ADHD, a feature that we exploit in our analysis. However, as we will show below, the estimates are remarkably similar in the U.S. and Canada despite differences in sampling and design, which lends strength to our conclusions. We have also re-estimated all of our models using sample weights, and this did not affect our conclusions.

The measurement of ADHD is key for our analysis. In the NLSCY data, the teachers and parents of all children aged 4 through 11 in 1994 were asked a series of 8 questions taken from both the Montreal Longitudinal Survey and the Ontario Child Health Study (we list the questions in the data appendix). The responses to these questions were added together to determine a hyperactivity score for the child. Since the hyperactivity score is generated from a set of questions asked of all respondents, our measure captures a set of ADHD symptoms and is not dependent on whether the child has been diagnosed with ADHD. This avoids criticisms of mental health measures based on the set of children who seek treatment for their illness (Frank and Gertler, 1991).

The NLSY Behavior Problems Index is asked to parents of children 4 to 14. There are 26 questions asked to all children, and 2 questions asked only to children who have been to school.

Five of the questions can be used to create a hyperactivity subscale.[10] This score is standardized by the child's sex and age. We convert this standardized score to one that has the same range as the score in the Canadian data. More information about how these scores are computed in both samples is available in the data appendix.

We focus on a set of outcomes that are intended to capture the child's human capital accumulation, broadly defined. These include: Grade repetition, mathematics scores, reading scores, and special education. We also look at delinquency, which may be more closely related to the child's behaviour problems. Further details about the construction of these variables are available in the data appendix, but some general discussion is warranted here.

Grade repetition is an important outcome, in that it is predictive of eventual schooling attainment. Since whether or not someone has ever repeated a grade is a cumulative measure, we ask whether the child repeated a grade between 1994 (when hyperactivity is measured) and 1998 (2000 in the NLSY). Mathematics and reading scores are two more immediate measures of schooling attainment. The NLSY assesses children using the Peabody Individual Achievement Tests (PIATs) for mathematics and reading recognition. These tests are administered in the home.

In the NLSCY, mathematics and reading tests were administered in schools to children in grades two through ten.[11] The math test was a shortened version of the Canadian Achievement

[10] In addition to hyperactivity, there are also NLSY subscales for: antisocial, anxious, depressed, headstrong, dependent, peer conflict, and withdrawal. The questions used to form the hyperactivity subscale were selected by doing a factor analysis of more complete scales to select those questions most strongly related to the disorder. Still, a five question scale is rather limited as a screener, and one question on obsessions is perhaps inappropriately included in this subscale. A second limitation is that the screener focuses on hyperactivity and cannot be used to identify the "predominantly inattentive" ADHD subtype, which is thought by some to be a separate disorder.

[11] Of the 9,542 children eligible to receive the tests, 86 percent of parents consented to have the school board administer the tests and 97 percent of school boards consented to conduct the tests. However, due to

Test Center's Mathematical Operations test, second edition. It measures the student's ability to do addition, subtraction, multiplication and division on whole numbers, decimals, fractions, negatives, and exponents. Problem solving using percentages and the order of operations was also measured. A separate version of the test was constructed for each grade level (except for 9 and 10 which received the same test). The 1998 test included 20 questions at each level (except for level 9-10 which had 15 questions) plus 5 questions selected from the test of the next higher level. The reading comprehension test is also from the Canadian Achievement Test, second edition. Each test consists of questions about two passages, which are designed to test the student's ability to recall information, identify the main idea, and analyze the passage. In order to avoid problems with test "ceilings", children were given a short assessment at home before they took the school tests. Children who scored perfectly on the home test, were given the test of the next highest grade level.

The special education variable in the NLSY, corresponds to a parental report that the child was in a special education class in 2000. In the NLSCY, the teacher is asked whether the child received special education because of a physical, emotional, and behavioural or other problem that limited their ability to do school work. We count only students who received special education because of a mental health condition. Although this might appear to be a more restrictive protocol than in the U.S., the prevalence of positive responses is actually higher in

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administrative problems, only 65 percent of the administered tests were returned to Statistics Canada in 1998. Therefore, of the original 9,542 children eligible to take the test, we have test scores for only 5,153 children (this number represents all children in the sample, including those outside the age range we investigate). The response rate for the 1996 was significantly higher (closer to 75 percent). Using the 1996 test scores rather than the 1998 test scores yields results that are qualitatively similar to those reported below. Statistics Canada has conducted an analysis of the nonresponse, and finds that there is very little difference between responders and nonresponders along observable dimensions (such as gender, type of school, whether the children had ever repeated a grade, or the importance that the parent respondent attaches to education).

Canada than in the U.S. Special education is an important variable to consider, because special education children tend to lag behind their peers throughout their schooling and are more likely to drop out.

The measure of delinquency that we construct using NLSY data corresponds closely to that used by the U.S. Department of Justice (DIJ) for this age group. The DIJ definition includes illegal drug use or sales, "destroyed property", "stolen something worth more than $50", "committed assault", and whether they have ever been arrested (Puzzanchera, 2000). The NLSCY measure is slightly broader in that it also includes questions about whether children have been questioned by police, or have run away from home. Questions about drug use and delinquency are answered by the child in both surveys.

While the Canadian survey has very good physical health information, the health information in the NLSY is limited, and difficult to use. For example, in the NLSY, questions about chronic conditions are asked only about children who have an activity limitation, and the "poor health" question is not asked in all waves of the survey. Hence, we limit our comparison of ADHD with physical health problems to the Canadian data. In the NLSCY, the respondent is asked to rate the health of the child on a scale of 1 to 5, with 1 being poor and 5 being excellent. We define poor health as the bottom three measures on this scale. Information is also collected on chronic conditions (these include allergies, asthma, heart disease, bronchitis, epilepsy, cerebral palsy, kidney troubles, and a category for other chronic conditions) for all children.[12]

[12] It is possible that a parent might classify a child with mental health problems but no physical health problems as in poor health. However, the correlation between the teacher-reported hyperactivity score and the poor health measure was only .09, suggesting that in general parents do not consider ADHD when answering questions about health status.

We excluded learning disabilities and psychological disabilities from this list of chronic conditions in order to focus on physical health problems.

We use total *permanent* household income as our measure of income. This variable is constructed by taking the mean income for all available waves.[13] Child outcomes are likely to be more strongly affected by permanent than by transitory income. The impact of random measurement error in the OLS estimates also will be attenuated by averaging.[14]

Means of all of our measures are shown for all children with non-missing hyperactivity scores are shown in columns 1 and 4 of Table 1. Columns 2 and 5 show means for the sample of children with siblings, who will be the focus in our fixed effects models. In the NLSY, all siblings in sampled households are interviewed, whereas in the NLSCY, one randomly chosen sibling is interviewed. Columns 3 and 6 show the number of siblings with a within-family difference in the variable in question, since these are the children who will identify the effects of hyperactivity in our models.

This table suggests that the sibling sample is quite similar to the "full" sample of children, and that there are sufficient numbers of siblings with differences in outcomes to pursue a fixed effects strategy for most of our outcomes. The mean difference in hyperactivity scores, where there is a difference, is 3.96 in Canada and 3.07 in the U.S, which is roughly a one standard deviation difference. Table 1 also shows that the mean difference in hyperactivity scores between boys and girls is relatively small (slightly larger in Canada than the US), while

[13] In the NLSY, we use all income measures from 1990 onwards.

[14] In cases where the household income is not reported, the NLSCY imputes it. We include a dummy variable for the imputation of household income in all of our analyses. We also re-estimated all our analyses omitting individuals for whom income had been imputed in order to be sure that there was nothing peculiar about the income imputation process. Our analyses are robust to these checks.

there is a much greater gender difference in the probability of being above the 90th percentile of the score distribution.

The table highlights similarities and differences between the U.S. and Canadian samples. The U.S. children are slightly older and born to somewhat younger mothers on average. They are also likely to have mothers who are depressed or have an activity limitation. All of these differences as well differences in other observable variables in the two data sets are controlled for in our Ordinary Least Squares (OLS) models, and many of them will be absorbed by family fixed effects in the fixed effects models. The U.S. children are much more likely to be delinquent, and twice as likely to repeat grades. However, they are slightly less likely to be in special education. The math and reading scores are scaled out of 15 and 20 respectively in Canada, and are reported as percentiles of a standardized score in the United States, so this difference in scaling should be kept in mind when comparing these means.[15]

Both the NLSY and the NLSCY have information about drug and psychiatric treatment for mental health conditions, as shown in Table 1. In 1994, only 1.4 percent of the Canadian children reported drug treatment compared to 3.3 percent of the American children. However, the NLSCY asks specifically about Ritalin, tranquillizers and nerve pills, whereas the NLSY asks a more general question about medications used to control activity levels or behavior.[16] The

[15] In the U.S., the scores are standardized using national norms for children of the same sex and age. Such norms are not available for these Canadian tests. However, we control for the child's sex and age in our regressions.

[16] In comparison, the Centre for Addiction and Mental Health in Ontario, which conducts a student drug use survey in 2001, found 4.2 percent of seventh and eighth graders in Ontario reported using Ritalin within the past 12 months (Adlaf and Paglia, 2001). However, in the NLSCY reported use of Ritalin has increased significantly since 1994. For example, among 10 year olds the incidence of Ritalin use increased from 2.5 to 4.1%, while among 11 year olds, it increased from 1.3 to 3.9% between 1994 and 1998.

Canadian children were also less likely to have seen a psychiatrist, resulting in overall treatment rates of 4.7 percent compared to 9.6 percent for the American children.

These differences in mean rates of treatment are perhaps surprising in view of differences in the insurance regimes in the two countries: In Canada, psychiatric treatment is covered under public health insurance, and all of the provinces have drug plans for low-income families. In the U.S., many private insurance plans severely restrict the coverage of mental health treatment, and Medicaid (the public system of health insurance for low income children) offers only limited coverage of psychiatric treatment. The low treatment rates in Canada may reflect greater stigma attached to mental illness, less faith in the efficacy of treatment, or both.

A comparison of the distribution of NLSCY teacher reports, NLSCY parent reports, and NLSY parent reports of hyperactivity is shown in Table 1b. The first two columns suggest that the teacher and parent reports do contain independent information–in Canada parents are much more likely to report low levels of symptoms than teachers and the correlation between the two scores is only .46. Half of the children receive scores of two or less from teachers, while the median parent score is 4. On the other hand, the $90^{th}$ percentiles are very similar in the two distributions.

The U.S. distribution indicates lower fractions of children with very low scores, and higher numbers of children with high scores since the median score is 6. However, the $90^{th}$ percentile score is 11 in the U.S. distribution and 10 in the Canadian distribution of teacher reports, suggesting greater consensus when it comes to identifying the most affected children.

Scores exceeding 8 have been shown in previous research to be associated with diagnosed ADHD (Baillargeon et al, 1999).[17]

Table 1c shows that there are mean differences between children above and below the 90th percentile of the hyperactivity score. In the US, high scores double the risk of grade repetition and special education, and are associated with a half of a standard deviation reduction in reading and mathematics scores. The difference in the probability of delinquency is more modest, which is perhaps surprising given that ADHD is thought of as a primarily behavioral problem. In Canada, the differences in outcomes between children with high and low scores are perhaps even more stark than in the US, with a rate of grade repetition that is more than three times higher, and a rate of special education that is more than 5 times higher.

An important question is whether we expect the effect of hyperactivity symptoms to be roughly linear, or whether scores above some threshold have much more deleterious effects? Figure 1 shows non-parametric Lowess plots of outcomes against hyperactivity scores for the U.S. and Canada. There are two striking things about these pictures. First, they are remarkably similar for the U.S. and Canada despite differences in samples, educational systems, variable definitions and so on. Second, all of the outcomes except delinquency change approximately linearly with hyperactivity scores. This observation suggests that even children with scores low enough that they would never be diagnosed with ADHD may nevertheless suffer ill effects of behaviours associated with the syndrome.

[17] In a survey of students in three Ontario school districts, Sgro et al. (2000) use a cutoff of 9 or higher as a "diagnosis" of ADHD and find rates around 5 percent. In our Canadian data, a cutoff of 9 yields prevalence rates of about 14 percent which corresponds with Willms (2002) finding that approximately 14 percent of children in the NLSCY are hyperactive Since response rates to the survey instrument used in Sgro et al, were less than 29 percent, it is likely that the NLSCY numbers are more accurate.

The negative effects of delinquency top out at around the 90th percentile of both the U.S. and Canadian distributions. In order to take account of this non-linearity we will compare results obtained using the 90th percentile of the U.S. and Canadian distributions as a cutoff to those obtained using the linear score. Focusing on the 90th percentile also isolates those children most likely to be formally diagnosed with ADHD.

**4. Methods**

We begin by estimating OLS models of the relationship between hyperactivity scores in 1994 and outcomes in 1998, controlling for a wide range of other potentially confounding variables, including permanent income; maternal health status, education and family structure (in 1994); child age (single year of age dummies), whether the child is first born, and sex.

These models have the following form:

$$(1) outcome98_i = \alpha + \beta ADHD94_i + \lambda X94_i + \varepsilon_i$$

where *outcome98* is one of the outcomes described above, ADHD94 is the child's hyperactivity score (either the continuous score or a cutoff for a score above the 90th percentile) and $X$ is the vector of covariates described above. If high hyperactivity scores are positively correlated with other factors that have a negative effect on child outcomes, then these estimates will overstate the true effect of hyperactivity.

We next attempt to control for unobserved heterogeneity by estimating family fixed effects models:

$$(2) outcome98_{if} = \alpha + \beta ADHD94_{if} + \lambda Z94_{if} + \mu_f + \varepsilon_{if}$$

In these models, the Z vector is similar to X but omits factors common to both siblings, and the *f* subscript indexes family. A comparison of (1) and (2) will indicate whether OLS estimates are driven by omitted variables bias.

If a high hyperactivity score for one sibling has negative effects on the achievement of other siblings in the household, then the difference between the two siblings will provide an under-estimate of the effects of hyperactivity. Estimates of (2) may also be biased downwards by random measurement error in the hyperactivity scores. In order to account for this possibility, we estimate fixed effects-IV models in which the teacher report of the hyperactivity score is instrumented using the parent's report. This is only feasible in the Canadian data, where we have both reports, but may shed light on the extent to which measurement error is likely to bias the estimated fixed effects coefficients in the U.S..

A third potential problem is that to the extent that treatment is effective, children who are being treated will have lower scores than they would have otherwise. Our procedures will produce valid estimates of the effects of actual scores on outcomes. But we may produce biased estimates of the effects of under-lying untreated scores on outcomes. In order to deal with this issue, we produce two additional sets of estimates. One set simply excludes treated children. These estimates examine the effect of scores on outcomes among all untreated children, ignoring selection into treatment. The second set of estimates imputes a score at the $90^{th}$ percentile of the hyperactivity distribution to children who are being treated in an attempt to approximate under-lying pre-treatment scores for these children.

We also examine gender differences in the effects of ADHD. As Table 1 shows, on average, boys score only slightly higher on the ADHD index than girls, but are much more likely to be above the $90^{th}$ percentile of the distribution. We ask whether similar levels of ADHD

scores affect boys and girls similarly by interacting the dummy variable for "male" with the hyperactivity score in models of the form (2).

We next turn to an investigation of the extent to which the effects of ADHD are mediated by income. The OLS models we estimate have the following form:

$$(3) outcome98_i = \alpha + \beta(income)_i + \phi income * ADHD94_i + \chi ADHD94_i + \lambda X94_i + \varepsilon_i$$

where now income has been broken out of the X vector, and interacted with the hyperactivity score. Following the discussion above, we also estimate similar models with family fixed effects.

Finally, we also estimate models of treatment probabilities that take the form (3). It is difficult to investigate the efficacy of treatment directly, given the high probability that the children with the worst problems will be most likely to receive treatment. This pattern will not be captured by a sibling fixed effect. Moreover, interactions between income and hyperactivity may also be biased if high-income families are systematically more or less likely than other families to seek treatment. As we show below, the conclusions regarding the relationship between scores, income, and treatment are less robust than those regarding the relationship between scores and outcomes.

**5. Results**

Table 2 presents our baseline OLS estimates of the effects of hyperactivity on child outcomes in the U.S. and Canada. Table 2 indicates that children with higher hyperactivity scores have outcomes that are worse in all of the measured dimensions. The estimated effects of hyperactivity are generally somewhat lower for the U.S. than for Canada, though for reading

scores, they are somewhat larger (recall that to compare effects, one needs to multiply the Canadian coefficients on reading and math by 5 and 6.67, respectively.)

One way to think about the size of these effects is to compare them with the effect of income, which has consistently significant effects, and generally has larger effects in the U.S. than in Canada. For example, in Canada, each $100,000 worth of permanent income is associated with a 3.8 percentage point decrease in the probability that a child repeats a grade between 1994 and 1998. But a Canadian child with a score of only 5 out of 16 on the hyperactivity index would be 3.5 percentage points more likely to have repeated a grade. Thus, in Canada, the effect of hyperactivity is large relative to the effect of income. The same comparison in the U.S. data suggests that each $100,000 increase in permanent income would decrease the probability of grade repetition by 5.3 percentage points, compared to a 2 percentage point increase in the probability for a child with a hyperactivity score of 5. Alternatively, if we used a score of 8 as a proxy for "diagnosis" of ADHD, then on average, the ADHD children would have math and reading scores more than a quarter of a standard deviation below the scores of children without ADHD symptoms.

Having a mother with at least a high school education is also consistently related to positive outcomes, especially in the U.S., with the effect being generally similar to that of $100,000 worth of income. Other variables with consistently significant effects are the indicator for Hispanic ethnicity which has negative effects in the NLSY data (race and ethnicity are not available in the NLSCY), and having two parents in 1994 which has positive effects in the NLSY data, though in Canada it is only statistically significant in the model of delinquency. Males are more likely to be delinquent, more likely to repeat grades, and (in the U.S.) more likely to be in special education, consistent with other studies.

The robustness of these effects is investigated further in Table 3. The first panel of Table 3 repeats the OLS estimates of the effects of hyperactivity and income from Table 2. The second panel presents fixed effects estimates. Except for delinquency, these within-family estimates are very similar to those in Panel 1, indicating that the OLS results for academic outcomes are not driven by unobserved heterogeneity between families. The fixed effects point estimates are generally slightly smaller than the OLS estimates, which is consistent with a small degree of measurement error. Panel 3 of Table 3 shows that if teacher-reported scores are instrumented with parent reports in the Canadian data, the fixed effects-IV estimates are similar to the OLS estimates for grade repetition and math scores and much higher than the fixed effects (or OLS) estimates for special education. (F-statistics for our first-stage are reported in the notes to the table).

Panels 4 and 5 of Table 3 focus on the children with the highest scores by using a dummy variable for scores above the $90^{th}$ percentile rather than the continuous hyperactivity score as the independent variable of interest. Having a high hyperactivity score has no effect on delinquency, but does affect all of the other outcomes. The coefficient estimates are consistent with roughly linear effects on grade repetition and special education, while the estimated effects on test scores are substantial but somewhat smaller than one would project on the basis of the linear models.

Table 4 shows estimates of models that either exclude treated children, or impute a high hyperactivity score to these children. For the most part, these alternative ways of handling the treated children produce estimates of the effects of hyperactivity on test scores that are very similar to those shown in Table 3. The main exception is that the hyperactivity score does not have a significant effect on the probability of special education in the U.S. in these models.

Table 5 asks whether effects differ for boys and girls. The results are striking. When we consider the linear score measure, it appears that girls suffer as much as boys from the symptoms of ADHD—none of the interaction terms are statistically significant. However, when we use the dummy for the 90$^{th}$ percentile of the hyperactivity distribution, interesting gender differences emerge. In particular, in both Canada and the U.S., only hyperactive boys appear to be at risk for being placed in special education. And in the U.S., the negative effects of hyperactivity on reading and math scores is confined to boys.

Table 6 offers an alternative way to think about the magnitude of these effects. In it, we compare the estimated effect of hyperactivity to the effects of physical health problems, using the Canadian data. Table 6 shows that in fixed effects models, neither having been diagnosed with a chronic health problem such as asthma (the most common chronic physical condition among children) as of 1994, nor a maternal report that a child is in poor health in 1994 is predictive of poorer outcomes as of 1998.[18] These results suggest that on average ADHD has a greater impact on academic achievement than physical health problems.

Table 7 reports estimates of equation (3) which includes interactions between hyperactivity scores and income. Panel 1 shows that in OLS models using the NLSY, the interactions are of the expected sign (that is, higher income appears to mitigate the effects of hyperactivity) but none of them are statistically significant. In contrast, in Canada all of the

[18] In OLS models, chronic conditions in 1994 have no effect on future outcomes but a maternal report that a child is in poor health is predictive of poorer outcomes in 1998. We cannot be certain that mothers answer this question with only their child's physical health in mind, but the correlation between being in poor health and the hyperactivity score is very small (0.09). In OLS models, a moderate hyperactivity score generally has worse effects than being in poor health. For example, among Canadian children, being in poor health in 1994 is associated with a reduction of .43 in 1998 mathematics scores, while a score of 5 out of 16 on the hyperactivity index is associated with reduction of 1.3 (on a mean score of 8.1).

interactions are significant in the OLS models, except in the model of delinquency. Panel 2 shows, however, that once we control for heterogeneity between families, the only interaction term that remains statistically significant is for grade repetition in Canada.

Panel 3 of Table 7 indicates that the interaction of income and having a hyperactivity score above the 90$^{th}$ percentile is associated with a higher probability of grade repetition in both the U.S. and Canada, and the point estimates in the two countries are quite similar (although the U.S. coefficient is only significant at the 90 percent level of confidence). However, the other interaction terms remain statistically insignificant. In summary then, higher income offers little protection against the negative effects of ADHD on test scores, but higher income children are less likely to be retained in grade conditional on their hyperactivity score.

Table 8 investigates the relationship between hyperactivity scores, income, and treatment. OLS estimates indicate that income has no effect on the probability of treatment in either the U.S. or Canada. This is a surprising result, particularly in the U.S. where richer children generally have better access to medical care. The main effects of income are insignificant as well, except that in the U.S., children from wealthier families are more likely to see a psychiatrist. In the U.S., maternal education also increases the probability of treatment as does having a mother who is depressed or has an activity limitation. Children of younger mothers and Hispanic children are much less likely to be treated, as are children in two parent families.

The second panel of Table 8 presents fixed-effects estimates. In these models, the only interaction that is significant suggests that conditional on their hyperactivity score, richer Canadian children are less likely to see a psychiatrist than other children.

While it may make sense to examine the relationship between actual scores and outcomes, in these models of treatment probabilities, we would really like to examine the

relationship between underlying hyperactivity scores (prior to treatment) and treatment. Hence, in panel 3 we impute the 90$^{th}$ percentile score to the treated children in an effort to approximate their true underlying scores. Assigning a high score to those who are treated will obviously increase the correlation between treatment and scores (the main effect of scores in these regressions).

It is more interesting to ask what happens to the interaction between scores and income. Suppose for example, that, as the evidence on access to physical health care suggests, high income children really were more likely to be treated, and that treatment lowered their hyperactivity scores. Then we would observe high income children with relatively low scores receiving treatment. Estimating an interaction between income and hyperactivity scores might then suggest that higher income children were more likely to be treated. This argument suggests that imputing high scores to treated children could lower the estimated interaction between income and hyperactivity scores. However, as panel 3 shows, the imputation of higher scores for treated children has little effect on our estimates, suggesting that there really is a very weak relationship between income and probability of treatment for ADHD, quite unlike the relationship observed for physical health.

**6. Discussion and Conclusions**

Children with symptoms of hyperactivity suffer large negative consequences in terms of their achievement test scores and schooling attainment. Hyperactivity is a more important determinant of reduced human capital accumulation than physical health problems. These results are qualitatively similar in the U.S. and Canada and are robust to many changes in specification.

We also find that a given level of symptoms has similar effects on the test scores of rich and poor children although richer children are less likely to be retained in grade. These results may reflect the surprising finding that conditional on their hyperactivity scores, rich and poor children are equally likely to be treated in both the U.S. and Canada. Boys and girls with moderate levels of symptoms also suffer equally in terms of academic outcomes, though boys with high hyperactivity scores do worse than girls, especially in the U.S..

Our results regarding the relationship between income and treatment contrast sharply with a large literature showing that richer children are more likely to be treated for physical health problems, conditional on the need for such treatment. Also, in earlier work (Currie and Stabile, 2004) we reported a positive relationship between income and treatment in an NLSY sample that included children over 12 years old. It is possible that over time treatment for ADHD has become more commonly available to low income children through Medicaid and through school referrals. Schools may face strong incentives to have children diagnosed and treated for ADHD so that they can be placed in special education (Cullen, 2003). At the same time, to the extent that treatment for ADHD is stigmatizing, high-income parents may avoid having their child diagnosed and treated.

A second finding is that even children whose relatively low level of symptoms make them unlikely candidates for diagnosis or treatment will suffer significant ill effects as a result of their behavioral problems. Little is known about the best ways to teach these children. Fiore, Becker and Nero (1993) suggest that using positive reinforcement, avoidance of long reprimands (which can serve as positive reinforcers by focusing attention on the child), and some ways of presenting information can all enhance the academic performance of ADHD children, but they conclude that “Overall, the literature on educationally relevant interventions for children and

youth with ADD is exploratory, not prescriptive. Though the problem of attention deficits is pervasive, investigators have tested relatively few interventions that speak to the day-to-day issues teachers face…" (page 170).[19] DuPaul and Eckert (1997) conclude in their review of school-based interventions that "few investigations would be characterized as methodologically rigorous" (page 20). The severity of the problems associated with ADHD and the pervasiveness of its symptoms suggest that efforts to find better ways to teach the relatively small number of children diagnosed with ADHD could have a larger payoff in terms of improving the academic outcomes of many children with milder symptoms.

[19] Some studies they review find that ADHD students take longer to complete a task if the initial information about the task is detailed rather than "global". Similarly, adding color to a search task improved the performance of ADHD children. Another study found that ADHD children's reading comprehension was greatest when a story was read without added detail.

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**Data Appendix**

**Appendix Table 1: Symptoms of Inattention and Hyperactivity** (Source: AAP, 2000).

Inattention:
A) Often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities.
B) Often has difficulty sustaining attention in tasks or play activities.
C) Often does not seem to listen when spoken to directly.
D) Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions).
E) Often has difficulty organizing tasks and activities.
F) Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework).
G) Often loses things necessary for tasks or activities (e.g. toys, school assignments, pencils, books, or tools.
H) Is often easily distracted by extraneous stimuli.
I) Is often forgetful in daily activities.

Hyperactivity:
A) Often fidgets with hands or feet or squirms in seat.
B) Often leaves seat in classroom or in other situations in which remaining seated is expected.
C) Often runs about or climbs excessively in situations in which it is inappropriate.
D) Often has difficulty playing or engaging in leisure activities quietly.
E) Is often "on the go" or often acts as if "driven by a motor".
F) Often talks excessively.
G) Often blurts out answers before questions have been completed.
H) Often has difficulty awaiting turn.
I) Often interrupts or intrudes on others (e.g. butts into conversations or games).

**2. Variable Definitions in the NLSCY**

**Respondent:** In the NLSCY the respondent is the "person most knowledgeable about the child" which is usually, but not always the mother (it is the mother 92% of the time). Because of this potential complication, we determine the education level of the mother using information about the PMK and the spouse of the PMK in all three survey years. We measure mother's education as follows: when the child's mother is also the PMK or the child's mother is the spouse of the PMK we use this information to calculate the mother's education. When no biological mother is present in the family in any of the three survey years we use the next closest female parent figure as the basis for calculating the mother's education. We then include dummy variables for the female parent figure being other than the biological mother, and/or for the PMK being other than the biological mother in all our analyses.

**Parent Reported Hyperactivity - Inattention Score variables** (variables ABECS06, BBECS06 and CBECS06 in cycles 1, 2 and 3 respectively) are derived using the PMK's responses to the following questions:

How often would you say that -- can't sit still, is restless or hyperactive?
How often would you say that – is distractible, has trouble sticking to an activity?
How often would you say that – fidgets?
How often would you say that – can't concentrate, can't pay attention for long?
How often would you say that – is impulsive, acts without thinking?
How often would you say that – has difficulty awaiting turn in games or groups?
How often would you say that – cannot settle to anything for more than a few moments?
How often would you say that – is inattentive?

The possible responses to these questions were: Never/Not True, Sometimes/Somewhat True or Often/Very True. The total score varies from 1-16 where a high score represents the presence of hyperactive or inattentive behaviour.

**The Teacher Hyperactivity - Inattention Score** variables (variables AETCS28B, BETCS28B and CETCS28B in cycles 1, 2 and 3 respectively) are derived using the respondent's teacher's responses to the same questions.

**The Delinquency Variable** is derived using the responses to the following questions.

I physically attack people. (cfbcq1aa)
I vandalize. (cfbcq1dd)
I steal outside my home. (cfbcq1pp)

The possible responses to these questions were Never or not true, Sometimes or somewhat true or Often of very true.

In the past 12 months, about how many times were you questioned by the police about anything that they thought you did? (cfbcbq2e)

In the past 12 months, about how many times have you run away from home? (cfbcbq2f)

The possible responses to these questions were Never, Once or Twice, Three or Four times or Five times or more.

Ages 10-11: Have you ever tried drugs or sniffed glue or solvents? (cdrcq10)The possible responses to this question are yes or no.

Ages 12-15: Have you ever tried marijuana and cannabis products (also known as joint, pot, grass, hash)? (cdrcc10a)

Have you ever tried glue or solvents (such as paint thinner, gasoline etc)? (cdrcb10b)

Ages 14-15: Have you ever tried Hallucinogens (like LSD, acid, magic mushrooms, "mesc" or PCP, "Angel dust" etc)? (cdrcb10c)

Ages 12-13: Have you ever tried other drugs (heroin, speed, PCP, crack/cocaine, LSD, acid ecstasy etc)? (cdrcc10f)

The possible responses to these questions are yes, no or I don't know what that drug is.

The variable delinquency takes on the value 1 if any of the above questions indicate delinquent behaviour, takes on the value 0 only if the answers to all these questions is no or 'I don't know what that drug is', and is a missing value if any of the questions were not answered.

The above questions were asked to children 10-15 in 1998, and hence the sample available to study delinquency is somewhat older than that available to study test scores. For younger children, there are a similar set of delinquency questions that are asked to the adult respondant. However, for a two year age range in which we have both self reports and adult reports (ages 10 and 11) we found that there were considerable differences in the reporting of delinquent behavior between parent and child. Given that the child's answers to these questions were recorded in writing confidentially[20] and the adult answers were recorded orally, we decided to use child self-reports as the more accurate reflect of true delinquency [21].

**Special Education**:

The special education variable is derived from a subset of respondents (the teacher in this case) who answer yes to the following question:

Does this student receive special education because a physical, emotional, behavioural, or some other problem limits the kind or amount of school work he/she can do? (cetcq21)

Respondents who answer yes are then asked a series of questions about why the student receives special education. We categorize the student as receiving special education for a mental health problem if they answered yes to any of the following reasons:

a) A learning disability.
b) An emotional or behavioural problem.
c) A mental disability or limitation.
d) Home environment.

[20]Children are asked to respond to a written questionnaire for these questions and then to return the answers in a sealed envelope, much like the sampling procedures used in the NLSY.

[21]For the delinquency analysis we restrict the sample to those children who do not have missing information for any of the questions used.

**Child Treatment**

Children are classified as taking drugs for mental health treatment if the PMK answers yes to one of the following questions:

DOES HE/SHE TAKE THE FOLLOWING PRESCRIBED MEDICATION ON A REGULAR BASIS: Ritalin? (ahlcq51b)
DOES HE/SHE TAKE THE FOLLOWING PRESCRIBED MEDICATION ON A REGULAR BASIS: Tranquilizers or nerve pills? (ahlcq51c)

Children are classified as visiting a doctor for mental health treatment based on the following question:

IN THE PAST YEAR, HOW MANY TIMES HAVE YOU SEEN OR TALKED ON THE TELEPHONE ABOUT CHILD'S PHYSICAL OR MENTAL HEALTH WITH: A psychiatrist or psychologist? (ahlcq48g)

**PMK Activity Limitations**

The PMK is asked if he/she are restricted in their daily activities. (variable ARSSD01).

**The PMK Depression Score** variable (variables ADPPS01, BDPPS01 and CDPPS01 in cycles 1, 2 and 3 respectively) is derived using the responses to the following questions.

How often have you felt this way during the past week: I did not feel like eating, my appetite was poor?
How often have you felt this way during the past week: I felt like I could not shake off the blues even with help from family or friends?
How often have you felt this way during the past week: I had trouble keeping my mind on what I was doing?
How often have you felt this way during the past week: I felt depressed.
How often have you felt this way during the past week: I felt that everything I did was an effort?
How often have you felt this way during the past week: I felt hopeful about the future.
How often have you felt this way during the past week: My sleep was restless.
How often have you felt this way during the past week: I was happy.
How often have you felt this way during the past week: I felt lonely.
How often have you felt this way during the past week: I enjoyed life.
How often have you felt this way during the past week: I had crying spells.
How often have you felt this way during the past week: I felt that people disliked me.

The possible responses to these questions were Rarely or none of the time (less than 1 day), Some or a little of the time (1-2 days), Occasionally or a moderate amount of the time (3-4 days) or Most or all of the time (5-7 days). The total score varies between 0 – 36, where a high score represents the presence of symptoms of depression.

We used the chose a cutoff such that 10 percent of the mothers in the survey were classified as depressed.

**3. Variables in the NLSY:** (Note: Question numbers are from the 2000 survey).

**Hyperactivity**: The Behavior Problems Index is asked to parents of children 4-14. There are 26 questions asked to all children, and 2 questions asked only to children who have been to school. For each question, parents reply that the statement is often true, sometimes, true, or not true. To convert into an index, they take not true to be zero and often true or sometimes true to be a one, and then sum up the answers to the questions (so the maximum score is either 26 or 28). In addition to hyperactivity, there are also subscales for: antisocial, anxious, depressed, headstrong, hyperactive, dependent, peer conflict, and withdrawal.

The hyperactivity subscore has 5 questions:

1. He/she has difficulty concentrating, cannot pay attention for long
2. He/she is easily confused, seems to be in a fog
3. He/she is impulsive, acts without thinking
4. He/she has a lot of difficulty getting his/her mind off certain though (has obsessions)
5. He/she is restless or overly active, cannot sit still.

This score is standardized by the child's sex and age. We convert this standardized score to one that has the same range as the score in the Canadian data.

**Delinquency**

Children 10-14 were consistently asked the following questions as part of the child self-administered questionnaire (Question 40 on the 2000 questionnaire):

In the last year, about how many times have you:

Hurt someone badly enough to need bandages or a doctor?
Taken something from a store without paying for it?
Damaged school property on purpose?

Children were asked additional questions, but they are not comparable with those asked to children 15+, so we do not use them. Also, we recode the answers as zero if the answer is never, and 1 otherwise.

For children 15 and older, the questions which are asked consistently from 94 to 2000 (as part of the young adult survey) are:

YASR-61B In the last year (last 12 months), have you ever gotten into a fight at school or work?

YASR-61C In the last year (last 12 months), have you ever taken something not belonging to you that was worth $50 or more?

YASR-61D In the last year (last 12 months) have you ever hit or seriously threatened to hit someone?

Note, prior to 2000, additional questions were asked but we do not use them, in order to maintain comparability across years..

These questionnaires also ask whether the respondent has ever used marijuana, cocaine, LSDs, uppers, downers, amphetamines, or sniffed or huffed substances to get high. We code a one if the respondent answers yes to any of these questions.

**Special Education**

BKGN-29C Has he/she participated in special education or a program for handicapped children in the past year? (yes/no).

This question was only asked in 2000. Previous surveys ask about remedial education in various subjects, but we do not use these questions.

**Test Scores**

Peabody Individual Achievement Tests (PIATs) were administered to children with PPVT ages of 5 to 14.

**Child Treatment**

HLTH-17 During the past 12 months has (child) seen a psychiatrist, psychologist, or counselor about any behavioral emotional, or mental problem?

HLTH-20 Does (child) regularly take any medicines or prescription drugs to help control his/her activity level or behavior?

**Maternal Activity Limitations**

Question Q11-5A is coded as 1 if the mother has any health problem that limits her ability to work, and zero otherwise.

**Maternal Depression**:

The mother was asked the following questions (Q11-H40CESD1B-1G in the 2000 questionnaire):

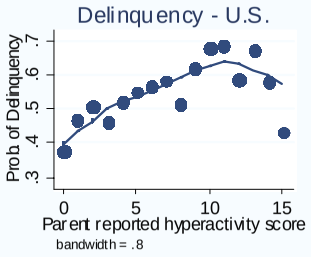
During the past week...

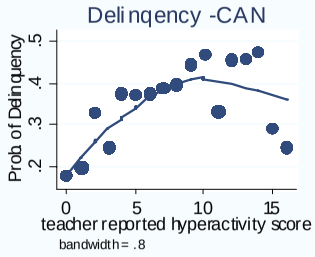
I had trouble keeping my mind on what I was doing.
I felt depressed.
I felt that everything I did was an effort.
My sleep was restless.
I felt sad.
I could not get going.

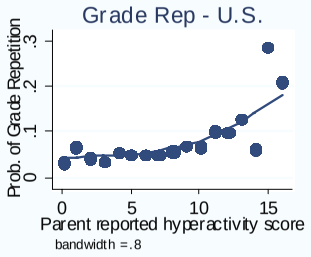
Possible responses were: Rarely/None of the time/1 Day; Some/A little of the time/1-2 Days/Occasionally/Moderate Amount of the Time/3-4 Days/Most/All of the Time/5-7 Days. These responses were given values 0, 1, 2, or 3.

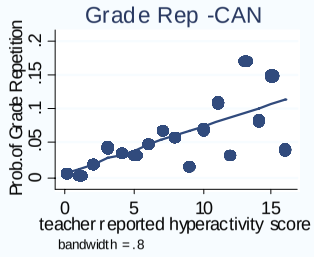
To create a depression score, we summed the responses for each question, and chose a cutoff so that 10% of the mothers were depressed.

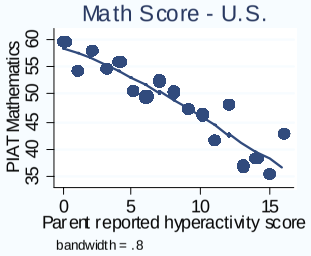
# Comparing US and Canadian Outcomes by Hyperactivity Score

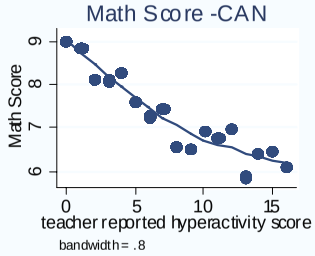


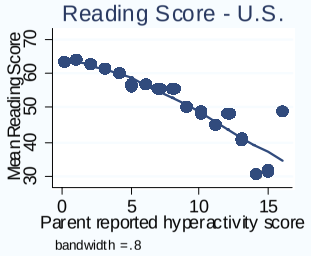



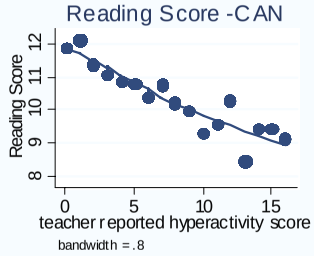



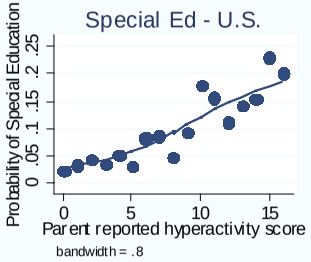



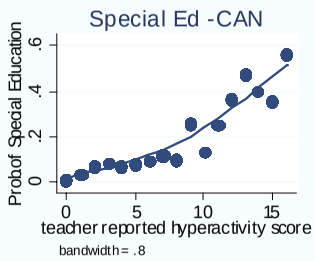



**Table 1: Means of Key Variables in Sample with Reading and Math Scores**

| | Canada All | Canada Sib Sample | # Canada Sibs in HH w diff. | U.S. All | U.S. Sib Sample | U.S. # Sibs in HH w diff. |
|---|---|---|---|---|---|---|
| Hyperactivity Score 1994 reported by teacher | 3.890 [4.065] | 3.699 [3.931] | 1300 | . | . | . |
| Hyperactivity Score reported by parent | 4.508 [3.487] | 4.291 [3.414] | 1332 | 5.930 [3.797] | 5.786 [3.809] | 2363 |
| Gender Difference Mean Scores | 2.216 | 2.039 | | 1.248 | 1.269 | |
| Probability score>90th ptile-male | 15.800 | 13.023 | | 12.300 | 12.237 | |
| Prob. score>90th ptile-female | 5.390 | 4.967 | | 7.508 | 7.253 | |
| Child Outcomes | | | | | | |
| Delinquent Behaviour 1998 | 0.307 | 0.282 | 248 | 0.502 | 0.492 | 135 |
| Grade Repetition 1998 | 0.037 | 0.036 | 88 | 0.075 | 0.072 | 238 |
| Mathematics score 1998 (/15 in Canada, /100 in US) | 8.100 [3.47] | 8.238 [3.442] | 608 | 51.622 [26.912] | 49.946 [26.726] | 1338 |
| Reading score 1998 (/20 in Canada, /100 in US) | 11.130 [3.64] | 11.081 [3.627] | 612 | 56.185 [28.806] | 53.981 [28.943] | 1332 |
| Special Education 1998/2000 | 0.104 | 0.951 | 32 | 0.071 | 0.078 | 63 |
| Alternative Health Indicators | | | | | | |
| Poor Health 1994 | 0.135 | 0.134 | | . | . | |
| Chronic Condition Indicator 1994 | 0.328 | 0.323 | | . | . | |
| Treatment | | | | | | |
| Drug Treatment 1994 | 0.014 | 0.010 | 30 | 0.033 | 0.032 | 155 |
| Psychiatrist 1994 (or Psychologist in NLSCY) | 0.036 | 0.033 | 72 | 0.081 | 0.085 | 280 |
| Any Treatment 1994 | 0.047 | 0.039 | 92 | 0.096 | 0.099 | 359 |
| Selected Covariates | | | | | | |
| Child Age 1994 | 7.890 | 7.890 | | 8.271 [2.300] | 8.172 [2.259] | |
| Male Child | 0.500 | 0.503 | | 0.513 | 0.513 | |
| First Born Child | 0.460 | 0.353 | | 0.387 | 0.296 | |
| Permanent Income | 54566 [33338] | 56608 [32092] | | 41483 [25867] | 42185 [26154] | |
| Mother High School or More | 0.558 | 0.570 | | 0.751 | 0.754 | |
| Family Size 1994 | 4.310 [1.063] | 4.530 [0.930] | | 4.313 [1.212] | 4.670 [1.164] | |
| Mother Teen at Child Birth | 0.045 | 0.026 | | 0.046 | 0.047 | |
| Mother's Age at Birth | 27.220 [4.709] | 27.140 [4.382] | | 24.689 [3.092] | 24.692 [3.103] | |
| Mother depressed or activity limitation | 0.158 | 0.154 | | 0.234 | 0.236 | |
| Number of Observations | 3925 | 1540 | | 3969 | 2406 | |

**Notes**: Canadian data from the 1994-95, 1996-97 and 1998-99 cycles of the NLSCY. Standard deviations in brackets.

U.S. data is means for 1990-1994 and for 1998 and 2000, see text. Sample includes those with non-missing test scores.

**Table 1b: Hyperactivity Score Distribution**

| Score | Canada Teacher Report % with score | Canada Parent Report % with score | U.S. Parent Report % with score |
|---|---|---|---|
| 0 | 29.2 | 10.4 | 10.53 |
| 1 | 12.2 | 11.9 | 5.85 |
| 2 | 9.2 | 11.5 | 5.95 |
| 3 | 7 | 10.3 | 4.23 |
| 4 | 6.5 | 9.5 | 13.83 |
| 5 | 5.6 | 9.3 | 6.32 |
| 6 | 6.4 | 8.6 | 10.71 |
| 7 | 5.3 | 7.5 | 9.3 |
| 8 | 5.4 | 6.9 | 5.85 |
| 9 | 2.7 | **4.8** | 11.21 |
| 10 | **1.9** | 3.1 | 3.78 |
| 11 | 2 | 2 | **4.76** |
| 12 | 1.4 | 1.4 | 3.05 |
| 13 | 1.6 | 1.1 | 1.74 |
| 14 | 1.1 | 0.9 | 1.08 |
| 15 | 1.2 | 0.7 | 0.98 |
| 16 | 1.1 | 0.3 | 0.83 |

Note: Median score is underlined. 90th percentile score indicated in bold.

**Table 1c: Means of Outcomes for Children Above and Below the 90th Percentile of Hyperactivity Score**

| | **Canada: Above** | **Canada: Below** | **U.S.: Above** | **U.S.: Below** |
|---|---|---|---|---|
| Grade repetition | 0.116 | 0.027 | 0.118 | 0.071 |
| Delinquent | 0.427 | 0.293 | 0.602 | 0.493 |
| Mathematics Score | 6.57 | 8.27 | 43.09 | 52.56 |
| Reading Score | 9.36 | 11.23 | 43.26 | 57.60 |
| Special Education | 0.380 | 0.070 | 0.143 | 0.063 |
| | | | | |
| Drug Treatment 1994 | 0.070 | 0.007 | 0.103 | 0.025 |
| Psychiatric Treatment 1994 | 0.096 | 0.029 | 0.174 | 0.070 |
| Any Treatment 1994 | 0.147 | 0.035 | 0.199 | 0.084 |

Note: The median teacher-reported score is used for Canada.

**Table 2: Effects of Hyperactivity on Future Outcomes**

| | [1] Canada Delinq. | [2] U.S. Delinq. | [3] Canada Grade Rep. | [4] U.S. Grade Rep. | [5] Canada Math | [6] U.S. Math | [7] Canada Reading | [8] U.S. Reading | [9] Canada Special Ed. | [10] U.S. Special Ed. |
|---|---|---|---|---|---|---|---|---|---|---|
| Hyperactivity Score 1994 | 0.015 | 0.013 | 0.007 | 0.004 | -0.206 | -0.868 | -0.170 | -1.176 | 0.023 | 0.008 |
| | [6.00]** | [2.98]** | [6.99]** | [2.49]** | [10.85]** | [6.57]** | [8.18]** | [8.14]** | [8.79]** | [3.85]** |
| Average Income | 0.008 | -0.086 | -0.038 | -0.053 | 1.067 | 15.382 | 1.044 | 13.977 | -0.031 | -0.024 |
| (in 100,000) | [0.33] | [1.21] | [4.28]** | [2.77]** | [4.72]** | [6.87]** | [4.69]** | [5.51]** | [1.44] | [0.73] |
| Adult Respondent | -0.040 | | -0.009 | | 0.077 | | 0.166 | | 0.078 | |
| Immigrant | [1.23] | | [0.94] | | [0.28] | | [0.56] | | [2.00]* | |
| Black | | -0.017 | | 0.007 | | -8.787 | | -2.835 | | -0.023 |
| | | [0.46] | | [0.50] | | [6.13]** | | [1.76]* | | [1.13] |
| Hispanic | | 0.03 | | 0.027 | | -12.485 | | -9.391 | | 0.004 |
| | | [0.83] | | [2.05]** | | [8.58]** | | [5.69]** | | [0.16] |
| Male | 0.099 | 0.029 | 0.005 | 0.016 | 0.258 | 4.539 | -0.042 | -0.444 | 0.023 | 0.034 |
| | [5.34]** | [1.03] | [0.79] | [1.70]* | [1.78]* | [4.65]** | [0.27] | [0.41] | [1.43] | [2.46]** |
| First Born Child | -0.032 | -0.062 | -0.003 | -0.003 | 0.464 | 2.221 | 1.037 | 5.375 | -0.003 | -0.015 |
| | [1.55] | [1.97]* | [0.49] | [0.29] | [2.89]** | [1.94]* | [6.06]** | [4.42]** | [0.19] | [0.85] |
| Log Family Size 1994 | 0.059 | -0.076 | 0.007 | 0 | 0.104 | -8.366 | 0.432 | -9.785 | 0.014 | 0.035 |
| | [1.23] | [1.35] | [0.41] | [0.02] | [0.27] | [3.61]** | [1.10] | [3.63]** | [0.34] | [0.90] |
| Two Parent Family 1994 | -0.111 | -0.063 | 0.000 | -0.021 | 0.020 | 2.128 | -0.042 | 1.773 | -0.048 | -0.027 |
| | [3.31]** | [1.94]* | [0.04] | [1.83]* | [0.08] | [1.74]* | [0.27] | [1.25] | [1.45] | [1.45] |
| Mother's Age at Birth | -0.001 | -0.019 | 0.000 | -0.001 | 0.039 | 0.543 | 0.081 | 0.477 | -0.001 | 0.002 |
| | [0.61] | [2.55]** | [0.12] | [0.60] | [2.16]** | [2.21]** | [4.17]** | [1.76]* | [0.49] | [0.78] |
| Teen Mother | 0.035 | -0.113 | -0.007 | 0.007 | -0.806 | 2.062 | -0.964 | 6.905 | 0.065 | 0.000 |
| | [0.70] | [1.99]** | [0.40] | [0.22] | [2.26]** | [0.43] | [2.68]** | [0.95] | [1.27] | [.] |
| Mother High School plus | -0.021 | -0.044 | -0.015 | -0.085 | 0.348 | 8.487 | 0.636 | 11.635 | -0.017 | -0.005 |
| | [1.08] | [1.25] | [2.25]** | [5.31]** | [2.21]** | [6.19]** | [3.84]** | [7.23]** | [1.02] | [0.22] |
| PMK depressed or | 0.034 | -0.018 | 0.004 | 0.002 | -0.101 | -2.499 | -0.140 | -0.491 | 0.024 | 0.025 |
| activity limit in 1994 | [1.29] | [0.55] | [0.41] | [0.14] | [0.49] | [1.87]* | [0.67] | [0.33] | [0.97] | [1.19] |
| Age 4 (in 1994) | | 0 | -0.036 | 0.059 | 0.967 | -2.306 | 0.229 | -2.062 | 0.000 | 0.006 |
| | | [.] | [3.11]** | [2.46]** | [2.42]** | [0.58] | [0.49] | [0.50] | [0.00] | [0.16] |
| Age 5 | -0.730 | 0 | 0.005 | 0.014 | 0.776 | -0.533 | -0.310 | -4.554 | 0.032 | 0.005 |
| | [16.02]** | [.] | [0.37] | [0.63] | [2.92]** | [0.13] | [1.12] | [1.10] | [0.58] | [0.12] |
| Age 6 | -0.216 | 0 | -0.010 | -0.029 | 0.813 | -0.621 | -0.597 | -3.063 | 0.009 | -0.017 |
| | [6.88]** | [.] | [0.83] | [1.66]* | [3.13]** | [0.16] | [2.22]** | [0.75] | [0.16] | [0.46] |
| Age 7 | -0.244 | 0 | -0.017 | -0.024 | 0.809 | -1.412 | -0.997 | -4.855 | 0.022 | 0.009 |
| | [7.95]** | [.] | [1.43] | [1.38] | [3.02]** | [0.36] | [3.44]** | [1.17] | [0.40] | [0.23] |
| Age 8 | -0.224 | -0.187 | -0.019 | -0.002 | -0.828 | -3.178 | -0.891 | -3.991 | -0.013 | 0.068 |
| | [7.22]** | [3.75]** | [1.69]* | [0.10] | [3.33]** | [0.80] | [3.27]** | [0.95] | [0.22] | [1.64] |
| Age 9 | -0.127 | -0.134 | -0.004 | 0.015 | -0.552 | -3.866 | -1.409 | -3.917 | 0.077 | 0.000 |
| | [3.92]** | [3.71]** | [0.32] | [0.84] | [2.11]** | [0.95] | [5.20]** | [0.93] | [1.26] | [.] |
| Age 10 | -0.016 | -0.104 | -0.024 | 0.023 | -0.961 | -1.725 | -0.746 | -2.429 | 0.079 | 0.000 |
| | [0.46] | [3.00]** | [2.23]** | [1.18] | [3.70]** | [0.40] | [2.80]** | [0.55] | [1.03] | [.] |
| Constant | 0.359 | 1.165 | 0.040 | 0.163 | 6.938 | 45.458 | 8.805 | 54.236 | 0.063 | -0.080 |
| | [3.54]** | [6.01]** | [1.15] | [2.34]** | [8.06]** | [5.38]** | [9.91]** | [5.88]** | [0.62] | [0.75] |
| Observations | 2516 | 1303 | 3925 | 3240 | 2209 | 2501 | 2209 | 2501 | 1357 | 1401 |
| R-squared | 0.090 | 0.06 | 0.040 | 0.06 | 0.150 | 0.23 | 0.120 | 0.2 | 0.14 | 0.05 |

Notes: Canadian data are from the 1994-95, 1996-97 and 1998-99 cycles of the NLSCY. Robust t-statistics are in brackets. A * is significant at the 90% level. A ** indicates significants at 95%. Standard errors clustered at the household level. In the U.S. data, the "1994" variables are means over the period 1988-1994, while the 1998 values are means for 1998 and 2000. Regressions for Canada also included indicators for whether the PMK was female, and for whether income was imputed.

**Table 3: Robustness of Effects of Hyperactivity on Future Outcomes**

| | [1] Canada | [2] U.S. | [3] Canada | [4] U.S. | [5] Canada | [6] U.S. | [7] Canada | [8] U.S. | [9] Canada | [10] U.S. |
|---|---|---|---|---|---|---|---|---|---|---|
| **1. OLS from Table 2** | **Delinq.** | **Delinq.** | **Grade Rep.** | **Grade Rep.** | **Math** | **Math** | **Reading** | **Reading** | **Special Ed.** | **Special Ed.** |
| Hyperactivity Score 1994 | 0.015 | 0.013 | 0.007 | 0.004 | -0.206 | -0.868 | -0.170 | -1.176 | 0.023 | 0.008 |
| | [6.00]** | [2.98]** | [6.99]** | [2.49]* | [10.85]** | [6.57]** | [8.18]** | [8.14]** | [8.79]** | [3.85]** |
| Average Income (100,000) | 0.008 | -0.086 | -0.038 | -0.053 | 1.067 | 15.382 | 1.044 | 13.977 | -0.031 | -0.024 |
| | [0.33] | [1.21] | [4.28]** | [2.77]** | [4.72]** | [6.87]** | [4.69]** | [5.51]** | [1.44] | [0.73] |
| Observations | 2516 | 1303 | 3925 | 3240 | 2209 | 2501 | 2209 | 2501 | 1357 | 1401 |
| R-squared | 0.090 | 0.06 | 0.040 | 0.06 | 0.150 | 0.23 | 0.120 | 0.2 | 0.140 | 0.050 |
| **2. Fixed Effects** | | | | | | | | | | |
| Hyperactivity Score 1994 | 0.008 | -0.015 | 0.005 | 0.005 | -0.177 | -0.996 | -0.132 | -0.834 | 0.021 | 0.009 |
| | [1.08] | [1.04] | [2.46]** | [1.85]* | [3.94]** | [4.00]** | [2.70]** | [3.14]** | [2.95]** | [1.74]* |
| Observations | 2514 | 1304 | 3923 | 3241 | 2208 | 2501 | 2208 | 2501 | 1357 | 1401 |
| R-squared | 0.9 | 0.9 | 0.85 | 0.76 | 0.91 | 0.86 | 0.9 | 0.86 | 0.95 | 0.84 |
| **3 FE, Instrumenting Teacher Report with Parent Report of Hyperactivity Score** | | | | | | | | | | |
| Hyperactivity Score 1994 | 0.012 | | 0.010 | | -0.218 | | -0.074 | | 0.083 | |
| | [0.71] | | [2.13]** | | [1.99]** | | [0.62] | | [3.09]** | |
| Observations | 2506 | | 3907 | | 2197 | | 2197 | | 1352 | |
| R-squared | 0.001 | | 0.02 | | 0.08 | | 0.08 | | 0.05 | |
| **4. FE - Dummy Variable for Hyperactivity Above 90th Percentile** | | | | | | | | | | |
| Hperactivity Score 1994 | -0.087 | 0.118 | 0.064 | 0.07 | -1.420 | -3.989 | -1.186 | -5.778 | 0.381 | 0.121 |
| Above 90th percentile | [1.02] | [0.86] | [2.89]** | [2.68]** | [2.59]** | [1.46] | [2.01]** | [1.98]** | [4.92]** | [2.00]** |
| Observations | 2514 | 1304 | 3923 | 3241 | 2208 | 2501 | 2208 | 2501 | 1357 | 1401 |
| R-squared | 0.9 | 0.9 | 0.85 | 0.76 | 0.9 | 0.86 | 0.9 | 0.86 | 0.96 | 0.84 |
| **5. FE - Dummy Variable for Hyperactivity Above 90th Percentile -IV** | | | | | | | | | | |
| Hperactivity Score 1994 | 0.203 | | 0.171 | | -4.304 | | -1.458 | | 1.242 | |
| Above 90th percentile | [0.70] | | [2.11]** | | [1.89]* | | [0.62] | | [2.94]** | |
| Observations | 2506 | | 3907 | | 2197 | | 2197 | | 1352 | |
| R-squared | 0.01 | | 0.02 | | 0.91 | | 0.9 | | 0.96 | |

**Notes**: Robust t-statistics in brackets. A * indicates significance at the 90% level. A ** indicates significance at 95%.
Standard errors clustered at the household level.
To compare effects on reading and math scores, multiply the Canadian coefficients by 5 and 6.67 respectively.
The first stage F-statistic for test that the parent score is 0 in our IV models is 154 (t-statistic of 12, R-squared of 0.90).

**Table 4: Further Robustness of Effects of Hyperactivity on Future Outcomes**

| | [1] Canada Delinq. | [2] U.S. Delinq. | [3] Canada Grade Rep. | [4] U.S. Grade Rep. | [5] Canada Math | [6] U.S. Math | [7] Canada Reading | [8] U.S. Reading | [9] Canada Special Ed. | [10] U.S. Special Ed |
|---|---|---|---|---|---|---|---|---|---|---|
| **1. FE - Excluding Children Treated in 1994** | | | | | | | | | | |
| Hyperactivity Score, 1994 | 0.007 | -0.023 | 0.004 | 0.003 | -0.186 | -0.770 | -0.128 | -0.694 | 0.024 | 0.005 |
| | [0.91] | [1.38] | [2.00]** | [1.29] | [3.93]** | [2.77]** | [2.45]** | [2.37]** | [3.52]** | [1.04] |
| Observations | 2382 | 1108 | 3735 | 2900 | 2096 | 2290 | 2096 | 2289 | 1299 | 1320 |
| R-squared | 0.9 | 0.91 | 0.85 | 0.79 | 0.91 | 0.87 | 0.9 | 0.87 | 0.95 | 0.84 |
| **2. FE - Assigning Treated Children the 90th Percentile Score** | | | | | | | | | | |
| Hyperactivity Score, 1994 | 0.008 | -0.017 | 0.004 | 0.004 | -0.208 | -0.968 | -0.158 | -0.847 | 0.024 | 0.006 |
| | [1.23] | [1.23] | [2.31]** | [1.62] | [4.69]** | [3.99]** | [3.25]** | [3.27]** | [3.39]** | [1.12] |
| Observations | 2515 | 1304 | 3923 | 3241 | 2208 | 2501 | 2208 | 2501 | 1356 | 1401 |
| R-squared | 0.9 | 0.901 | 0.85 | 0.762 | 0.91 | 0.858 | 0.9 | 0.858 | 0.95 | 0.843 |
| **3. FE - Excluding Children Treated in 1994 - Hyperactivity above 90th Percentile** | | | | | | | | | | |
| Hyperactivity Score, 1994 | -0.111 | -0.044 | 0.065 | 0.063 | -1.451 | -4.520 | -1.016 | -6.390 | 0.378 | 0.092 |
| | [1.21] | [0.28] | [2.84]** | [2.11]** | [2.54]** | [1.43] | [1.63] | [1.93]* | [5.16]** | [1.38] |
| Observations | 2382 | 1108 | 3735 | 2900 | 2096 | 2290 | 2096 | 2289 | 1299 | 1320 |
| R-squared | 0.9 | 0.91 | 0.85 | 0.79 | 0.91 | 0.87 | 0.9 | 0.87 | 0.96 | 0.84 |
| **4. FE - Assigning Treated Children the 90th Percentile Score - Hyperactivty above 90th Percentile** | | | | | | | | | | |
| Hyperactivity Score, 1994 | -0.047 | -0.046 | 0.059 | 0.962 | -1.814 | -3.020 | -1.503 | -7.930 | 0.382 | 0.088 |
| | [.61] | [0.29] | [2.95]** | [2.09]** | [3.63]** | [1.02] | [2.77]** | [2.52]** | [5.69]** | [1.24] |
| Observations | 2515 | 1304 | 3923 | 3241 | 2208 | 2501 | 2208 | 2501 | 1356 | 1401 |
| R-squared | 0.9 | 0.9 | 0.85 | 0.763 | 0.91 | 0.983 | 0.9 | 0.858 | 0.96 | 0.844 |

**Table 5: Differences Between Boys and Girls**

| | [1] Canada Delinq. | [2] U.S. Delinq. | [3] Canada Grade Rep. | [4] U.S. Grade Rep. | [5] Canada Math | [6] U.S. Math | [7] Canada Reading | [8] U.S. Reading | [9] Canada Special Ed. | [10] U.S. Special Ed. |
|---|---|---|---|---|---|---|---|---|---|---|
| **1. FE - Interaction of Hyperactivity Score with Male** | | | | | | | | | | |
| Hyperactivity Score, 1994 | 0.008 | -0.006 | 0.003 | 0.004 | -0.144 | -0.990 | -0.117 | -0.689 | 0.007 | 0.005 |
| | [0.68] | [0.38] | [1.02] | [1.43] | [2.20]** | [3.48]** | [1.64] | [2.25]** | [0.61] | [0.97] |
| Male*Hyper Score | 0.000 | -0.006 | 0.003 | -0.001 | -0.053 | 0.184 | -0.024 | -0.303 | 0.020 | 0.004 |
| | [0.01] | [0.60] | [0.83] | [0.64] | [0.68] | [0.90] | [0.29] | [1.38] | [1.54] | [0.89] |
| Observations | 2514 | | 3923 | | 2207 | | 2207 | | 1356 | |
| R-squared | 0.9 | | 0.85 | | 0.91 | | 0.9 | | 0.95 | |
| **2. FE - Interaction of 90th percentile of Hyperactivity Score with Male** | | | | | | | | | | |
| Hyperactivity Score, 1994 | -0.064 | 0.226 | 0.097 | 0.097 | -1.499 | 2.970 | -1.654 | -0.940 | 0.177 | 0.002 |
| | [0.39] | [1.13] | [2.48]** | [2.45]** | [1.57] | [0.72] | [1.61] | [0.21] | [1.32] | [0.02] |
| Male*Hyper Score | -0.029 | -0.126 | -0.046 | -0.040 | 0.112 | -9.570 | 0.661 | -9.200 | 0.287 | 0.215 |
| | [0.16] | [.57] | [1.03] | [0.88] | [0.10] | [2.03]** | [0.56] | [1.82]* | [1.86]* | [1.98]** |
| Observations | 2514 | 1304 | 3923 | 3241 | 2207 | 2501 | 2207 | 2501 | 1356 | 1401 |
| R-squared | 0.9 | 0.9 | 0.85 | 0.75 | 0.91 | 0.86 | 0.9 | 0.85 | 0.96 | 0.84 |

**Table 6: Comparing Effects of Hyperactivity, Poor Health, & Chronic Conditions, Canada**

**Fixed Effects Regressions**

| **Panel 1** | **Delinq.** | **Grade Rep.** | **Math** | **Reading** | **Special Ed.** |
|---|---|---|---|---|---|
| Hyperactivity Score 1994 | 0.008 | 0.005 | -0.177 | -0.132 | 0.021 |
| | [1.08] | [2.46]** | [3.94]** | [2.70]** | [2.95]** |
| Observations | 2514 | 3923 | 2208 | 2208 | 1357 |
| R-squared | 0.9 | 0.85 | 0.91 | 0.9 | 0.95 |
| **Panel 2** | | | | | |
| Chronic Condition 1994 | 0.024 | 0.006 | 0.287 | 0.346 | 0.042 |
| | [0.47] | [0.45] | [0.80] | [0.90] | [0.76] |
| # Observations | 2514 | 3923 | 2208 | 2208 | 1357 |
| R-squared | 0.9 | 0.85 | 0.91 | 0.9 | 0.95 |
| **Panel 3** | | | | | |
| Poor Health in 1994 | 0.084 | 0.021 | 0.026 | 0.191 | -0.035 |
| | [1.15] | [0.037] | [0.05] | [0.35] | [0.44] |
| # Observations | 2511 | 3920 | 2206 | 2206 | 1356 |
| R-squared | 0.9 | 0.85 | 0.91 | 0.9 | 0.95 |

**Table 7: Interactions of Income With Hyperactivity**

| | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] | [10] |
|---|---|---|---|---|---|---|---|---|---|---|
| | Canada | U.S. | Canada | U.S. | Canada | U.S. | Canada | U.S. | Canada | U.S. |
| **1. OLS - Income** | **Delinq.** | **Delinq.** | **Grade Rep.** | **Grade Rep.** | **Math** | **Math** | **Reading** | **Reading** | **Special Ed.** | **Special Ed.** |
| Interaction | 0.000 | -0.004 | -0.011 | -0.003 | 0.113 | 0.069 | 0.123 | 0.614 | -0.016 | -0.003 |
| | [0.01] | [0.23] | [4.16]** | [0.49] | [2.30]** | [0.15] | [2.47]** | [1.25] | [2.72]** | [0.34] |
| Hyperactivity 1994 | 0.015 | 0.014 | 0.012 | 0.005 | -0.264 | -0.896 | -0.233 | -1.428 | 0.031 | 0.009 |
| | [3.37]** | [1.83]* | [6.23]** | [1.52] | [8.26]** | [3.98]** | [6.79]** | [5.58]** | [7.23]** | [2.16]** |
| Average Income | 0.008 | -0.066 | -0.006 | -0.038 | 0.763 | 15.039 | 0.711 | 10.909 | 0.013 | -0.011 |
| [100,000] | [0.33] | [0.62] | [0.80] | [1.45] | [3.38]** | [5.16]** | [2.79]** | [3.20]** | [0.78] | [0.31] |
| Observations | 2516 | 1303 | 3925 | 3240 | 2209 | 2501 | 2209 | 2501 | 1357 | 1401 |
| R-squared | 0.09 | 0.06 | 0.04 | 0.06 | 0.15 | 0.23 | 0.13 | 0.2 | 0.15 | 0.05 |
| **2. Fixed Effects** | | | | | | | | | | |
| Interaction | 0.024 | -0.033 | -0.013 | 0.001 | 0.029 | 0.107 | -0.125 | 0.581 | -0.004 | -0.021 |
| | [1.02] | [0.44] | [2.58]** | [0.06] | [0.28] | [0.12] | [1.11] | [0.60] | [0.33] | [1.14] |
| Hyperactivity 1994 | -0.006 | -0.002 | 0.012 | 0.004 | -0.194 | -1.041 | -0.058 | -1.083 | 0.024 | 0.018 |
| | [0.40] | [0.08] | [3.51]** | [0.93] | [2.56]** | [2.26]** | [0.70] | [2.20]** | [2.19]** | [1.88]* |
| Observations | 2514 | 1304 | 3923 | 3241 | 2208 | 2501 | 2208 | 2501 | 1357 | 1401 |
| R-squared | 0.9 | 0.9 | 0.85 | 0.76 | 0.91 | 0.86 | 0.9 | 0.86 | 0.95 | 0.85 |
| **3. Fixed Effects - Indicator for Hyperactivity Score >=90th percentile** | | | | | | | | | | |
| Interaction | 0.369 | -0.045 | -0.215 | -0.267 | 0.068 | -16.888 | -1.971 | -6.455 | -0.139 | -0.128 |
| | [1.19] | [0.05] | [3.15]** | [1.79]* | [0.05] | [1.10] | [1.33] | [0.40] | [1.02] | [0.41] |
| Hperactivity Score 1994 | -0.285 | 0.132 | 0.178 | 0.155 | -1.459 | 1.824 | -0.044 | -3.556 | 0.466 | 0.17 |
| Above 90th percentile | [1.52] | [0.43] | [4.21]** | [2.86]** | [1.51] | [0.31] | [0.04] | [0.56] | [4.11]** | [1.28] |
| Observations | 2514 | 1304 | 3923 | 3241 | 2208 | 2501 | 2208 | 2501 | 1357 | 1401 |
| R-squared | 0.9 | 0.9 | 0.85 | 0.76 | 0.91 | 0.86 | 0.9 | 0.86 | 0.96 | 0.85 |

Notes: See Table 3.

**Table 8: Effects of Hyperactivity in 1994 and Income on Treatment in 1994**

| | [1] Canada | [2] Canada | [3] Canada | [4] Canada | [5] Canada | [6] Canada | [7] U.S. | [8] U.S. | [9] U.S. | [10] U.S. | [11] U.S. | [12] U.S. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. OLS** | **Drug** | **Drug** | **Psych.** | **Psych.** | **Any** | **Any** | **Drug** | **Drug** | **Psych.** | **Psych.** | **Any** | **Any** |
| Hyper Score 1994 | 0.005 | 0.005 | 0.005 | 0.006 | 0.009 | 0.009 | 0.007 | 0.008 | 0.013 | 0.009 | 0.014 | 0.011 |
| | [5.85]** | [3.89]** | [5.35]** | [3.49]** | [7.44]** | [4.73]** | [7.02]** | [3.12]** | [8.78]** | [3.36]** | [9.53]** | [3.90]** |
| Interaction hyper | | -0.001 | | -0.002 | | -0.002 | | 0 | | 0.009 | | 0.008 |
| & income | | [0.39] | | [0.70] | | [0.58] | | [0.03] | | [1.48] | | [1.32] |
| Average Income | -0.005 | -0.003 | -0.007 | -0.002 | -0.009 | -0.004 | -0.004 | -0.003 | 0.045 | 0.003 | 0.03 | -0.009 |
| [100,000] | [1.26] | [0.61] | [0.81] | [0.16] | [1.01] | [0.39] | [0.29] | [0.16] | [2.15]** | [0.11] | [1.35] | [0.31] |
| # Observations | 3925 | 3925 | 3920 | 3920 | 3920 | 3920 | 3749 | 3749 | 3745 | 3745 | 3745 | 3745 |
| R-squared | 0.04 | 0.04 | 0.03 | 0.03 | 0.05 | 0.05 | 0.04 | 0.04 | 0.09 | 0.09 | 0.09 | 0.09 |
| **2. Fixed Effects** | | | | | | | | | | | | |
| Hyper Score 1994 | 0.002 | 0.001 | 0.005 | 0.010 | 0.006 | 0.01 | 0.009 | 0.011 | 0.015 | 0.013 | 0.018 | 0.013 |
| | [2.00]** | [0.67] | [2.77]** | [3.16]** | [3.31]** | [2.94]** | [5.46]** | [3.44]** | [6.95]** | [3.11]** | [7.11]** | [2.77]** |
| Interaction hyper | | 0.001 | | -0.009 | | -0.007 | | -0.004 | | 0.006 | | 0.012 |
| & income | | [0.49] | | [1.97]** | | [1.36] | | [0.60] | | [0.75] | | [1.25] |
| # Observations | 3923 | 3923 | 3918 | 3918 | 3918 | 3918 | 3749 | 3749 | 3745 | 3745 | 3745 | 3745 |
| R-squared | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.72 | 0.72 | 0.789 | 0.789 | 0.77 | 0.77 |
| **3. FE - Assigning 90th percentile to treated children** | | | | | | | | | | | | |
| Hyper Score 1994 | 0.003 | 0.002 | 0.012 | 0.012 | 0.015 | 0.014 | 0.014 | 0.013 | 0.031 | 0.027 | 0.039 | 0.034 |
| | [2.86]** | [1.11] | [7.31]** | [3.88]** | [8.10]** | [4.09]** | [8.75]** | [4.41]** | [15.90]** | [7.51]** | [18.24]** | [8.50]** |
| Interaction hyper | | 0.001 | | 0.000 | | 0.001 | | 0.002 | | 0.009 | | 0.012 |
| & income | | [0.48] | | [0.00] | | [0.24] | | [.350] | | [1.23] | | [1.54] |
| # Observations | 3923 | 3923 | 3918 | 3918 | 3918 | 3918 | 3749 | 3749 | 3745 | 3745 | 3745 | 3745 |
| R-squared | 0.87 | 0.87 | 0.88 | 0.88 | 0.88 | 0.88 | 0.729 | 0.729 | 0.817 | 0.817 | 0.822 | 0.822 |

Notes: See Table 3.