# CHILDHOOD PSYCHOPATHOLOGY AND ADULT BODY WEIGHT

# THE RELATIONSHIP BETWEEN CHILDHOOD- AND ADOLESCENT-ONSET PSYCHOPATHOLOGY AND ADULT BODY WEIGHT

**By**

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## ABSTRACT

Current public health initiatives recognize that obesity is increasing to epidemic proportions in developed countries. In keeping with the view of obesity as a developmental, progressive condition, targeting childhood factors that predict increases in body mass index (BMI) may result in the development of more effective prevention interventions. To date, prospective studies of child-onset psychopathology and adult overweight in representative community samples are limited by short duration of follow-up into adulthood and an inability to make psychiatric diagnoses. Where available, childhood data has been analyzed together with adolescent data, such that it is difficult to disentangle the relationship between early psychological distress and adult overweight in these developmentally heterogeneous groups. The main objective of this thesis is to examine the relationship between childhood and adolescent symptoms of (i) Depression (ii) Attention Deficit Hyperactivity Disorder [ADHD] and (iii) Conduct Disorder [CD] with adult overweight, in a large, prospectively followed, community sample of Canadian children.

This thesis includes the 1,992 children aged 4-11 years and 1,302 adolescents aged 12-16 years who participated in the Ontario Child Health Survey (OCHS), a provincially funded, prospective cohort study of the psychiatric and general child health of a representative sample of Ontario community children undertaken in 1983 with follow-up assessment in 2000. Data are collected from multiple informants; psychiatric disorders are determined by a combination of parental, youth and teacher self-report and

interviewer-administered measures. BMI is a derived variable determined from self-reported height and weight in 2000. Multiple regression analyses are undertaken to examine the association of child and adolescent mental illness with adult overweight, after controlling for the effects of age, sex, socioeconomic status, parental psychiatric history and, among the adolescent subgroup, cigarette smoking and alcohol use.

Adults with a history of depression, ADHD or CD identified in childhood have increased body mass (BMI = 27.2 kg/$m^2$, 27.7 kg/$m^2$, and 27.9 kg/$m^2$, respectively) compared to their nonaffected peers (BMI= 24.8 kg/$m^2$). Children who experienced increased depressive symptoms (among boys) and CD symptoms (boys and girls) are at greater risk for future weight gain than children with fewer symptoms. Adolescent girls with Depression or Conduct Disorder are heavier in adulthood than their psychologically healthier peers. Although ADHD was initially found to be associated with adult overweight, this relationship is accounted for by the effect of conduct disturbance, regardless of child sex.

This thesis suggests that psychopathology in childhood and adolescence predicts increased adult body mass in a large community sample of Ontario youth. In childhood, boys with depressive symptoms and boys and girls with disruptive behaviour are at particular risk. Among adolescents, girls with greater depressive symptoms or conduct disturbance are at increased risk of future weight gain. Research examining the trajectories of children with depressive and externalizing disorders is needed to understand the mechanism of the relationship between these disorders in childhood and eating behaviours in adulthood.

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# CHAPTER 1 - BACKGROUND

Current public health initiatives recognize that obesity, a leading cause of morbidity and mortality, is increasing to epidemic proportions in developed countries[1]. The rising prevalence of overweight and obesity has resulted in a rapid increase in costs for health care in North America, estimated at 4.6% and 5.7% of the national health expenditures in Canada and the United States, respectively, in recent years[2, 3]. In addition, obese individuals experience decreased quality of life[4-6], greater activity restriction and increased levels of occupational dysfunction, leading to significant lost productivity costs[3]. Despite growing awareness of nutritional and physical activity patterns that contribute to the development of obesity, effective treatments are limited, leading to increased focus on prevention strategies in at-risk populations, including youth. In keeping with the view of obesity as a developmental, progressive condition[7-11], targeting childhood factors that predict increases in body mass index (BMI), a measure of overweight and obesity, may result in the development of more effective prevention interventions.

## 1.1 Depression and Overweight

Numerous cross-sectional investigations have observed an association between psychological distress and BMI in both child and adult samples. In particular, investigation of the relationship between depression and obesity in adult populations has been the topic of numerous individual studies and literature reviews[12-16]. A recent meta-analysis of 17 (primarily cross-sectional) studies of the relationship between

depression and obesity in community-based adult samples included a total of 204, 507 participants[17]. In this study, deWit et al found a significant overall association between depression and obesity (OR 1.26; 95% CI 1.17-1.36). Subgroup analyses indicated possible differences between males and females, however, with stronger positive associations found in females (OR 1.28; 95% CI 1.17-1.39) than in males (OR 1.05; 95% CI .87-1.28). Interestingly, while the female comparisons were homogeneous, the male subjects showed considerable heterogeneity ($I^2 = 55.8$), indicating that it may be possible to identify subgroups of males at greater risk.

In examining the association of depression and overweight, the cross-sectional data have provided useful information. However, cross-sectional studies are clearly limited in their ability to evaluate a temporal association between the variables of interest. Investigation of a directional association between psychological distress and BMI using longitudinal methods of study is necessary in order to elucidate mechanisms of association. With respect to youth onset predictors of adult outcomes, investigators have generally taken one of three approaches: examining either (i) the association of early-onset obesity with adult depressive illness, (ii) the association of early-onset depression with adult BMI, or (iii) the possibility of a bidirectional relationship between the two illness states. The literature is discussed under these headings below:

## A. Association of BMI in Youth with Adult Depression

In probing the directionality of the relationship between depression and obesity reported in cross-sectional studies, researchers have tested the hypothesis that the

presence of obesity increases an individual's risk for depressive illness. Although studies of this question have been few, results from adult samples have reported a positive association [18, 19]. In adolescent samples, the longitudinal research is limited to four prospective studies, summarized in Table 1-1, which provide conflicting results. In a population of rural, Caucasian 9-16 year old participants, Mustillo et al[20] found that obese boys were at greater risk of depression at eight-year follow-up than non-obese boys. The same association was not found for girls in the study. Conversely, Boutelle et al[21] reported an increased risk of depressive symptoms for obese adolescent girls, but not boys, followed for only a three year period to a mean age of 16 years. In contrast, two studies of large, representative community samples that were followed for at least 15 years into adulthood demonstrated greater agreement in their findings with respect to girls: both Herva et al[22] and Anderson et al[23] found adolescent obesity to be associated with the adult development of depression. In a Finnish cohort, Herva and colleagues found that high BMI at age 14 years was associated with depressive symptoms at age 31 years for both males (OR 1.97, 95% CI 1.06-3.68) and females (OR 1.64, 95% CI 1.16-2.32)[22]. In comparison, Anderson et al[23] assessed adolescents at three time points over a 20 year period and showed that that the risk of depression was present for obese adolescent girls only (HR 3.9, 95%CI 1.3-11.8)[23]. The different findings with respect to gender may be due in part to the different methods used to assess depression status in these studies: Herva et al assessed depressive symptoms using a standardized self-report measure as compared with the structured diagnostic interview used by

**TABLE 1-1 Child and Adolescent Overweight/Obesity and Adult Depression: Studies included**

| n | First author, country, year | Study design, (P/R) | Age-base-line (yrs) | Age at follow-up (yrs) | Female (%) | Final sample size | Weight variable assessed at baseline (m/s) | Psychological symptoms assessed at baseline (measure) | Psychological variable at follow-up (measure) | Results (+ / - ) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| 1 | Mustillo S, 2003 (20) | P | 9 | 16 | 44 | 991 | Obesity (m) | +(CAPA) | CAPA | - girls<br>+ boys |
| 2 | Boutelle KN, 2010 (21) | P | 11-15 | 14-18 | 100 | 488 | Obesity (m) | + (K-SADS-PL) | Depressive symptoms/Depression (KSADS-PL) | + depressive symptoms: girls<br>- depression: girls |
| 3 | Herva A, Finland, 2006 (22) | P | 14 | 31 | 52 | 8,451 | Obesity (s) | - | HSCL-25 | + girls<br>+ boys |
| 4 | Anderson SE, USA, 2007 (23) | P | 9-18 | 28-39 | 53 | 661 | Obesity (s)* | +(DISC) | MDD (SCID-IV) | + girls<br>- boys |

P = prospective; R = retrospective; BMI = body mass index; m= measured; s= self-report; + = positive association reported; - = no association reported; CAPA = Child and Adolescent Psychiatric Assessment[25]; K-SADS-PL = The Schedule for Affective Disorders and Schizophrenia for school-age children – Present and Lifetime version[26]; HSCL-25= Hopkins Symptom Checklist-25[27]; DISC = The Diagnostic Interview Schedule for Children[28]; MDD = Major Depressive Disorder; SCID = Structured Clinical Interview for DSM-IV Disorders [29]

*parent report of height/weight at baseline, participant self-report for participants thereafter

Anderson et al. In using a diagnostic interview to make depression diagnoses, Anderson et al may have obtained a more accurate estimation of psychiatric illness. On the other hand, men in the Anderson study may have under-reported depressive symptoms, as research suggests that men may be less likely to endorse depressive symptoms in interviews as compared with self-report measures, depending on the gender of the interviewer[24]. As a result, an under-identification of depression may have occurred, leading to a lower likelihood of detecting an association between adolescent obesity and adult depression among men in the Anderson study. The discrepant findings by sex may be also due, in part, to differences in the studies' ability to retain participants over these long periods of time. Herva et al achieved a 74% rate of follow-up, in contrast to 96% rate of follow-up in the study by Anderson et al. As Herva et al did not report demographic data for the missing individuals, it is not possible to make inferences about this group compared with those that continued in the study. It may be, for example, that non-depressed males were more engaged in their daily activities at the time of the follow-up survey and less likely to participate in the ongoing study assessment, thereby overestimating the association of early overweight with later depression in this study. Despite these caveats, however, the evidence to date suggests that while it is unclear if obese boys are at greater risk for future depression, obese girls are more likely to develop depression in adulthood than their thinner peers.

## B. Association of Depression in Youth with Adult BMI

To date, seven longitudinal studies of major depression among adolescents and later overweight or obesity exist [30-36]; these are summarized in Table 1-2. Out of the four studies that examined a relationship specifically with obesity[30, 31, 33, 36], three found that depressed adolescents were at increased risk of obesity[30, 31, 33]. Findings with respect to gender in these studies were discordant: Goodman et al[33] reported an increased risk for both males and females (OR 2.05; 95%CI 1.18-3.56) though both Anderson et al[35] and Richardson et al[30] found only depressed adolescent girls were at increased risk of later obesity (OR 2.32; 95%CI 1.39-3.83), with depressed adolescent boys appearing to be at lower risk for adult obesity compared to non-depressed boys in the former sample. In contrast, Wickrama et al [36] found no association between adolescent depression and obesity after a six-year period of follow-up, however, these data were not analyzed separately for girls and boys. Studies examining the association between adolescent depression and later overweight, as opposed to obesity per se, have been similarly discordant (Table 1-2), with two studies determining that depressed adolescents are at increased risk of future overweight[32, 35], and two studies finding no association[31, 34] between these factors. All of these investigations are subject to methodological limitations, including short periods (1-6 years) of follow-up into later adolescence or young adulthood[32-34] and the ascertainment of racially non-diverse, primarily Caucasian, study samples[30, 31]. Moreover, only one study followed participants past the age of 28 years in a community-based sample of 661 American

**TABLE 1-2 Adolescent Depression and Adult Overweight/Obesity: Studies included**

| n | First author, country, year | Study design, (p/r) | Age-base-line (yrs) | Age at follow-up (yrs) | Female (%) | Final sample size | Psychological measure used | BMI assessed in adolescence (m/s) | Outcome at follow-up (m/s) | Results (+ / - ) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| 1 | Richardson LP., New Zealand, 2003 (30) | P | 11-15 /18-21 | 26/26 | 48 | 881/884 | DISC/DIS | + (m) | Obesity (m) | - girls, - boys / + girls, - boys |
| 2 | Pine DS., USA, 1997 (31) | P | 9-18 | 17-28 | 52 | 644 | DISC | - | Obesity (s) /BMI (s) | + girls, - boys/ - girls, - boys |
| 3 | Franko DL, USA, 2005 (32) | P | 16 | 21-23 | 100 | 1554 | CES-D | +(m) | BMI (s) | + girls |
| 4 | Goodman E, USA, 2002 (33) | P | 12-19 | 13-20 | 49 | 9374 | CES-D | +(s) | Obesity (s) | + boys and girls (data not presented separated by sex) |
| 5 | Bardone AM, New Zealand, 1998 (34) | P | 15 | 21 | 100 | 459 | DISC | +(m) | BMI (m) | - girls |
| 6 | Anderson SE, USA, 2006 (35) | P | 9-18 | 28-40 | 53 | 661 | DISC | +(s) | BMI (s*) | + girls - boys |
| 7 | Wickrama KA, USA, 2009 (36) | P | 12-19 | 18-25 | 52 | 11,404 | CES-D | +(s) | Obesity (s) | - overall (not examined by sex) |

P = prospective; R = retrospective; BMI = body mass index; m= measured; s=self-report; + = positive association reported; - = no association reported; DISC = The diagnostic interview schedule for children[28]; DIS = The diagnostic interview schedule [37]; CES-D = Center for epidemiological studies – Depression scale[38]; *parent report of height/weight at baseline, participant self-report for participants > 13 years thereafter

children and adolescents[35], such that longer-term data with respect to slowly accumulating weight gain are limited. Examination of study findings based on the methodological strength of the measures employed, however, does not yield further clarity (Figure 1-1). Thus, the discordance between research results cannot be explained on this basis. In addition, these studies had comparable rates of participant follow-up (85%-95%), with the exception of that of Wickrama et al [36] in which the rate of follow-up was significantly lower (70%). In analysis of the study variables, Wickrama et al [36] found little difference between adolescents with missing and complete data. As a result, although existing research indicates that depression in adolescence may confer increased risk of obesity for affected girls in particular, data are conflicting; this may be due in part to the relatively long periods of follow-up required to allow for examination of the outcome of interest.

Increases in the prevalence of depression and obesity from adolescence to adulthood noted in recent years may obscure the examination of the temporal association between the two disorders. In particular, the prevalence of overweight and obesity significantly increases during the pre-pubertal and pubertal years, making the examination of depression in the absence of the outcome variable of interest more challenging. Thus, investigating the relationship between earlier, childhood-onset psychopathology and adult overweight and obesity may be of specific value in determining whether these factors are indeed early correlates of later obesity. Pine et al[39], in a case-control study of a clinical sample of children and adolescents with major depressive disorder (mean age = 11 years), found depression during childhood to

**FIGURE 1-1** **Studies of Adolescent MDD and Future Risk of Overweight or Obesity for Girls*: Outcomes by Study Design**

| Assessment of depression (predictor): | Assessment of overweight/obesity (outcome): Self-report height/weight | Assessment of overweight/obesity (outcome): Measured height/weight |
|---|---|---|
| Self-report measure | *(+) Goodman et al (27): OBES* | (+) Franko et al (26): OWT |
| Diagnostic interview | (+) Anderson et al (29): OWT<br>(+) Pine et al (25): OBES<br>(-) Pine et al (25): OWT<br>*(-) Wickrama et al (30):OBES* | (-) Bardone et al (28): OWT<br>(+) Richardson et al (24): OBES |

(+) = positive association observed; (-) = no association observed; OWT = Overweight; OBES = Obesity
**italics indicate studies that did not examine outcomes separately for girls and boys*

be positively associated with adult BMI. This association was not explained by a number of potential confounding factors. However, these findings were not replicated by Tanofsky-Kraff et al[40] in their study of psychological predictors of body fat gain in a convenience sample of 6-12 year old children in the Washington DC area, in which no association between depressive symptoms and increases in body fat over the mean four year study period were found. The latter study, however, had a number of significant limitations which may have impacted the study findings, including a study sample solely of overweight or at-risk for overweight children, use of self-report questionnaire as the only measure of child depressive symptoms, and a short, variable period of participant follow-up which did not extend into adulthood. Two additional studies[30, 35] included children less than 12 years of age (Anderson; 9-18 years, Richardson; 11-15 years) in their predominantly adolescent study samples, but did not analyze the pre-adolescent subgroup separately. Further research examining the association between childhood-onset depression and adult BMI in prospective, longitudinal studies in representative community samples are needed.

### C. Bidirectional Association of Depression and BMI

These findings have prompted some investigators to consider the possibility of a bidirectional relationship between the two disorders. Although research aimed at answering this question is limited, several authors have undertaken secondary data analyses in an attempt to address the concept of bidirectionality. In a recent meta-

analysis of longitudinal studies, Luppino et al[41] concluded that evidence of a reciprocal relationship between depression and obesity exists and further, that the association between depression and obesity (OR 1.58; 95%CI 1.33-1.87) is stronger than the association between depression and overweight (OR 1.20; 95%CI 0.87-1.66). Although the magnitude of the relationship was similar regardless of directionality in this meta-analysis, the studies included for analysis were predominantly based on adult samples. Subgroup analyses among persons younger than 20 years of age was undertaken, and consisted of only two studies of primarily adolescent subjects within the overweight/obese exposure subgroup, thereby making definitive comments regarding bidirectionality among youth difficult. A study of bidirectionality among child and adolescent aged populations has not been published. With respect to the adult literature, however, the findings of Luppino et al [41] echo those investigating the relationship between depression and obesity-related conditions, including diabetes mellitus[42], in noting that the interaction between the two complex, multifactorial pathological processes is likely to be reciprocal in nature.

### 1.2 Non-Depressive Psychopathology and Overweight

Limited prospective studies of non-depressive psychopathology in childhood and adolescents have found an association between behaviour disorders[43, 44], conduct[31] and anxiety[35] disorders in adolescent females, and childhood binge-eating and dieting[40] and later increased body weight.

Research exploring the association of childhood behaviour problems and later overweight or obesity has been generally consistent in reporting an increased risk of later

obesity for affected youth regardless of gender (Table 1-3), however, the studies are limited by young age at follow-up[34, 43-45], and the inability to make clinical diagnoses [43-45]. In a Finnish population-based cohort of boys, Duarte et al[45] found that Rutter questionnaire-detected[46] conduct problems at age 8 years were associated with increased risk of measured obesity at 18-23 years of age (OR 1.9; 95%CI 1.2-2.8). In this study, childhood hyperactivity symptoms also initially appeared to predict later obesity, however, this association did not persist after adjustment for conduct problems. Two prospective, interview-based studies of youth psychopathology and later obesity have been conducted with divergent results. In an American population based study, Pine et al[31] found that Conduct Disorder (CD) in adolescence (mean age 14 years) predicted early adult obesity (mean age 22 years) among both male and female participants. These findings are in contrast to those of Bardone et al[34] in a New Zealand based cohort of girls only, in which conduct disorder at age 15 years was associated with lower BMI at age 21 years. Although both studies utilized the DISC interview to determine diagnoses of conduct disorder, only the study by Bardone et al[34] used measured (vs. self-reported) height and weight to determine BMI. Thus, the findings of Bardone et al are of interest: as the only negative study of the association between early-onset conduct problems and later obesity, it is also the only prospective study of externalizing disorders with both interview-based psychological diagnosis and measured BMI outcome data to date. Of note, Bardone et al included adolescent girls with a diagnosis of Oppositional Defiant Disorder (ODD) in their CD sample. In doing so, they may have diluted the psychopathology present in the sample, thereby obscuring their ability to see a

**TABLE 1-3 Child/Adolescent Behaviour Problems and Adult Overweight/Obesity: Studies included**

| n | First author, country, year | Study design, (p/r) | Age-base-line (yrs) | Age at follow-up (yrs) | Female (%) | Final sample size | Psychological measure used | BMI assessed at baseline (m/s) | Outcome variable at follow-up (m/s) | Results (+ / - ) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| 1 | Pine DS, USA, 1997 (25) | P | 9-18 | 17-28 | 52 | 644 | DISC (CD symptoms) | - | Obesity (s) | + girls<br>+boys |
| 2 | Bardone AM, New Zealand, 1998 (28) | P | 15 | 21 | 100 | 459 | DISC (CD or ODD) | + (m) | BMI (m) | - girls (decreased BMI in girls with CD/ODD) |
| 3 | Lumeng JC, USA, 2003 (35) | P | 8-11 | 10-13 | 47 | 629 | BPI (behaviour problems) | + (m) | BMI (78% m; 22% s) | + overall, analyses by sex not examined |
| 4 | Mamun AA, Australia, 2009 (36) | P | 5 | 21 | | 2,004 | CBCL (behaviour problems) | + (m) | BMI/Obesity (m) | + child-onset ,<br>- adolescent-onset, analyses by sex not examined |
| 5 | Duarte CS, Finland, 2010 (37) | P | 8 | 18-23 | 0 | 2,209 | Rutter Questionnaire (hyperactivity and/or conduct problems) | - | BMI/Obesity (m) | Conduct: + overweight; + obesity<br>Hyperactivity: - overweight, - obesity |

P=prospective; R=retrospective; m=measured; s=self-report; + = positive association reported; - = no association reported; BMI=body mass index; DISC = The diagnostic interview schedule for children[28]; CD = conduct disorder; ODD = oppositional defiant disorder; BPI= behavioural problems index[47]; CBCL=Child behaviour checklist[48]

relationship between adolescent CD and later obesity. Summarizing these five studies, research indicates that early onset non-specific behaviour problems may be associated with increased body weight in adolescence/young adulthood for affected boys, with conflicting findings for disruptive adolescent boys and girls.

## 1.3 Study Objectives

The primary objective of the present study is to examine the association of child and adolescent depressive symptoms with adult overweight in a large community sample of Ontario children. It is hypothesized that the presence of increased depressive symptoms in childhood and adolescence will be associated with increased overweight in adulthood. The secondary objectives of this study are to examine the association between increased childhood behavioural disturbance (ADHD and CD symptoms) and adult overweight and to evaluate whether the relationships between childhood and adolescent psychopathology and adult overweight, if present, are specific to sex.

## 1.4 Relevance

The present study overcomes in many ways the limitations of much of the current literature, which is derived from investigation of adolescent and adult samples, by examining a longitudinal cohort of young children who typically have a lesser burden of medical and psychological confounding factors than older individuals. This allows for a clearer examination of the variables of interest in examining the temporal association of psychopathology and obesity. Further strengths of the current study include (i)

prospective collection of early childhood psychological data, (ii) a long (17 year) study period which allows participant follow-up into adulthood, and (iii) a representative, community-based study sample. Together, these features of study design allow the results to fill an important gap in current knowledge regarding the relationship between early psychopathology and adult overweight and obesity.

# CHAPTER 2 - METHOD

## 2.1 Original OCHS Survey

The Ontario Child Health Survey is a publicly-funded, longitudinal community survey of child health in the province of Ontario. The primary study objective was to estimate the prevalence of emotional and behavioural disorders among Ontario children 4 to 16 years of age. Children and adolescents were originally enrolled for study participation in 1983, with follow-up assessments occurring in 1987 and 2000. Data were collected from multiple informants including youth, parents and teachers using a combination of self-administered and interviewer-administered measures.

### A. Participants

The target population of the OCHS included all children born between January 1, 1966 through January 1, 1979 living in Ontario. Children living on Aboriginal reservations, institutions, or in houses constructed after June 1, 1981 were excluded from study representation. These three groups of excluded children represented 3.3% of the total population of children 4 to 16 years of age.

The Ontario Ministry of Community and Social Services was comprised of four administrative regions. Each administrative region was further determined to consist of three strata based on population density: large urban (population greater than 25,000), small urban (population between 3,000 and 25,000), and rural (population less than 3,000) areas. Households were sampled in proportion to the provincial distribution of households in large urban (70%), small urban (9%) and rural (21%) areas. Sample selection of households (the sampling unit) was done by stratified, clustered and random sampling of all households in the 1981 Census of Canada (the sampling frame). Within each of the four Ministry regions, a simple random sample of households in large

urban areas was selected. In small urban and rural areas, divisions or clusters were selected initially; households were subsequently selected with known probability[49]. A total of 2,623 households were selected, of which 78.2% were eligible based on the age of children living in the home. Among eligible households, 1,869 (91.1%) agreed to participate in the survey, yielding a total of 3,294 children aged 4 to 16 years. Eligibility and participation did not vary by population density group. The follow-up in 2000 aimed to include all individuals who participated in the original 1983 survey, achieving a response rate of 59.1%.

**B. Survey Measures**

Trained interviewers from the Special Surveys Division of Statistics Canada visited all sampled households to screen for eligibility and to conduct survey interviews. Verbal consent was obtained prior to the interview. Written permission was obtained for Statistics Canada to share respondent information with the study investigators. Home interviews were conducted with parents (95% mothers) and youth aged 12 to 16 years. Parents completed interviews about their 4 to 11 year old children as well as themselves. Youth aged 12 to 16 years reported on their own experiences. Consent was obtained to request teacher reported data for children and youth attending school.

Information was collected under three broad headings: Risk Factors, Health Status, and Consequences. Data obtained under the category of Risk Factors included information pertaining to demography, early neonatal and developmental course, and family composition, functioning and stressors. Data collected under the category of Consequences was comprised of information pertaining to health and social service utilization and the degree of functional impairment, if any, of participants. In addition to general medical information, the Health Status section of the survey

investigated four childhood disorders: hyperactivity, conduct disorder, emotional disorder, and somatisation. The Child Behaviour Checklist [48] provided the core pool of 40 survey questions for these disorders, with 6 additional items included to cover diagnostic criteria for the hyperactivity and somatisation disorders as outlined by the DSM-III [50], thereby forming the Survey Diagnostic Instrument (SDI) of the study. Parents, teachers of children and adolescents, and youth aged 12 to 16 years of age completed comparable surveys. In addition, youth aged 12 to 16 years reported on their use of substances including alcohol, cigarettes, and other substances of abuse. Respondents assessed each item based on the previous six months. Specific detail regarding the measurement of the disorders included in the present study follows below.

### C. Missing Data

Missing data in the OCHS survey was treated by the original OCHS investigators in the following way: Scales in which more than 33% of the items were not completed were coded as missing; for scales in which at least 67% of items were completed, data imputation was used. Following examination of five methods of imputation, it was determined that substitution of the missing item with the value of the item in the same scale that was most highly correlated with the item in question represented the best combination of accuracy and economy. Greater detail regarding the alternate imputation methods examined are available elsewhere [49].

## 2.2 Measurement of Psychopathology

### A. Depression

The diagnosis of emotional disorder from the 1983 study survey included symptoms of depression and anxiety. A distinct diagnosis of a depressive disorder was not included. However, 'Major Depressive Syndrome (MDS)' has since been defined by previous OCHS investigators[51] by matching symptoms from the OCHS study survey to those comprising the DSM-III-R diagnosis of a Major Depressive Episode (MDE), the occurrence of which is the hallmark of Major Depressive Disorder (MDD). Fleming et al[51] determined three levels of diagnostic certainty by varying the symptom severity required for each level and examined five external validators for each level of certainty, concluding that estimates of "medium" and "high" severity levels most accurately reflect MDE. Moreover, the study group later demonstrated increased rates of clinically significant depression among youth in the "medium/high" (MDS) group as compared with the control group (25% vs. 6.9%) in the 1987 OCHS follow-up survey [52].

Although the identical, previously computed MDS variable was not available for the present study, sufficient detail was provided in the Fleming et al 1989 study methodology such that replication of the construct could be undertaken. A variable representing MDE was thus derived from the 1983 OCHS dataset, using the following symptoms contained within the OCHS survey:

| | |
|---|---|
| *Core symptom:* | *(1) Depressed mood* |
| *Additional symptoms:* | *(2) Overeating (parent and youth only)* |
| | *(3) Poor appetite* |
| | *(4) Trouble sleeping* |
| | *(5) Sleeping more than most children (parent and youth only) or sleeps in class (teacher only)* |

*(6) Has trouble enjoying self*
*(7) Unable to concentrate or pay attention for long*
*(8) Feels worthless or inferior*
*(9) Feels too guilty*
*(10) Deliberate self-harm or suicide attempts*
*(11) Talks about killing self*
*(12) Underactive, slow-moving or lacks energy*
*(13) Can't sit still, restless or hyperactive*

The continuous variable 'Major Depressive Symptoms' was thus constructed: symptom response categories for symptoms occurring within the past six months included 'never or not true', 'sometimes or somewhat true', and 'often or very true', for which scores of 0, 1, and 2 were assigned, respectively. The scores for each of the 13 questions included in the MDS construct were summed such that the maximum score achievable for this variable was 26. For a diagnosis of either medium or high certainty to be applied, respondents were required to have a score of 2 on the core depressive symptom as well as a score of 1 or 2 on at least 4 associated depressive symptoms.

Using these parameters, a MDS variable was computed that yielded similar prevalence rates to those reported by Fleming et al: 2.9% (present study) vs. 3.3%[51] for preadolescents and 9.1% (present study) vs. 9.6% [51] for adolescents. Small differences in these rates may be due in part to the definition of core symptom positivity. Within the study Survey Diagnostic Instrument, at least three questions pertained to depressed mood (i.e. feeling unhappy, feeling sad, and crying) though the specific depressed mood questions included in the MDS variable were not detailed by Fleming et al. For the present study, a score of 2 on any of these three questions was considered to be positive

for depressed mood. The symptom items used in the MDS construct and the corresponding DSM-III-R [53]symptoms are presented in Table 2-1. Of note, the DSM-IV extends the core symptoms of MDE to include anhedonia and for children and adolescents, to further include irritability. These additional symptoms were not included in the present MDS computation in order to be faithful to the previously validated construct, which did not specify their inclusion as core symptoms. Finally, small differences in prevalence rates computed in this study as compared with those reported by Fleming et al among the pre-adolescent age group may also be due in part to differences in the study sample analyzed. Fleming et al excluded children aged 4-5 years from the depression analyses due to poor teacher response rate in children less than 6 years of age. However, the present study includes these children in order to add new information about this young age group which has generally not been studied in previous investigations.

## B. Attention Deficit Hyperactivity Disorder

The diagnosis of ADHD in the original 1983 OCHS survey (termed "Hyperactivity disorder" at that time) was comprised of six questions (items) developed to operationalize symptoms defined by the DSM-III-R[53], and added together to form a score. Parents, teachers and youth were asked to respond to all items. The six items contained within the OCHS scale include:

*Hyperactivity*

*(1) Fidgets*

*(2) Trouble staying still, restless or hyperactive*

**TABLE 2-1 Symptom Comparison of MDE (DSM-IV-TR) with MDS**

| MDE (DSM-IV-TR) | MDS |
|---|---|
| **Either (1) or (2) must be present, plus 4 additional symptoms.** | **(1) must be present (score = 2) "often or very true", plus 4 additional symptoms (score ≥ 1)** |
| (1) Depressed or Irritable mood | (1) Depressed mood |
| (2) Anhedonia – loss of interest or pleasure in all, or almost all, activities | (2) Has trouble enjoying self |
| (3) Significant weight loss (when not dieting) *or* weight gain, *or* decrease *or* increase in appetite. In children: consider failure to make expected weight gains. | (3) Overeating (parent and youth only) *or* (4) poor appetite |
| (4) Insomnia *or* hypersomnia | (5) Trouble sleeping *or* sleeping more than most children (parent and youth only) *or* (6) sleeps in class (teacher only) |
| (5) Psychomotor agitation *or* retardation | (7) Underactive, slow-moving or lacks energy *or* (8) can't sit still, restless or hyperactive |
| (6) Fatigue or loss of energy | ---------- |
| (7) Feelings of worthlessness or excessive or inappropriate guilt | (9) Feels worthless or inferior and/or (10) feels too guilty |
| (8) Diminished ability to think or concentrate, or indecisiveness | (11) Unable to concentrate or pay attention for long |
| (9) Recurrent thoughts of death, recurrent suicidal ideation, or a suicide attempt or specific plan for committing suicide | (12) Deliberate self-harm or suicide attempts and/or (13) talks about killing self |
| **Reference time period: past 2 weeks** | **Reference time period: past 6 months** |

*Impulsiveness*

*(3) Difficulty awaiting turn in games or groups*

*(4) Impulsive, or acts without thinking*

*Inattention*

*(5) Trouble concentrating or paying attention*

*(6) Easily distracted, difficulty sticking to any activity*

The symptom items used in the OCHS survey and the corresponding DSM-III-R symptom are presented in Table 2-2. As there are many more DSM-III-R criteria than there were OCHS items designed to operationalize the hyperactivity and impulsivity constructs, OCHS items may map onto more than one DSM-III-R symptom outlined in Table 2-2. Although alternate mappings may be plausible, Table 2-2 presents the best option for each OCHS scale item in an effort to optimize the overall readability of the Table.

Items on the ADHD scale were given a rating of 0, 1, or 2 indicating responses of "never or not true", "sometimes or somewhat true" or "often or very true", respectively. Threshold scores for classifying a disorder as present or absent were the scale scores that best discriminated clinical diagnoses made independently by child psychiatrists in a stratified random sample of children (n=194) from the 1983 survey [54]. Agreement between the child psychiatrists' diagnoses and the survey assessments of ADHD has been shown to be high for both the 4-11 year old (k =0.78) and the 12-16 year old (k=0.79) groups (5). Previous evaluation of the ADHD scale used in the original OCHS survey has reported good internal consistency, convergent validity and discriminant validity when examined in both the 4-11 year old and 12-16 year old age groups [54].

**TABLE 2-2 Symptom Comparison of ADHD (DSM-III-R) with Hyperactivity Disorder* (OCHS).**

| ADHD (DSM-III-R) | Hyperactivity Disorder |
|---|---|
| (1) Often fidgets with hands or feet or squirms in seat (in adolescents may be limited to subjective feelings of restlessness) | (1) Fidgets |
| (2) Has difficulty remaining seated when required to. | (2) Trouble sitting still, restless or hyperactive |
| (3) Is easily distracted by extraneous stimuli. | |
| (4) Has difficulty awaiting turns in games or group situations. | (3) Difficulty awaiting turn in games or groups |
| (5) Often blurts out answers to questions before they have been completed. | |
| (6) Has difficulty following through on instructions from others (not due to oppositional behavior or failure of comprehension). | |
| (7) Has difficulty sustaining attention in tasks or play activities. | (4) Trouble concentrating or paying attention |
| (8) Often shifts from one uncompleted activity to another. | (5) Easily distracted, difficulty sticking to any activity |
| (9) Has difficulty playing quietly. | |
| (10) Often talks excessively. | |
| (11) Often interrupts or intrudes on others, e.g., butts into other people's games. | (6) Impulsive, or acts without thinking |
| (12) Often does not seem to listen to what is being said to him or her. | |
| (13)Often loses things necessary for tasks or activities at school or at home (e.g., toys, pencils, books). | |
| (14)Often engages in physically dangerous activities without considering possible consequences (not for the purpose of thrill-seeking), e.g., runs into street | |
| **Reference time period: past 6 months** | **Reference time period: past 6 months** |

*Items from the OCHS survey may be relevant or map to more than one symptom as outlined by the DSM.

## C. Conduct Disorder

The diagnosis of conduct disorder in the 1983 survey was comprised of 15 questions (items) developed to operationalize symptoms defined by the DSM-III-R[53] and added together to form a score. The items comprising the conduct disorder scale include:

*Physical violence against persons or property as part of a persistent pattern*

*(1) Cruelty to animals*

*(2) Cruelty, bullying, or meanness to others*

*(3) Physically attacks people*

*(4) Gets in many fights*

*(5) Destroys his/her own things*

*(6) Destroys things belonging to his/her family or other children*

*(7) Vandalism*

*(8) Sets fires*

*Serious violation of social norms*

*(9) Disobedient at school*

*(10) Truancy, skips school*

*(11) Threatens people*

*(12) Lying or cheating*

*(13) Steals at home*

*(14) Steals outside the home*

*(15) Runs away from home*

A comparison of the symptom items used in the OCHS survey of parents and youth with the corresponding DSM-III-R symptoms, are presented in Table 2-3. On the teacher-completed scale, items OCHS(5,10): “steals at home, steals outside the home” and OCHS(11): “has run

**TABLE 2-3 Symptom Comparison of Conduct Disorder Definition: DSM-III-R vs. OCHS.**

| DSM-III-R | OCHS |
|---|---|
| (1) Often bullies, threatens, or intimidates others | (1) Cruelty, bullying, or meanness to others |
| (2) Often initiates physical fights | (2) Gets in many fights |
| (3) Has used a weapon that can cause serious physical harm to others (e.g. a bat, brick, broken bottle, knife, gun) | (3) Physically attacks people |
| (4) Has been physically cruel to people | |
| (5) Has been physically cruel to animals | (4) Cruelty to animals |
| (6) Has stolen while confronting a victim (e.g. mugging, purse snatching, extortion, armed robbery) | (5) Steals outside the home* |
| (7) Has forced someone into sexual activity | |
| (8) Has deliberately engaged in fire-setting with the intention of causing serious damage | (6) Sets fires |
| (9) Has deliberately destroyed others' property (other than by fire-setting) | (7) Destroys things belonging to his/her family or other children |
| (10) Has broken into someone else's house, building or car | (8) Vandalism |
| (11) Often lies to obtain goods or favours or to avoid obligations (i.e. "cons" others) | (9) Lying or cheating |
| (12) Has stolen items of nontrivial value without confronting a victim (e.g. shoplifting, but without breaking and entering; forgery) | (10) Steals at home* |
| (13) Often stays out at night despite parental prohibitions, beginning before age 13 years | |
| (14) Has run away from home overnight at least twice (or once without returning for a lengthy period) | (11) Runs away from home* |
| (15) Is often truant from school, beginning before age 13 years | (12) Skips school |
| | (13) Disobedient at school |
| | (14) Threatens people |
| | (15) Destroys his/her own things |
| **Reference time period: past 12 months** | **Reference time period: past 6 months** |

*item omitted in the teacher-completed scale

away from home overnight at least twice while living in parental or parental surrogate home (or once without returning)" were omitted, as it was felt that teachers would not be able to assess these adequately. In addition, a questionnaire item for symptom DSM(7) "has forced someone into sexual activity with him/her" was not developed as it was thought it would be seldom reported and would possibly be offensive to respondents. Items on the Conduct disorder scale were given a rating of 0, 1, or 2 indicating responses of "never or not true", "sometimes or somewhat true" or "often or very true", respectively. Threshold scores for classifying a disorder as present or absent were the scale scores that best discriminated clinical diagnoses made independently by child psychiatrists in a stratified random sample of children (n=194) from the 1983 survey [54]. Agreement between the child psychiatrists' diagnoses and the survey assessments of ADHD has been shown to be high for the 4-11 year old group (k=0.68) and acceptable for the 12-16 year old group (k=0.39) (5). Previous evaluation of the Conduct Disorder scale used in the original OCHS survey has reported good internal consistency, convergent validity and discriminant validity when examined in both the 4-11 year old and 12-16 year old age groups [54].

### 2.3 Measurement of Covariates

In investigating the association between early-onset MDD, hyperactivity, and conduct disorder with adult weight, covariates were selected based on the current literature (e.g. gender, socioeconomic status, family psychiatric history) or on the potential for confounding the association. For example, as both alcohol use and cigarette smoking are known to be associated with these early-onset psychological conditions as well as with weight changes[55-58], both factors were included as covariates in the investigation among youth respondents. In the examination of early-onset MDD

and adult overweight, adult depression status was also included as a covariate, to examine for illness effects which may be specific to early age at disease onset. As measures of ADHD or Conduct Disorder were not included for the adult participants of the year 2000 survey wave, comparable covariates could not be included for evaluation of the relationship between these disorders and body weight. An overview of the covariates included in the analyses is presented in Table 2-4.

Adolescents were considered to be positive for tobacco use if they smoked cigarettes or cigars every day for 30 days or more in the 6-month period prior to the survey. Adolescents were considered to be positive for alcohol use if they consumed alcoholic beverages at least once a week for a continuous 4-week period or longer over the six month period preceding the survey, and consumed at least two drinks or became intoxicated on at least one of those occasions. Parental report of lifetime history of mental health treatment "have you ever been treated for nerves or a nervous condition?" was included as a covariate in the analyses of each child and youth onset psychiatric illness examined. Depressive symptoms in adulthood were also taken into account in the examination of the association between early depressive symptoms and adult BMI. Depressive symptoms in the year 2000 survey were assessed using the Composite International Diagnostic Interview –Short Form, a standardized interviewer-administered measure. Depression in adulthood was included as a continuous measure in the analyses. Finally, a composite measure of socioeconomic status (SES) was computed comprising household income, maternal and paternal level of education and maternal/paternal occupation, and included as a covariate in the examination of early-onset psychopathology with increased adult BMI.

**TABLE 2-4 Covariates Included in Analyses of the Relationship Between Childhood Psychopathology and Adult BMI.**

| | Age | Sex | SES | Parental Psychiatric History | Cigarette Smoking | Alcohol Use | Adult Depression Score |
|---|---|---|---|---|---|---|---|
| **Depression** | | | | | | | |
| 4-11 years | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| 12-16 years | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | | | | | | |
| **ADHD** | | | | | | | |
| 4-11 years | ✓ | ✓ | ✓ | ✓ | | | |
| 12-16 years | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| | | | | | | | |
| **Conduct** | | | | | | | |
| 4-11 years | ✓ | ✓ | ✓ | ✓ | | | |
| 12-16 years | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |

## 2.4 Measurement of Outcome

The primary outcome variable of interest is body mass index (BMI) in adulthood, as determined by respondent self-report in the third wave of the OCHS study in 2000. Respondents reported their weight and height such that BMI was computed using the formula BMI = weight (kg)/height$^2$ ($m^2$).

## 2.5 Multiple Informants

The OCHS survey collected data from parents, teachers and youth, thus providing information about the psychological symptoms of children and youth from a number of informants. Of these sources, response rates were lowest among teachers. The rate of teacher non-response was 18.3% overall: 16.3% for children 4 to 11 years old and 21.4% for youth 12 to 16 years old. The number of missing responses on teacher-returned checklists was also high, and noted to be particularly high on evaluations of youth 12-16 years of age, where missing responses ranged from 18.5% to 69.2%. Due to the high rate of non-response and missing response by teachers, the original study investigators did not use teacher data to assess disorders in the older age group; similarly, these data have not been included to assess disorders of youth in the present study.

For children ages 4 to 11 years, symptoms of depressive, ADHD and conduct disorders were initially intended to include both parental and teacher report, however, due to very low teacher response rate regarding depressive symptoms (detailed in section 3.1 (A) below), analyses of depressive symptoms in this age group include parental report only. For children 12 to 16 years, psychological symptoms as reported by youth and parents included for analyses.

## 2.6 Statistical Analyses

Descriptive statistics were utilized to determine the prevalence rate of psychiatric illness by age and informant subgroup within the study sample and to compare age, sex and SES between affected and non-affected participants as well as between participants with and without available BMI data at the time of adult follow-up. Categorical definitions of psychiatric disorder were utilized for descriptive comparisons. Student's t-test, chi-square analysis, and kappa statistic were used to compare means, proportions, and measure informant-agreement on the presence of disorder, respectively, for these purposes.

To address the primary hypothesis, that childhood and adolescent onset depression would be associated with increased adult BMI, multiple regression analyses were conducted for each age group (e.g. 4-11 yr old group and 12-16 year old group). Depressive symptoms were included as a continuous variable. For the 4-11 year old regression analysis, childhood variables of age, sex, and depressive symptoms were included as covariates in step one, followed by family variables (SES and parental psychiatric history) in step two and then the participant's adult depression score in step three. The analyses for the 12-16 year old participant group were similarly conducted, with the further addition of alcohol and cigarette use as covariates.

To address the hypothesis that the early-onset of externalizing disorders (ADHD and CD) would be associated with an increased risk of adult overweight, multiple regression analyses were conducted for each age group (e.g. 4-11 yr old group and 12-16 year old group). Symptoms of ADHD or Conduct disorder were included as continuous variables. For the 4-11 year old regression analysis, participant childhood variables of age, sex were included as covariates in step one, followed by family variables (SES and parental psychiatric history) in step two. The analyses for the 12-16

year old participant group were similarly conducted, with the further addition of alcohol and cigarette use as covariates in step three. A summary of the covariates included for each disorder and age group is presented in Table 2-4.

Where both the mental illness (Depression, ADHD or CD) and sex were determined to be significant predictor variables, the presence of an interaction effect was assessed. Determination of the interaction variable was conducted after computing centered variables for inclusion in the regression analysis. Centering, or subtracting the mean from a variable and leaving deviation scores, was performed under these circumstances to improve the interpretability of the regression coefficients and reduce multicollinearity among predictor variables [59]. As centering has no effect at all on linear regression coefficients unless an interaction term is included, centering was undertaken when the interaction between sex and mental illness was assessed in the analyses. Where sex was an important predictor variable, in the absence of an interaction effect, data were analyzed separately for boys and girls. Analysis by sex subgroup addressed the study's secondary objective regarding the role of sex in the relationship between childhood psychopathology and adult weight (section 1.3 above) and further permitted comparison of the findings of this thesis with the current literature.

# CHAPTER 3 - RESULTS

The study sample was comprised of 1,992 children aged 4-11 years in 1983. Body mass index calculations for the 1,147 (58%) participants for whom data were obtained at the year 2000 follow-up revealed a mean BMI of 25.0 kg/$m^2$ (SD 4.8) with a BMI range of 15.5 kg/m2 to 57.6 kg/$m^2$. Of the 1,302 youth 12-16 years of age who participated in the 1983 wave of the OCHS, BMI data were obtained for 739 (57%) individuals in the year 2000. The mean adult BMI of the youth studied was 25.6 kg/$m^2$ (SD = 4.7), with values ranging from 13.7 kg/m2 to 44.7 kg/$m^2$.

Participants who were initially included as 4-11 year old children in 1983 were 21 – 28 years of age at the time of follow-up; those included as 12-16 year old youth in 1983 were 29 – 33 years of age at adult follow-up in the year 2000.

## 3.1 Depression

### A. Children

The study sample was comprised of 1,992 children aged 4-11 years in 1983. Table 3-1 presents the age, sex, and total number of respondents for whom data is available, for children meeting criteria for MDS as reported by parent (pMDS) and teacher (tMDS) response.

Agreement between parent and teacher report of MDS diagnosis showed that of the 42 cases parent-reported depression, teachers identified two as depressed and eight as non-depressed; teacher report data were not available for the remaining 32 parent-identified cases. A total of 57 children were thus identified as depressed by either parent or teacher report, though parent-teacher agreement was poor (k=0.13). Due to the large number of children for whom teacher responses were unavailable (70%), further investigations of depression in the pre-adolescent age group have been based on parent report only. Children who were depressed did not differ in age or sex from those

**TABLE 3-1** **Age, Sex and Data Available for Determinations of MDS by Parental and Teacher Report.**

| | pMDS | tMDS | Total |
|---|---|---|---|
| n (%) | 42 (2.2) | 17 (2.8) | |
| age: yrs (SD) | 7.9 (2.3) | 7.5 (2.4) | 7.7 (2.3) |
| female: n (%) | 23 (55%) | 6 (35%) | 967 (48%) |
| n (data available) | 1,928 | 605 | 1,992 |
| n (missing data) | 64 | 1387 | --- |

who were not depressed (mean 7.7 years, $t$=0.71, $p$=.50; 51% male, $\chi^2$= 0.44, $p$=0.53). Moreover, exploration of the age and sex of those children for whom parent-report data were missing (n=64) revealed no differences in age or sex as compared with those for whom data were available (mean 7.64 years, $t$=0.14, $p$=.90; 61% male, $\chi^2$=0.12, $p$=.10).

Of the 42 children with MDS in 1983, BMI data were available for 21 (50%) in 2000. This figure is comparable to the proportion of non-depressed children for whom adult BMI data were available at the time of follow-up (58%, $\chi^2$= 1.12, $p$=.34). Investigation of demographic information among depressed children for whom BMI were available did not demonstrate any differences in age ($t$ =1.41, $p$=.17), sex ($\chi^2$=.02, $p$=.80), or SES ($t$=1.55, $p$=.13), as compared with those of depressed children for whom data regarding adult BMI were missing. Adults with childhood onset depression had a BMI of 27.3 kg/m$^2$ (SD=6.4) as compared with a BMI of 25 kg/m$^2$ (SD=4.8) for adults who were non-depressed as children, regardless of lifetime depression status ($t$=2.20, $p$=.02).

The presence of depression in childhood was no longer significantly associated with adult BMI after accounting for demographic and family-related variables ($p$ =.07) (Table 3-2), however, the effect of sex was noted to be strongly significant in the overall model ($p < .001$) with absence of a depression-sex interaction. Thus, analyses were computed separately for boys and girls (Tables 3-3 and 3-4, respectively). Investigation of the relationship between depression in childhood and adult BMI by gender revealed a positive association for boys only ($p$ =.02; Table 3-3). Boys with depression in childhood were heavier in adulthood than their non-depressed peers. Among girls, there was no association between depression in childhood and adult weight (Table 3-4).

**TABLE 3-2** **The Association of Childhood Onset Depression (ages 4-11 years) and Adult BMI (boys and girls)**

| | | *B* | *SE B* | *β* | *p* |
|---|---|---|---|---|---|
| Step 1 | | | | | |
| | Constant | 24.79 | 0.66 | | |
| | Depression | 0.18 | 0.07 | 0.08 | .008 |
| | Age | 0.20 | 0.06 | 0.10 | .001 |
| | Sex | -1.11 | 0.29 | -0.13 | <.001 |
| Step 2 | | | | | |
| | Constant | 24.90 | 0.66 | | |
| | Depression | 0.13 | 0.07 | 0.06 | .057 |
| | Age | 0.18 | 0.06 | 0.09 | .003 |
| | Sex | -1.07 | 0.28 | -0.11 | <.001 |
| | SES | -0.16 | 0.04 | -0.11 | <.001 |
| | Parental Psychiatric Illness | 0.70 | 0.36 | 0.06 | .050 |
| Step 3 | | | | | |
| | Constant | 24.90 | 0.66 | | |
| | Depression | 0.12 | 0.07 | 0.06 | .069 |
| | Age | 0.18 | 0.06 | 0.09 | .003 |
| | Sex | -1.12 | 0.29 | -0.12 | <.001 |
| | SES | -0.16 | 0.04 | -0.11 | <.001 |
| | Parental Psychiatric Illness | 0.68 | 0.36 | 0.06 | .060 |
| | Adult depression score | 0.10 | 0.08 | 0.04 | .223 |

**TABLE 3-3** **The Association of Childhood Depression and Adult BMI Among Boys (N = 548)**

| | B | SE B | β | p |
|---|---|---|---|---|
| Constant | 23.45 | 0.62 | | |
| Depression | 0.18 | 0.08 | 0.10 | .022 |
| Age | 0.21 | 0.08 | 0.12 | .006 |
| SES | -0.06 | 0.05 | -0.05 | .262 |
| Parent Psychiatric Illness | 0.68 | 0.43 | 0.07 | .113 |
| Adult depression score | 0.03 | 0.12 | 0.01 | .787 |

Note: $R^2 = .04$

**TABLE 3-4** **The Association of Childhood Depression and Adult BMI Among Girls (N = 564)**

| | B | SE B | β | p |
|---|---|---|---|---|
| Constant | 22.95 | 0.80 | | |
| Depression | 0.07 | 0.11 | 0.03 | .523 |
| Age | 0.16 | 0.10 | 0.07 | .087 |
| SES | -0.24 | 0.07 | -0.16 | <.001 |
| Parent Psychiatric Illness | 0.68 | 0.58 | 0.05 | .237 |
| Adult depression score | 0.13 | 0.12 | 0.05 | .263 |

Note: $R^2 = .04$

## B. Adolescents

The study sample was comprised of 1,302 adolescents aged 12-16 years in 1983. Table 3-5 presents the age, sex and total number of respondents for whom data were available, for children meeting criteria for MDS as reported by youth (yMDS), parent (pMDS), and teacher (tMDS) response. Comparison of youth and parent report in determination of MDS diagnosis revealed little agreement (k=0.06): of the 118 cases of youth-report depression, parents identified 6 as depressed and the remainder as non-depressed. In total, 135 youth were identified as depressed by either self or parent report. Compared to non-depressed youth, adolescents with MDS were of similar age (mean 14 years vs. 13.9 years, $t$=0.23, $p$=.80) and more likely to be female (59% vs. 50%, $\chi^2$=4.0, $p$=.05). Youth for whom MDS-related data were available were of similar age and sex to those for whom data were missing (mean 13.9 years, $t$=0.15, $p$=.89; 43% female, $\chi^2$=0.39, $p$ =.43)

Of the 118 youth with MDS in 1983, BMI data were available for 72 (61%) in 2000. This figure is comparable to the proportion of non-depressed youth for whom adult BMI data were available at the time of follow-up (57%, $\chi^2$=0.39, $p$=.43). Investigation of demographic information among adolescents with MDS for whom adult BMI data were available did not suggest any differences in age ($t$=1.14, $p$=.26), sex ($\chi^2$=0.79, $p$=.90), or SES ($t$=0.48, $p$=.63) as compared with depressed youth for whom adult BMI data were missing.

Depression in adolescence predicted weight in adulthood (Table 3-6), after controlling for the effects of age, sex, SES, parental psychiatric history, substance use and current depressive symptoms. Examination of the association between adolescent depression and adult weight also

**TABLE 3-5** **Age, Sex and Data Available for MDS Diagnosis by Youth, Parent, and Teacher Report**.

| | yMDS | pMDS | tMDS | Total |
|---|---|---|---|---|
| n | 118 | 23 | 9 | |
| age: yrs (SD) | 14.0 (1.4) | 13.8 (1.4) | 13.2 (1.5) | 13.9 (1.4) |
| female: n (%) | 70 (59%) | 15 (60%) | 2 (22%) | 653 (50%) |
| n (data available) | 1,230 | 1,246 | 409 | 1,302 |
| n (missing data) | 72 | 56 | 893 | --- |

**TABLE 3-6 The Interaction of Adolescent Depression and Sex in the Association with Adult BMI: Parent and Youth Report**

| | | B | SE B | β | p |
|---|---|---|---|---|---|
| Step 1 | | | | | |
| | Constant | 24.00 | 1.90 | | |
| | Depression | 0.13 | 0.04 | 0 .12 | .001 |
| | Age | 0.24 | 0.13 | 0.07 | .07 |
| | Sex | -1.47 | 0.36 | -0.16 | <.001 |
| Step 2 | | | | | |
| | Constant | 24.05 | 1.89 | | |
| | Depression | 0.13 | 0.04 | 0.12 | .002 |
| | Age | 0.23 | 0.13 | 0.07 | .07 |
| | Sex | -1.46 | 0.36 | -0.16 | <.001 |
| | SES | -0.08 | 0.05 | -0.06 | .10 |
| | Parental Psychiatric Illness | -0.22 | 0.43 | -0.02 | .60 |
| Step 3 | | | | | |
| | Constant | 20.06 | 2.96 | | |
| | Depression | 0.14 | 0.04 | 0.14 | <.001 |
| | Age | 0.33 | 0.14 | 0.09 | .02 |
| | Sex | -1.38 | 0.36 | -0.15 | <.001 |
| | SES | -0.08 | 0.05 | -0.07 | .07 |
| | Parental Psychiatric Illness | -0.15 | 0.43 | 0.01 | .72 |
| | Alcohol Abuse | 0.84 | 0.68 | 0.05 | .22 |
| | Cigarette Smoking | 0.48 | 0.60 | 0.03 | .42 |
| | Adult depression score | -0.17 | 0.10 | -0.07 | .09 |

**TABLE 3-6 The Interaction of Adolescent Depression and Sex in the Association with Adult BMI: Parent and Youth Report (cont'd)**

| | | | | |
|---|---|---|---|---|
| Step 4 | | | | |
| Constant | 22.94 | 3.15 | | |
| Depression | -0.19 | 0.13 | -0.19 | .16 |
| Age | 0.31 | 0.14 | 0.09 | .02 |
| Sex | -1.34 | 0.36 | -0.15 | <.001 |
| SES | -0.09 | 0.05 | -0.07 | .06 |
| Parental Psychiatric Illness | -0.17 | 0.43 | -0.02 | .70 |
| Alcohol Abuse | 0.84 | 0.67 | 0.05 | .22 |
| Cigarette Smoking | 0.38 | 0.56 | 0.03 | .52 |
| Adult depression score | -0.18 | 0.10 | -0.07 | .08 |
| Depression*Sex | 0.21 | 0.08 | 0.34 | .01 |

Note: $R^2$ (stage 1) = .04; $\Delta R^2$ (stage 2) = .004; $\Delta R^2$ (stage 3) = .009

demonstrated the effect of sex, such that a potential interaction between depression in adolescence and sex was computed and determined to be present ($p$ =.01). Adolescent girls with greater depressive symptoms were more likely to become overweight as adults when compared with girls with a decreased depressive symptom burden (Figure 3-1). This relationship was not found among adolescent boys, for whom depressive symptoms did not predict increased adult weight (Figure 3-2).

## 3.2 Attention Deficit Hyperactivity Disorder

### A. Children

Parents and teachers reported on symptoms of hyperactivity for children 4-11 years of age. The age and sex of children meeting criteria for disorder-level hyperactivity symptoms are presented in Table 3-7.

Investigation of agreement between parent and teacher report of ADHD diagnosis showed that of the 83 cases of teacher-reported ADHD, parents identified 11 as hyperactive and 71 as non-hyperactive (missing data for one tADHD positive case precluded determination of agreement), indicating poor agreement between parent and teacher reports (k=0.19). A total of 105 children were identified as having ADHD by either parent or teacher report. Children with ADHD were of similar age as those without ADHD (mean 7.6 years; $t$=1.49, $p$=.14) and were more likely to be male (74% male; $\chi^2$ =22.01, $p$=<.001). Exploration of the age and sex of those children for whom teacher or parent report data were missing determined that children with missing data were more likely to be younger (mean 6.9 yrs; $t$=9.34, $p$<.001) than children for whom ADHD data were available. There were no differences in sex between children with and without available hyperactivity data ($\chi^2$=0.99, $p$=.32).

**FIGURE 3-1**. **Depressive Symptoms in Adolescence Predict Overweight in Adulthood Among Girls**

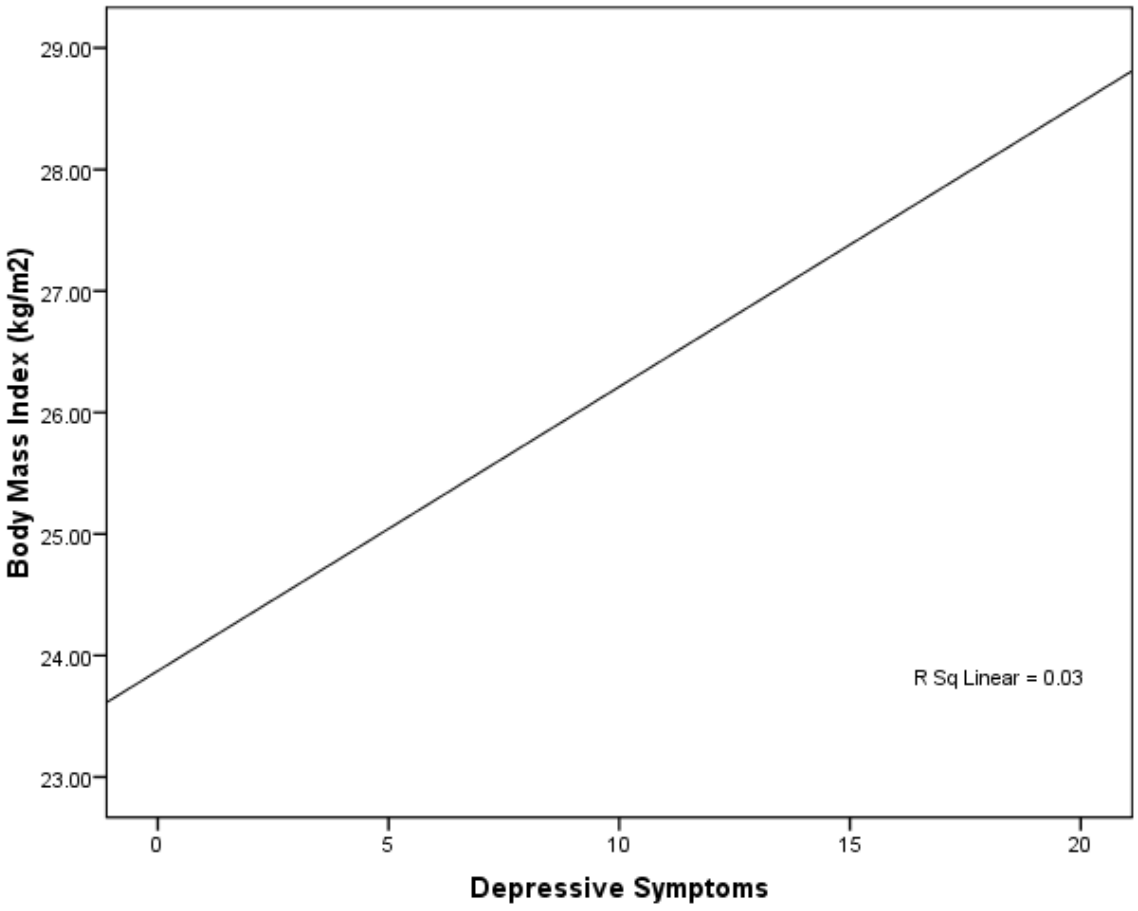

**FIGURE 3-2** **Depressive Symptoms in Adolescence Do Not Predict Increased Adult Body Weight Among Boys**

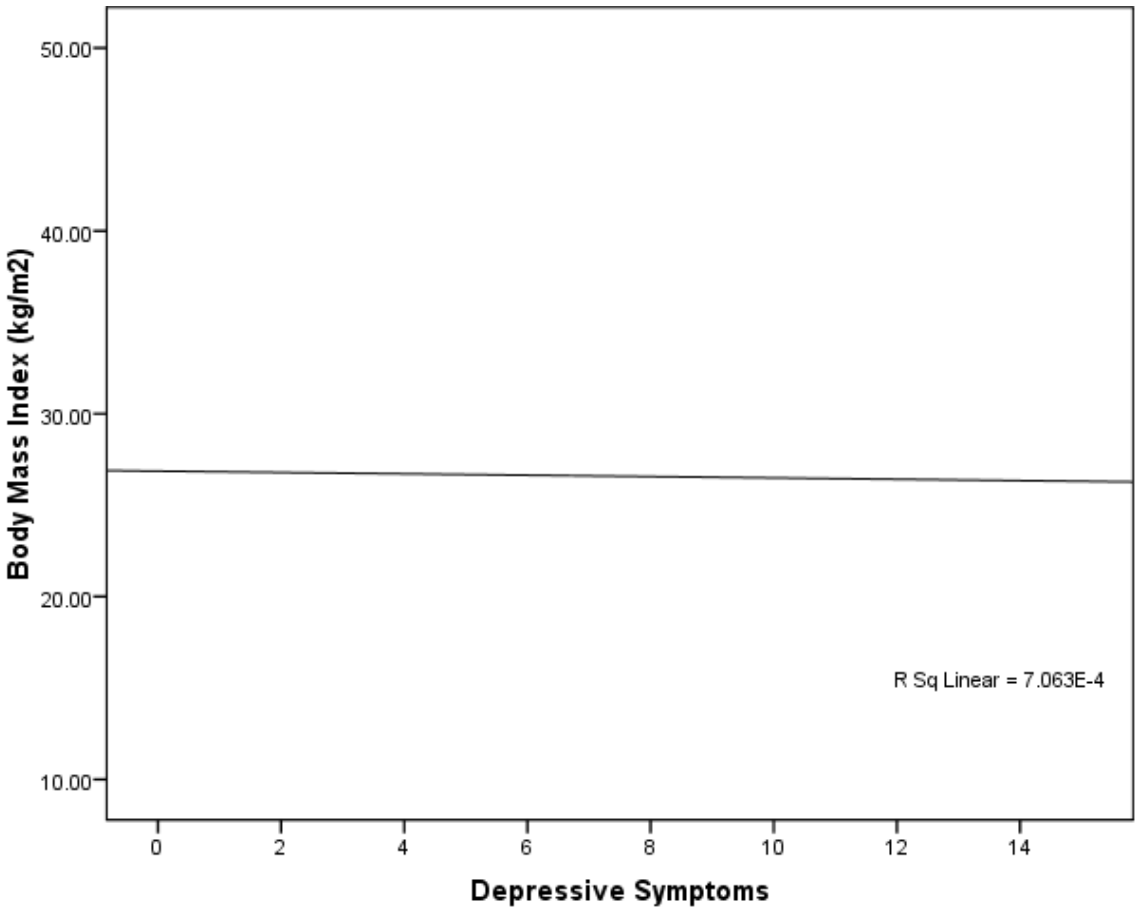

**TABLE 3-7** **Age, Sex and Data Available for Determination of Hyperactivity Disorder by Parental (pADHD) and Teacher (tADHD) Report.**

| | pADHD | tADHD | Total |
|---|---|---|---|
| n (%) | 33 (1.7%) | 83 (4.2%) | |
| age: yrs (SD) | 8.1 (2.0) | 7.6 (2.0) | 7.7 (2.3) |
| male: n (%) | 24 (75%) | 64 (77%) | 1,025 (52%) |
| n (data available) | 1,968 | 1,497 | 1,992 |
| n (missing data) | 24 | 495 | --- |

Of the 105 children with ADHD in 1983, BMI data were available for 49 (47%) in 2000, which is comparable to the proportion of non-ADHD children for whom adult BMI data were available at the time of follow-up (58%; $\chi^2$=1.69, *p*=.19). Investigation of demographic information among hyperactive children for whom BMI were available did not reveal any differences in age (*t*=0.65, *p*=.52), sex ($\chi^2$=0.89, *p*=.35) or SES (*t*=0.27, *p*=.12) as compared with those of hyperactive children for whom data regarding adult BMI were missing. Adults with childhood hyperactivity had a BMI of 27.7 kg/m$^2$ (SD=5.6) as compared with a BMI of 24.8 kg/m$^2$ (SD 4.8) for adults who were not hyperactive as children (*t*=4.03, *p*=<.001).

Children who had greater difficulties with attention and hyperactivity at ages 4-11 years were heavier in adulthood after age, sex, SES and parental psychiatric history were taken into account (Table 3-8). The association between childhood hyperactivity and adult BMI did not vary by informant: parent- (p = .04) and teacher- (p =.03) report of attention and concentration impairments yielded similar magnitude of association with adult BMI. Further, the association was strongest among participants who exhibited the most severe attentional problems as children. Children meeting disorder level thresholds for ADHD by either parent or teacher had an increased likelihood of becoming overweight as adults (p =.001) when compared to children with fewer or no ADHD symptoms. As sex was also identified as an important predictor of adult weight, analyses were computed separately by gender, confirming an association between disorder-level ADHD and adult weight among both boys (p=.004) and girls (p=.03) (data not shown).

**TABLE 3-8** **The Association of Childhood ADHD (4-11 years) and Adult BMI (boys and girls)**

| | | *B* | *SE B* | *β* | *p* |
|---|---|---|---|---|---|
| Step 1 | | | | | |
| | Constant | 24.35 | 0.84 | | |
| | ADHD | 0.12 | 0.04 | 0.10 | .003 |
| | Age | 0.23 | 0.07 | 0.10 | .002 |
| | Sex | -1.11 | 0.34 | -0.11 | .001 |
| Step 2 | | | | | |
| | Constant | 24.63 | 0.84 | | |
| | ADHD | 0.09 | 0.04 | 0.08 | .03 |
| | Age | 0.20 | 0.07 | 0.09 | .01 |
| | Sex | -1.15 | 0.34 | -0.12 | .001 |
| | SES | -0.14 | 0.40 | -0.10 | .02 |
| | Parental Psychiatric Illness | 0.97 | 0.05 | 0.08 | .01 |

Note: $R^2$ (stage 1) = .04 $\Delta R^2$(stage 2) = .02

**B. Adolescents**

Youth and their parents reported on symptoms of hyperactivity in 1983. The age, sex and total number of respondents for whom data were available for adolescents meeting the threshold for disorder-level ADHD symptoms are presented by informant in Table 3-9.

Agreement between parent and youth report of ADHD diagnosis showed that of the 35 cases of youth-reported ADHD, parents identified 2 as hyperactive and 33 as non-hyperactive, indicating poor agreement between parent and youth reports (k= 0.04). A total of 61 youth were identified as having ADHD by either self or parent report. Adolescents with ADHD were of similar age as those without ADHD (mean 14.0 years; $t$=0.51, $p$=.61) and were more likely to be male (67% male; $\chi^2$=7.70, $p$=.006). There were no differences in SES between groups ($t$=0.78, $p$=.43). Exploration of the age and sex of those adolescents for whom youth or parent report data were missing determined that there were no differences in age (mean 14.2 years; $t$=0.94, $p$=.35), sex (48% male; $\chi^2$=0.04, $p$=.85) or SES ($t$=1.66, $p$=.10) between adolescents with and without available hyperactivity data.

Of the 63 adolescents with ADHD in 1983, BMI data were available for 34 (54%) in 2000, which is comparable to the proportion of non-ADHD children for whom adult BMI data were available at the time of follow-up (57%; $\chi^2$=0.20, $p$=.66). Investigation of demographic information among youth with ADHD for whom BMI were available did not reveal any differences in age ($t$=0.61, $p$=.54), sex ($\chi^2$=0.65, $p$=.79) or SES ($t$=1.39, $p$=.17) as compared with those of ADHD positive adolescents for whom data regarding adult BMI were missing. Adults with adolescent ADHD (n=34) had a BMI of 26.0 kg/m$^2$ (SD=4.4) as compared with a BMI of 25.9 kg/m$^2$ (SD 4.7) for adults who were not hyperactive as adolescents ($t$=0.04, $p$=.97).

**TABLE 3-9** **Age, Sex and Data Available for Determination of Hyperactivity Disorder by Youth (yADHD) and Parent (pADHD) Report.**

| | yADHD | pADHD | Total |
|---|---|---|---|
| n (%) | 35 (2.7%) | 28 (2.2%) | |
| age: yrs (SD) | 14.0 (1.5) | 14.0 (1.6) | 13.9 (1.4) |
| male: n (%) | 24 (69%) | 19 (68%) | 649 (50%) |
| n (data available) | 1,258 | 1,279 | 1,302 |
| n (missing data) | 44 | 23 | --- |

Hyperactivity in adolescence, as determined by either youth or parent report, was not associated with increased adult weight (Table 3-10). As sex was determined to be a predictor of this relationship, analyses were then conducted separately by sex. The subgroup data were consistent with the overall findings, however, in that the presence of attention and concentration difficulties in adolescence did not demonstrate an increased risk of adult overweight for either girls ($p$=.38) or boys ($p$=.87) (data not shown).

## 3.3 Conduct Disorder

### A. Children

Parents and teachers reported on symptoms of conduct disturbance for children 4-11 years of age. The age and sex of children meeting criteria for CD are presented in Table 3-11. Agreement between parent and teacher report of conduct disturbance was poor: of the 54 cases of teacher-reported diagnoses, parents identified three as having conduct disorder (k=0.08). A total of 69 children were identified as having conduct disorder by either teacher or parent report. Children with CD were of similar age (mean 8.0 vs. 7.7 years; $t$=1.24, $p$=.22), were more likely to be male (75% vs. 52%; $\chi^2$ =16.45, $p$=<.001) and were from families of lower SES ($t$=5.35, $p$<.001) as compared with children without CD. Exploration of the age and sex of those children for whom teacher or parent report data were missing determined that children with missing data were more likely to be younger than children for whom conduct data were available. There were no differences in age ($t$=0.25, $p$=.80), sex ($\chi^2$=0.44, p=.51), or SES ($t$=1.0, $p$=.31) between children with and without available conduct symptom data.

**TABLE 3-10 The Association of Adolescent ADHD and Adult BMI (boys and girls)**

| | | B | SE B | β | p |
|---|---|---|---|---|---|
| Step 1 | | | | | |
| | Constant | 24.29 | 2.17 | | |
| | ADHD | 0.04 | 0.04 | 0 .05 | .29 |
| | Age | 0.24 | 0.14 | 0.07 | .004 |
| | Sex | -1.20 | 0.42 | -0.13 | .10 |
| Step 2 | | | | | |
| | Constant | 24.37 | 2.17 | | |
| | ADHD | 0.04 | 0.04 | 0.04 | .34 |
| | Age | 0.23 | 0.15 | 0.07 | .11 |
| | Sex | -1.22 | 0.42 | -0.13 | .004 |
| | SES | -0.05 | 0.06 | -0.04 | .39 |
| | Parental Psychiatric Illness | 0.04 | 0.48 | 0.01 | .93 |
| Step 3 | | | | | |
| | Constant | 22.85 | 3.43 | | |
| | ADHD | 0.04 | 0.04 | 0.04 | .34 |
| | Age | 0.26 | 0.16 | 0.08 | .09 |
| | Sex | -1.21 | 0.42 | -0.13 | .004 |
| | SES | -0.09 | 0.05 | -0.07 | .38 |
| | Parental Psychiatric | 0.04 | 0.49 | 0.01 | .93 |
| | Illness | | | | |
| | Alcohol Abuse | 0.57 | 0.79 | 0.03 | .48 |
| | Cigarette Smoking | -0.01 | 0.72 | 0.00 | .99 |

Note: $R^2$ (stage 1) = .03 $\Delta R^2$(stage 2) = .001 $\Delta R^2$(stage 3) = .001

**TABLE 3-11 Age, Sex and Data Available for Determinations of Conduct Disorder by Parental (pCD) and Teacher (tCD) report.**

| | pCD | tCD | Total |
|---|---|---|---|
| n | 18 (0.9%) | 54 (2.7%) | |
| age: yrs (SD) | 8.6 (1.8) | 7.9 (2.3) | 7.7 (2.3) |
| male: n (%) | 14 (78%) | 41 (76%) | 1,025 (52%) |
| n (data available) | 1,967 | 1,473 | 1,992 |
| n (missing data) | 25 | 519 | --- |

Of the 72 children with CD in 1983, BMI data were available for 40 (56%) in 2000, which is comparable to the proportion of children without CD for whom adult BMI data were available at the time of follow-up (58%; $\chi^2$=0.05, *p*=.82). Investigation of demographic information among children with CD for whom BMI data were available did not reveal any differences in age (*t*=0.29, *p*=.78), sex ($\chi^2$=0.05, *p*=.83) or SES (*t*=1.16, *p*=.11) as compared with those of children with CD for whom data regarding adult BMI were missing. Adults with childhood CD had a BMI of 27.9 kg/m$^2$ (SD=4.7) as compared with a BMI of 24.9 kg/m$^2$ (SD 4.8) for adults who did not have conduct disorder as children (*t*=3.86, *p*<.001).

Disturbances of conduct among 4-11 year old children were associated with increased adult BMI (p =.001) (Table 3-12). As sex was a significant predictor of this relationship, separate analyses by sex were undertaken and confirmed that conduct disturbance increased the risk of adult overweight for both girls (*p* =.004*)* and boys (*p*=.04) (data not shown). Moreover, the previously noted association of hyperactivity with adult BMI was completely accounted for by the effect of conduct disturbance (Table 3-13). That is, once conduct disturbance symptoms were added to the model, hyperactivity in childhood no longer predicted increased adult weight (*p*=.61).

**B. Adolescents**

Parent and youth report were used to make determinations of CD for adolescents 12-16 years of age. The age and sex of adolescents meeting criteria for CD are presented in Table 3-14. Agreement between youth and parent report of conduct disturbance was fair (k= 0.23): of the 64 cases of youth-reported diagnoses, parents identified 13 as having conduct disorder.

**TABLE 3-12** **Childhood Conduct Disturbance is Predictive of Adult BMI for Boys and Girls.**

| | | *B* | *SE B* | *β* | *p* |
|---|---|---|---|---|---|
| Step 1 | | | | | |
| | Constant | 24.11 | 0.81 | | |
| | Conduct | 0.22 | 0.05 | 0.16 | <.001 |
| | Age | 0.23 | 0.07 | 0.11 | .002 |
| | Sex | -0.98 | 0.33 | -0.10 | .004 |
| Step 2 | | | | | |
| | Constant | 24.32 | 0.81 | | |
| | Conduct | 0.22 | 0.05 | 0.16 | <.001 |
| | Age | 0.21 | 0.07 | 0.10 | .004 |
| | Sex | -1.01 | 0.33 | -0.10 | .003 |
| | SES | -0.12 | 0.05 | -0.08 | .016 |
| | Parental Psychiatric Illness | 0.78 | 0.40 | 0.07 | .051 |

Note: $R^2$ (stage 1) = .06 $\Delta R^2$ (stage 2) = .01

**TABLE 3-13** **Childhood Conduct Disturbance Accounts for the Effects of Hyperactivity (ADHD) in Predicting Adult Weight.**

| | | *B* | *SE B* | *β* | *p* |
|---|---|---|---|---|---|
| Step 1 | | | | | |
| | Constant | 24.70 | 0.84 | | |
| | Age | 0.21 | 0.07 | 0.09 | .01 |
| | Sex | -1.17 | 0.34 | -0.12 | .001 |
| | ADHD | 0.08 | 0.04 | 0.07 | .04 |
| | SES | -0.14 | 0.05 | -0.09 | .01 |
| | Parental Psychiatric Illness | 0.86 | 0.41 | 0.07 | .03 |
| Step 2 | | | | | |
| | Constant | 24.43 | 0.84 | | |
| | Age | 0.21 | 0.07 | 0.10 | .004 |
| | Sex | -1.03 | 0.34 | -0.11 | .002 |
| | ADHD | -0.03 | 0.05 | -0.08 | .61 |
| | SES | -0.12 | 0.05 | -0.08 | .02 |
| | Parental Psychiatric Illness | 0.80 | 0.40 | 0.07 | .05 |
| | Conduct | 0.21 | 0.06 | 0.15 | <.001 |

Note: $R^2$ (stage 1) = .05; $\Delta R^2$ (stage 2) = .01

**TABLE 3-14** **Age, Sex and Data Available for Conduct Disorder by Youth (yCD) and Parent (pCD) Report.**

| | yCD | pCD | Total |
|---|---|---|---|
| n (%) | 64 (4.9%) | 37 (2.8%) | |
| age: yrs (SD) | 14.4 (1.4) | 14.6 (1.3) | 13.9 (1.4) |
| male: n (%) | 45 (70%) | 24 (65%) | 649 (50%) |
| n (data available) | 1,262 | 1,281 | 1,302 |
| n (missing data) | 40 | 21 | --- |

A total of 88 youth were identified as having Conduct disorder by either self or parent report. Adolescents with conduct disorder were older (mean 14.4 vs 13.9 years; $t$=3.48, $p$=.001), more likely to be male (67% vs. 52%; $\chi^2$ =11.18, $p$=.001) and were from families of lower SES ($t$=2.98, $p$=.003) compared with those without conduct disorder. Exploration of the age and sex of those children for whom youth or parent report data were missing determined that there were no differences in age ($t$=0.48, $p$=.63), sex ($\chi^2$=0, $p$=1), or SES ($t$=0.94, $p$=.35) between youth with and without available conduct symptom data.

Of the 88 adolescents with CD in 1983, BMI data were available for 49 (56%) in 2000, which is comparable to the proportion of adolescents without CD for whom adult BMI data were available at the time of follow-up (58%; $\chi^2$=0.06, $p$=.81). Investigation of demographic information among adolescents with CD for whom BMI were available did not reveal any differences in age ($t$=0.15, $p$=.89), sex ($\chi^2$=0.06, $p$=.81) or SES ($t$=1.29, $p$=.20) as compared with those of conduct disordered youth for whom data regarding adult BMI were missing. Adults with CD as adolescents had a BMI of 27.1 kg/m$^2$ (SD=4.6) as compared with a BMI of 25.9 kg/m$^2$ (SD 4.7) for adults who did not have conduct disorder as children ($t$=1.68, $p$=.09).

As sex was found to be an important predictor of the relationship between youth conduct disturbance and adult BMI (Table 3-15), analyses were conducted separately by sex (Tables 3-16, 3-17). Adolescent girls with conduct disturbance were at increased risk of adult overweight compared with behaviourally appropriate youth ($p$=.02). Conduct disturbance among adolescent boys did not predict increased adult weight ($p$=.66).

**TABLE 3-15** **The Association of Adolescent Conduct Disturbance and Adult BMI (boys and girls)**

| | | *B* | *SE B* | *β* | *p* |
|---|---|---|---|---|---|
| Step 1 | | | | | |
| | Constant | 28.93 | 2.92 | | |
| | Conduct | -1.79 | 1.11 | -0.06 | .11 |
| | Age | 0.19 | 0.12 | 0.06 | .12 |
| | Sex | -1.38 | 0.35 | -0.15 | <.001 |
| Step 2 | | | | | |
| | Constant | 28.96 | 2.92 | | |
| | Conduct | -1.78 | 1.11 | -0.06 | .11 |
| | Age | 0.19 | 0.12 | 0.06 | .13 |
| | Sex | -1.37 | 0.35 | -0.15 | <.001 |
| | SES | -0.08 | 0.05 | -0.06 | .09 |
| | Parental Psychiatric Illness | -0.07 | 0.40 | -0.01 | .86 |
| Step 3 | | | | | |
| | Constant | 26.64 | 3.55 | | |
| | Conduct | -1.86 | 1.13 | -0.06 | .10 |
| | Age | 0.24 | 0.13 | 0.07 | .07 |
| | Sex | -1.36 | 0.35 | -0.15 | <.001 |
| | SES | -0.08 | 0.05 | -0.07 | .07 |
| | Parental Psychiatric Illness | -0.04 | 0.41 | -0.03 | .93 |
| | Alcohol Abuse | 0.52 | 0.67 | 0.03 | .44 |
| | Cigarette Smoking | 0.39 | 0.58 | 0.03 | .51 |

Note: $R^2$ (stage 1) = .03 $\Delta R^2$ (stage 2) = .004; $\Delta R^2$ (stage 3) = .003

**TABLE 3-16 Conduct Disturbance in Adolescent Girls Predicts Adult BMI**

| | *B* | *SE B* | *β* | *p* |
|---|---|---|---|---|
| Constant | 18.8 | 4.11 | | |
| Conduct | 2.73 | 1.35 | 0.11 | .04 |
| Age | 0.29 | 0.20 | 0.08 | .15 |
| SES | -0.08 | 0.07 | -0.06 | .24 |
| Parental Psychiatric Illness | 0.33 | 0.60 | 0.03 | .58 |
| Alcohol Abuse | 1.76 | 1.00 | 0.10 | .08 |
| Cigarette Smoking | -0.60 | 0.89 | -0.68 | .50 |

Note: $R^2 = .03$

**TABLE 3-17 Conduct Disturbance in Adolescent Boys Does Not Predict Adult BMI**

| | *B* | *SE B* | *β* | *p* |
|---|---|---|---|---|
| Constant | 22.8 | 4.11 | | |
| Conduct | 0.45 | 0.83 | 0.03 | .59 |
| Age | 0.15 | 0.17 | 0.05 | .39 |
| SES | -0.08 | 0.06 | -0.07 | .19 |
| Parental Psychiatric Illness | -0.53 | 0.54 | -0.05 | .33 |
| Alcohol Abuse | -0.34 | 0.90 | -0.02 | .70 |
| Cigarette Smoking | 1.36 | 0.76 | 0.11 | .08 |

Note: $R^2 = .03$

# CHAPTER 4 - DISCUSSION

## 4.1 Depression and BMI

In this community sample, parents identified approximately 2% of 4-11 year old children as depressed. This figure is consistent with prevalence rates reported by Birmaher et al[60] using multiple (parent, child, teacher) informants but more than double than the 0.9% reported by Korczak and Goldstein in their retrospective epidemiological study of childhood onset MDD among adults in the United States. An increased prevalence in this study may be due to the use of parent (vs. child) informants. As arbiters of their children's feelings of depression, worthlessness, guilt, and other internalizing symptoms, parents may not always accurately ascribe their observations to the correct internal state of their child. Conversely, adult participants may erroneously recall their age-of-depression onset for a number of reasons, including a desire to believe their childhood as a happy time in their life, the influence of family and friend's recollections of the individual as a child, or their knowledge and understanding of depressive illness (for example, that onset is commonly in young adulthood) at the time of study participation. Research investigating the effect of recall bias among depressed populations have noted that when collected prospectively, prevalence rates of illness are twice that of those collected using retrospective methods[61]. Interestingly, teachers identified a similar proportion of children as depressed as compared with parent report (2.8%). However, the very low teacher response rate (30%) and the overall poor agreement with parent-informants, make interpretation of teacher-reported data difficult. Also of interest is the relative equal sex distribution of children with pre-adolescent onset of depression, which is

consistent with traditional understanding and is in contrast to the female predominance of adolescent and adult-onset depression found in this study and others [60, 62].

The primary novel finding of this study is that boys with childhood depressive symptoms are at increased risk becoming overweight in adulthood compared with their non-depressed peers. This is consistent with the results reported by Pine et al[39] in a case-control study of depressed children and adolescents (mean age 11 years), though data were not analyzed separately by sex in this clinical population[39] . In contrast, Anderson et al[35] did not find an association between childhood depression and adult overweight among boys in a large community sample, however, children and adolescents (age 9-18 years) were analyzed together such that a relationship specific to childhood symptoms could not be addressed.

Among adolescents, the relationship between depressive symptoms and adult weight was different for boys and for girls in that the presence of depression was related to increased BMI only among girls. This is consistent with the results reported by previous researchers of large community populations in which diagnostic interviews were used to ascertain depressive symptoms[30, 35] . Similarly, the present study confirms an absence of an association between adolescent depression and adult overweight among males, as has been reported previously[30, 31, 35, 36].

As discussed above, boys with depression in childhood became heavier adults than their non-depressed peers. Childhood-onset depression predicted adult overweight for affected boys after controlling for key individual and family variables. That this relationship persisted even after accounting for depression in adulthood is consistent with previous findings of childhood onset illness as a severe subtype of depression that is

associated with increased morbidity, mortality, and health-care utilization life-long[63, 64]. Further, it suggests that there may be unique illness or childhood-specific factors which, when present, portend poorly for future weight gain and exert a differential effect based on gender.

As evidence supporting an association between depression and obesity grows, interest in the potential mechanisms underlying the relationship has similarly increased. Hypotheses have fallen broadly into those investigating a psychological explanation and those exploring a biological link. Investigators with a psychological approach have posited that depressive symptoms, including dietary patterns or carbohydrate rich food choices of depressed individuals, sedentary activity patterns, and early-onset of an obesogenic "stress-eating" response leads depressed adolescents, and particularly girls, to be at increased risk of adult obesity[9, 65, 66]. Examination of the development of maladaptive eating and activity behaviours suggests that onset of depression during childhood may interfere with acquisition of healthy eating and activity behaviours, the effects of which persist beyond the depressive period.

Researchers contemplating a biological link between depression and obesity have suggested that the illnesses may share common a biological vulnerability with respect to neuroendocrinological or immuno-inflammatory dysfunction or genetic susceptibility which may account for the increased comorbidity rates[67-70]. Research of biological correlates of depression, for example, has confirmed the increased immune activity in depression including increased pro-inflammatory cytokines (IL-1, IL-6, TNF-a, IFN-a) and increased C-reactive protein levels which are similarly increased in obesity[71-73].

In these adult samples, evidence supports the role of pro-inflammatory cytokines as mediators in the potential interaction between obesity and depression[74]. Whether levels of pro-inflammatory cytokines are also increased in child and adolescent populations with MDD remains unknown, and requires investigation to delineate their potential contribution to the development of obesity in this population. Further evidence of shared neurobiological mechanisms between depression and obesity include evidence linking these conditions with alterations in serotonin and its metabolites[75]. As such, there may be both a theoretical basis, and early data, to suggest that the treatment of obesity with antidepressant medication may be an area of interest for future investigation [76, 77].

This study is consistent with previous research in the finding that the relationship between depression in adolescence and adult weight differs by sex [30], finding a positive association among women only. This study extends present knowledge of this relationship with the finding that among young children with depression, only boys are at greater risk of increased adult weight. These data suggest that the mechanism of association between depression and BMI may differ by sex and age. Many possible reasons exist for the sex and age differences observed in this study. For example, women with depression report more symptoms of psychomotor retardation and increased appetite compared with men[78, 79], such that different patterns of depressive symptomatology with age may account for differences in the association of depression and BMI among men and women. Another possibility is that anti-depressant treatment may vary by sex, and may affect weight gain, as females have increased rates of help-seeking and treatment for depression compared with men[78, 80]. As detailed information regarding anti-depressant medication usage was not available, this study

was unable to account for the possible effects of medication in the relationship between depression and body weight. Finally, environmental factors, such as involvement with physical activity, may differ by sex and age. Physical activity has been found to decrease more profoundly in females than in males with age, which may be due to fewer opportunities for athletic activity or lack of interest or motivation[81]. Depressive symptoms may further interfere with interest in seeking out exercise opportunities and may exaggerate the increase in sedentary lifestyle among adolescent females compared with males.

Taken together, current evidence points to the presence of a multi-factorial relationship between depression and BMI which encompasses both biological and psychosocial factors. Understanding the temporal and directional association of the pathology is important in order to further clarify the potential mechanism of association as well as to determine key targets for intervention.

### 4.2 Attention Deficit Hyperactivity Disorder and BMI

Teachers of children aged 4 to 11 years identified ADHD more often than did their parents (4.2% vs. 1.6%) and more in keeping with population estimates (3% to 9%)[82, 83] for this age group. Although childhood ADHD symptoms were initially found to be predictive of adult BMI for affected boys and girls, this effect was no longer significant in the presence of conduct symptoms. As data regarding treatment with stimulant medication were not collected as part of the original OCHS study protocol, the potential influence of receiving potentially appetite-suppressing stimulant treatment for ADHD on future weight gain could not be evaluated. Despite this limitation, however, the inclusion of stimulant usage data is unlikely to

alter the findings of the present study significantly, for the following three reasons: (1) there was an overall low rate of stimulant usage for treatment of childhood ADHD in the early 1980's in Canada [84, 85], (2) research regarding health care utilization for mental health problems among children has demonstrated that less than 20% of children who participated in the OCHS, with an identified mental health problem, received appropriate mental health treatment for their difficulties[86] and (3) current evidence does not support a plausible mechanism by which stimulant usage in childhood might impact adult overweight at present. Moreover, these findings are in keeping with those reported by Duarte et al[45], in their examination of the association of disruptive behaviour problems at age 8 years and young adult BMI in a prospective population-based sample of male subjects in Finland, in which the initial association between ADHD and adult overweight was nullified upon inclusion of CD symptoms to the model.

In addition, this study did not find a relationship between hyperactivity in adolescence and adult overweight, irrespective of the inclusion of conduct symptoms in the model. This does not appear to be the result of an informant effect: in both the 4-11 year old group and the 12-16 year old group the two informants (parent/teacher and parent/youth, respectively) were consistent with one another and with the overall result in their report (data not shown). It is possible that among adolescents, ADHD symptoms (as included in the present study) are non-specific markers of functional impairment rather than specific to ADHD. Difficulties of attention and hyperactivity may be reflective of a number of underlying problems (e.g. substance use, relationship conflicts with peers, partners or family members, mood disorders) that similarly increase in prevalence during the adolescent years and which may obscure the

relationship between ADHD and adult overweight, if present. Additionally, the ADHD scale items in the OCHS survey emphasized hyperactive/impulsive rather than inattentive symptoms of illness. As a result, it is also possible that the children and youth with greater ADHD symptoms in this study represented a more physically active subgroup of children with ADHD, leading to a decreased ability to observe a positive association between ADHD and adult overweight. The findings of this thesis are consistent with previous research[45, 87] and together indicate that in the absence of conduct disorder, ADHD in children and youth does not impart an increased risk of overweight in adulthood.

### 4.3 Conduct Disorder and BMI

Conduct problems in childhood predicted adult overweight for affected boys and girls after controlling for factors which may affect this association, including socioeconomic status and parental psychiatric history. Although these findings are in keeping with previous research examining the association between childhood-onset conduct problems and later obesity[31, 44, 45], earlier studies have been limited by their inability to make psychiatric diagnoses[43, 44] short duration of follow-up into young adulthood[43-45], exclusion of female subjects[45], and a wide age range consisting of predominantly adolescent data[31]. All of these factors have been addressed by our study, thus strengthening our findings.

As the original OCHS survey did not obtain BMI data from participants in 1983, the temporal relationship between childhood conduct problems and adult overweight cannot be determined by the present study. However, in a study of 700 subjects in the National Longitudinal Survey of Youth in the United States[43], behaviour problems predicted

subsequent overweight among previously normal-weight children (OR 5.23; 95% CI 1.37-19.93), though the duration of follow-up was short and did not extend into adulthood. Mamun et al were also able to control for childhood BMI in the study of a large community-based Australian cohort of children[44], and similarly reported that child-onset behaviour problems increased risk of overweight at age 21 years, although this study was also limited by an inability to make psychiatric diagnoses and a short follow-up into adulthood.

If conduct problems do indeed precede overweight, then it is unlikely that they are a reaction to weight-related bullying or stigmatization. Other possible shared vulnerabilities may include gene-environment interactions[88, 89], disruption of sleep patterns[90], and neurobiological factors. For example, abnormalities in serotonin may result in both impulsive aggression, as seen in conduct disturbance[91], and binge-eating[92] or other impulse-control related dietary changes leading to increased body weight. In addition, investigators of potential predictors of childhood behavioural problems have identified a number of factors which overlap with those identified as risks for obesity, including parental distress, poor self-regulation, decreased SES and poor social and academic functioning as more frequently present in children affected with either illness[9, 93, 94]. Psychosocial factors that may contribute to the association of early disruptive behaviour and later overweight may include a repeated childhood experience of rejection from social groups (e.g. sports teams, interest clubs) due to misbehaviour and aggression and poor school performance resulting in both poor adult self-esteem, food-companionship and a failure to establish healthy activity patterns lifelong. In addition, learning disabilities and cognitive difficulties, which are frequently comorbid among children with conduct disturbance[95], may further impair the ability to replace poor eating

habits with adaptive coping strategies once they are established. Studies aimed at investigating the relationship between childhood conduct problems and adult overweight are needed to examine the potential roles of these factors.

In adolescence, conduct problems predicted increased adult weight among girls only. In comparison, Pine et al reported that conduct symptoms predicted adult overweight for both girls and boys in a community sample of 9-18 year old children and adolescents[31]. In contrast, however, Bardone et al reported that adolescent girls with disruptive behaviour were at decreased risk of adult overweight when compared to that of non-disruptive adolescent girls[34]. In considering the findings of the present study, particularly in the context of the research by Pine et al and Bardone et al, there are a number of factors to consider. For example, research has suggested that adolescent girls with CD may have a more severe subtype of illness, and represent persistent childhood-onset CD rather than the more commonly encountered adolescent-onset CD[93]. Consistent with this possibility is that among 4-11 year olds, the association of CD symptoms with adult BMI was stronger for affected girls than for affected boys (SE $\beta = 0.12$, $p = .004$ vs. SE $\beta = 0.08$ $p = .04$; data not shown). In keeping with this view, it may be that the adolescent girls who participated in the Bardone study exhibited more attenuated psychopathology, as the investigators also included female youth with oppositional defiant disorder, and thereby less severe disruptive behaviour, in their definition of conduct disorder[34]. Secondly, the comparative role of substance (including nicotine) use in the association between conduct disorder and adult weight is of note. Nicotine is an appetite suppressant[96]. However, Bardone et al did not account for the effects of cigarette smoking in their study participants, of which 74% were daily smokers. In contrast, the present study does

account for the effect of cigarette smoking, which was found to have an inverse, though non-significant, relationship with adult BMI among participants (Table 3-16). Finally, the role of alcohol use must also be considered in the association of adolescent conduct symptoms and adult weight among females. That Bardone et al did not consider the potential impact of alcohol use further limits the generalizability of the study results. In contrast, although there was only a significant trend (p =.08), the present study demonstrated that the magnitude of the effect of alcohol with respect to adult overweight is comparable to that of CD symptoms ($\beta_{Alcohol} = 0.10$ vs. $\beta_{Conduct} = 0.11$; Table 3-16). Thus, the present study addresses a number of the limitations of previous research of the association between child and adolescent CD symptoms and adult weight by (1) including interview-based determinations of CD, (2) providing a long period of follow-up into adulthood and (3) controlling for the effects of cigarette and alcohol use in a population in which substance use disorders are highly comorbid.

## 4.4 Comorbidity

Consistent with current literature, ADHD was observed more commonly than CD or MDS among 4-11 year old participants (Table 4-1). Of children with MDS, a minority also met threshold level criteria for ADHD (18%) or CD (14%). ADHD and CD co-occurred more commonly: 39% of children with ADHD also met criteria for CD, and 59% of children with

**TABLE 4-1 Co-moribidity of MDS, ADHD, CD: Number of 4-11 Year Old Participants**

| | CD | ADHD | MDS |
|---|---|---|---|
| **CD** | 69 | 41 | 8 |
| **ADHD** | 41 | 105 | 10 |
| **MDS** | 8 | 10 | 57 |

CD also met criteria for ADHD. With respect to the disruptive behavioural disorders, these figures are comparable to those reported elsewhere[97, 98].

In contrast to the child subgroup, MDS was observed more commonly than CD or ADHD among 12-16 year old participants (Table 4-2). Compared to the younger subgroup, a similar proportion of depressed youth had comorbid ADHD (18%) or CD (20%); a similar proportion of youth with ADHD also met criteria for CD (39%). In contrast to the younger group, however, only 32% of adolescents with CD met criteria for ADHD.

Examination of the prevalence of comorbidity among children and adolescents for the conditions under study suggests that the current sample is representative of the general population with respect to mental health. While it is possible that the presence of comorbidity among participants may impact the study findings with respect to adult overweight, examining associations in single-illness samples may limit study generalizability, in addition to presenting the practical challenges of sample ascertainment.

**TABLE 4-2 Co-morbidity of MDS, ADHD, CD: Number of 12-16 Year Old Participants**

| | CD | ADHD | MDS |
|---|---|---|---|
| **CD** | 88 | 28 | 26 |
| **ADHD** | 28 | 61 | 24 |
| **MDS** | 26 | 24 | 135 |

# CHAPTER 5 - MEASUREMENT

## 5.1 Measurement of Psychopathology: General Considerations

Accurate measurement of early-onset psychopathology is a key consideration in the determination of the relationship of child and adolescent psychiatric illness and adult body weight. The measures must reflect those employed in clinical settings in order to translate to the clinical population with confidence. An appreciation of variation in the definition of illness over time is important to evaluate the relevance of the study findings to current populations. An overview of the development of psychiatric diagnoses, from the time of the initial OCHS survey in 1983 to present, is outlined below, followed by more specific information pertinent to the diagnoses of depression, ADHD and conduct disorder.

The OCHS checklists contained items that pertained to depressive, inattentive/hyperactive and conduct symptoms based on the diagnostic manual of reference in 1983, the Diagnostic and Statistics Manual, third edition (DSM-III)[50]. This manual was revised in 1987 with the publication of the DSM-III-R[53]. In contrast to the DSM-III, the development of the DSM-III-R included itemized criteria which comprised each disorder. Subsequently, a fourth edition and revision of the DSM (DSM-IV-TR)[99] was released in 1994 and replaced the previous versions as the standard by which psychiatric diagnoses are determined. Currently, psychiatric illnesses are defined by the DSM-IV-TR. The diagnostic criteria defining the diagnoses of depression, ADHD and conduct disorder based on the DSM version of reference are compared in Tables 2-1, 5-1, 5-2. Since the introduction of diagnostic criteria in DSM-III-R, only minor changes have been made to the diagnoses of depression, ADHD and conduct disorder when compared to present diagnostic standards.

**TABLE 5-1 ADHD: Criteria for OCHS, DSM-III-R and DSM-IV-TR-based Diagnoses.**

| OCHS | DSM-III-R | DSM-IV-TR |
|---|---|---|
| (1) Fidgets | (1) Often fidgets with hands or feet or squirms in seat (in adolescents may be limited to subjective feelings of restlessness) | (1) Often fidgets with hands or feet or squirms in seat |
| (2) Trouble sitting still, restless or hyperactive | (2) Has difficulty remaining seated when required to do so. | (2) Often leaves seat in classroom or other situations in which remaining seated is expected. |
| | (3) Is easily distracted by extraneous stimuli. | (3) Is often easily distracted by extraneous stimuli. |
| (3) Difficulty awaiting turn in games or groups | (4) Has difficulty awaiting turns in games or group situations. | (4) Often has difficulty awaiting turns |
| | (5) Often blurts out answers to questions before they have been completed. | (5) Often blurts out answers to questions before they have been completed. |
| | (6) Has difficulty following through on instructions from others (not due to oppositional behavior or failure of comprehension). | (6) Has difficulty following through on instructions from others (not due to oppositional behavior or failure of comprehension). |
| (4) Trouble concentrating or paying attention | (7) Has difficulty sustaining attention in tasks or play activities. | (7) Often has difficulty sustaining attention in tasks or play activities. |
| (5) Easily distracted, difficulty sticking to any activity | (8) Often shifts from one uncompleted activity to another. | |
| | (9) Has difficulty playing quietly. | (8) Has difficulty playing or engaging in leisure activities quietly. |
| | (10) Often talks excessively. | (9) Often talks excessively. |
| (6) Impulsive, or acts without thinking | (11) Often interrupts or intrudes on others, e.g., butts into other people's games. | (10) Often interrupts or intrudes on others, e.g., butts into conversations or games. |
| | (12) Often does not seem to listen to what is being said to him or her. | (11) Often does not seem to listen to what is being said to him or her. |
| | (13)Often loses things necessary for tasks or activities at school or at home (e.g., toys, pencils, books). | (12)Often loses things necessary for tasks or activities at school or at home (e.g., toys, pencils, books). |
| | (14)Often engages in physically dangerous activities without considering possible consequences (not for the purpose of thrill- | (13)Often engages in physically dangerous activities without considering possible consequences (not for the purpose |

| | | |
|---|---|---|
| | seeking), e.g., runs into street | of thrill-seeking), e.g., runs into street |
| | | (14) Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework). |
| | | (15) Often fails to give close attention to details or makes careless mistakes in schoolwork, work or other activities |
| | | (16) Often has difficulty organizing tasks and activities |
| | | (17) Often runs about or climbs excessively in situations in which it is inappropriate (in adolescents/adults, may be limited to subjective feelings of restlessness) |
| | | (18) Is often "on the go" or often acts as if "driven by a motor" |
| **Reference time period: past 6 months** | **Reference time period: none, onset prior to age 7 years** | **Reference time period: none, some symptoms present prior to age 7 years** |

*Items from the OCHS survey may be relevant or map to more than one symptom as outlined by the DSM.

**TABLE 5-2 Conduct Disorder: Criteria for OCHS, DSM-III-R and DSM-IV-TR-based Diagnoses**

| OCHS | DSM-III-R | DSM-IV-TR |
|---|---|---|
| (1) Threatens people | | (1) Often bullies, threatens, or intimidates others |
| (2) Gets in many fights | (1) Often initiates physical fights | (2) Often initiates physical fights |
| (3) Physically attacks people | (2) Has used a weapon in more than one fight | (3) Has used a weapon that can cause serious physical harm to others (e.g. a bat, brick, broken bottle, knife, gun) |
| (4) Cruelty, bullying, or meaness to others | (3) Has been physically cruel to people | (4) Has been physically cruel to people |
| (5) Cruelty to animals | (4) Has been physically cruel to animals | (5) Has been physically cruel to animals |
| (6) Steals outside the home | (5) Has stolen while confronting a victim (e.g. mugging, purse snatching, extortion, armed robbery) | (6) Has stolen while confronting a victim (e.g. mugging, purse snatching, extortion, armed robbery) |
| | (6) Has forced someone into sexual activity | (7) Has forced someone into sexual activity |
| (7) Sets fires | (7) Has deliberately engaged in fire-setting | (8) Has deliberately engaged in fire-setting with the intention of causing serious damage |
| (8) Destroys things belonging to his/her family or other children | (8) Has deliberately destroyed others' property (other than by fire-setting) | (9) Has deliberately destroyed others' property (other than by fire-setting) |
| (9) Vandalism | (9) Has broken into someone else's house, building or car | (10) Has broken into someone else's house, building or car |
| (10) Lying or cheating | (10) Often lies (other than to avoid physical or sexual abuse) | (11) Often lies to obtain goods or favours or to avoid obligations (i.e. "cons" others) |
| (11) Steals at home | (11) Has stolen without confronting a victim on more than one occasion (including forgery) | (12) Has stolen items of nontrivial value without confronting a victim (e.g. shoplifting, but without breaking and entering; forgery) |
| | | (13) Often stays out at night despite parental prohibitions, beginning before age 13 years |

| | | |
|---|---|---|
| (12) Runs away from home | (12) Has run away from home overnight at least twice (or once without returning) | (14) Has run away from home overnight at least twice (or once without returning for a lengthy period) |
| (13) Skips school | (13) Is often truant from school | (15) Is often truant from school, beginning before age 13 years |
| (14) Disobedient at school | | |
| (15) Destroys his/her own things | | |
| **Reference time period: past 6 months** | **Reference time period: none** | **Reference time period: past 12 months, at least one criterion present in past 6 months** |

## 5.2 Depression: Diagnostic Criteria Considerations

In contrast to ADHD and Conduct Disorder, which were conceived and measured as such in the OCHS, the original OCHS scale for depression was subsumed by the "emotional disorder" scale which encompassed both depressive and anxious symptoms. However, major depressive syndrome (MDS), a construct based on the DSM-III-R and comprised of items contained within the OCHS, has since been validated by Fleming et al[52] and found to be similar to Major Depressive Episode, as defined by the current DSM-IV-TR[99].

Depression, as measured in the present study, is highly analogous to the illness defined by the DSM-IV-TR. The definitions are very similar, the prevalence rates are comparable and the outcomes with respect to future episodes of illness are congruent. There are, however, a few differences between MDS and MDE to consider (Table 2-1). As mentioned above, in addition to depressed mood, the DSM-IV provides for inclusion of anhedonia as a core symptom as well as for irritability as a mood equivalent for children and adolescents. The current MDS construct does not include the mood equivalent, including only those children whose psychological expression of mood disturbance is one of profound dysphoria. In addition, MDE is based on a marginally more broadly defined illness in the DSM-IV as compared with the present study: the DSM requires 4 out of a possible 8 non-mood (associated) symptoms to meet diagnostic criteria, which compares with 4 out of a possible 7 associated symptoms in the present study[1] (Table 2-1). Lastly, the DSM-IV requires that symptoms counting toward a diagnosis of MDE occur contemporaneously, more days than not, over a two-week period. In

[1] The question pertaining to decreased energy also included feeling slow moving or underactive (parent and teacher forms) and as a result was combined with feelings of increased activity to represent the DSM associated symptom of psychomotor changes. The comparable question in the youth form was then similarly considered. A separate question dedicated to fatigue and decreased energy, as in the DSM definition of MDE, was not included in the SDI.

contrast, the SDI asked respondents about the previous six-month period and did not specify contemporaneous occurrence, though research suggests that individuals responding to questions about remote events may respond more based on recent experiences than those of the past[100]. Taken together, although MDS is likely highly similar to MDE, the construct employed by the current study may be a more parsimonious and homogeneous illness than that described in the DSM-IV.

### 5.3 ADHD: Diagnostic Criteria Considerations

Following the release of DSM-III-R, the original study investigators examined the reliability and validity of the disorder scales employed by the OCHS and determined that the ADHD (termed "Hyperactivity" at that time) scales were reliable and valid. Since that time, the definition of ADHD has been further revised as outlined in DSM-IV[99]. The criteria comprising the OCHS Hyperactivity scale is compared with those of the DSM-III-R and DSM-IV ADHD definitions in Table 5-1. When compared with either the DSM-III-R or the DSM-IV ADHD scales, the OCHS Hyperactivity scale presents a more limited number of items which address either inattentive or hyperactive/impulsive symptoms. With regard to item content, the OCHS scale is aligned more closely with the DSM-III-R criteria, in that both scales inquire about hyperactive/impulsivity symptoms more frequently than they address inattentive symptoms. Of the six items in the Hyperactivity scale, only two refer to inattention. In comparison, 5 out of 14 items in the DSM-III-R ADHD scale and 9 out of 18 items in the DSM-IV ADHD scale inquire about inattentive symptoms. Other differences between these scales include (1) time period of reference, (2) age at onset and (3) evidence of functional

impairment. While the OCHS examines only those behaviours present within the past six months of the survey, neither of the DSM-based definitions mandate a specific time period of reference. In contrast, the OCHS does not require a specific age at symptom onset, whereas the DSM-III-R specifies that illness onset must have occurred prior to age seven years, and the DSM-IV acknowledges that some symptoms must have been present prior to the age of seven years, though early-onset of full criteria is not necessary. Finally, as compared with the OCHS and the DSM-III-R, the DSM-IV requires that the symptoms result in functional impairment in at least one domain (e.g. academic or social functioning). The effect of these diagnostic differences on the appreciation of the present study findings is unclear. It would seem that given the preponderance of hyperactive/impulsive items on the OCHS scale, the limited number of total items, and the restriction of the time-period of reference to the preceding six months only, children and adolescents scoring highly on the OCHS Hyperactivity scale may be a more symptomatically active and homogeneous hyperactive/impulsive population as compared with a highly scoring ADHD population based on DSM-IV criteria. As hyperactivity and impulsivity may be more highly correlated with increased physical activity, and may be more likely to be identified and treated with stimulant medication, the relative lack of predominantly inattentive ADHD subtype children may underestimate the relationship of childhood and adolescent onset ADHD with adult BMI in the present study.

### 5.4 Conduct Disorder: Diagnostic Criteria Considerations

Following the release of DSM-III-R, the original study investigators examined the reliability and validity of the conduct disorder scale employed by the OCHS and determined

that it was reliable and valid[54]. With the release of the DSM-IV in 1994, the definition of Conduct Disorder was further revised, as presented in Table 5-2. Compared with the earlier definition, the revised DSM-IV criteria included two additional non-violent behaviours (DSM-IV (1) and (13)) that children or adolescents might exhibit, introduced a time period of reference (the previous 12 months, provided that at least one criterion is present within the preceding six months), restricted the onset of truancy or curfew violations to age less than 13 years, and added the stipulation that the behaviours must result in impairment in any sphere of functioning (e.g. social, academic). With these changes, DSM-IV simultaneously broadened (with respect to the range of misbehaviour) and narrowed (with respect to the time reference range, age at onset of truancy and curfew-violation, and mandatory demonstration of functional impairment) the diagnostic criteria. The net effect of these changes on prevalence rates of CD, however, was negligible[101]. On examination, the conduct disorder scale utilized by the OCHS survey compares closely to both the DSM-III-R and DSM-IV definitions. Similar to DSM-IV, the OCHS CD scale includes two additional non-violent criteria (OCHS14, 15) and includes a time-range of reference. However, the OCHS' time-range of reference is the preceding six months only. In limiting the behaviours to the preceding six months, the OCHS may have narrowed the problem-set to focus on those children and adolescents who are more active in their behavioural disturbance. As a result, it is possible that the present study may include a more severe population of children and adolescents with conduct disturbance when compared with other CD community samples. The effect of examining the preceding six versus 12 months of behavioural disruption, while it may be present, is likely to be small.

### 5.5 Measurement of Body Mass Index

Body Mass Index was calculated using self-reported weight and height data in the 2000 survey. Using participant reported, rather than measured, weight and height data raises the question regarding the accuracy of the figures provided and the resultant validity of the BMI data included in the analyses. Research examining the acceptability of self-report weight and height has confirmed that these data are generally accurate when compared with measured values in population-based adolescent and adult samples in the U.S.[102], the Netherlands [103] and Scotland [104]. Among the Scottish sample of 1,836 participants, self-reporting was noted to lead to an underestimation of weight, but also an underestimation of height, resulting in BMI estimates of low error overall [104]. In contrast, participants of a Canadian community health survey were more likely to overestimate their height and underestimate their weight, leading to an underestimation of overweight and obesity [105]. Research investigating the effects of depression on the self-report of height and weight did not find any differences in reporting among those with depressed mood compared with those without [33, 106]. Thus, while studies have generally suggested that self-report BMI is likely to be accurate, it is possible that an underestimation of BMI may have occurred in the present study. If present, the magnitude of inaccuracy is likely to be too small to significantly affect conclusions about associations in large-scale epidemiological studies [102, 107]

### 5.6 Continuous vs. Categorical Variables

Although a categorical definition of illness may be useful for clinical application, dichotomizing the burden of symptoms into categories of ‘presence’ or ‘absence’ of diagnosis

is suboptimal for a number of reasons. First, dichotomizing the data would lead to a loss of statistical power to determine a difference in BMI between groups with varying levels of psychopathology. Second, the ability to understand the relationship between small but steady increases in psychological symptoms and weight gain would be lost if illness was considered solely as a categorical variable. Ironically, the third concern regarding the dichotomization of disease symptoms is specific to depression and clinical in nature. Based on the current limitations of knowledge of the measurement, prevalence, and outcomes of depression in prepubertal and early adolescent children, it is not clear that the diagnostic thresholds used in adult populations are appropriate for this early-onset illness group. Further, utilizing a "presence or absence" model of disease is inconsistent with the clinical experience of illness.

For these reasons, the examination of the relationship of early-onset mental illness with adult BMI in the present study employed continuous measures of illness. Categorical illness variables were employed solely to examine the illness prevalence among child and adolescent study participants and compare these figures by informant and with the existing literature.

### 5.7 Choice of Reporting Informant

Evidence suggests that children and adolescents are able to capably report on their own symptoms of internalizing disorders (e.g. depression, anxiety disorders) and with respect to depression, may be better informants of their mood, energy level, feelings of worthlessness or guilt and suicidality than are their parents[108, 109]. In contrast, parents may be helpful informants of the presence and severity of neurovegetative symptoms such as anorexia/weight change or sleep disturbance. Perhaps as a result of the internalizing nature of the symptoms,

and the context within which their observations occur, teachers are poorly situated to assess depressive symptoms and have been demonstrated to be inaccurate informants of these difficulties for students[110]. In this study, data regarding the depressive symptoms of 4 to 11 year old children was obtained from parents and teachers only. Children did not complete a self-report inventory. In addition, teacher response rate of depressive items in this age group was low (30%) and unlikely to be accurate given current knowledge. As a result, determination of depressive symptoms among 4 to 11 year old children was based on parent report. As adolescents did complete self-report measures, the determination of depressive symptoms among 12 to 16 year olds was based on both youth and parent report.

In contrasts to the internalizing disorders, evidence suggests that parents and teachers may be better informants of symptoms of disruptive behaviour disorders (e.g. ADHD, conduct disorder) than children and adolescents themselves. This may be due to a lack of insight or a resistance to report these difficulties (either due to feelings of embarrassment, guilt, or a fear of consequences) on the part of the child/adolescent. Further, in the context of externalizing disorders, parents and teachers may contribute unique information as they observe and interact to the children under different conditions. For example, while parents may be able to report on symptoms observed in the context of relationships with familiar loved ones and siblings, teachers have the opportunity of reporting on symptoms which occur in the context of the academic and social stressors that occur at school. For these reasons, both parents and teachers can be valuable informants of child and adolescent externalizing disorders[111]. However, teachers of adolescents 12 to 16 years of age completed survey measures at too low of a response rate (21% nonresponse; 69% missing responses) to be included in the study analyses.

Thus, while determination of ADHD and conduct symptoms in the 4 to 11 year old group was based on both parent and teacher report, the determination of these disorders in the 12 to 16 year old group was based on youth and parent report.

### 5.8 Missing Data

The follow-up survey in 2000 aimed to include all individuals who participated in the original 1983 survey, achieving a response rate of 59.1%. Given this degree of attrition over the 17 year study period, a discussion of the potential for sampling bias in the 2000 follow-up, and the potential impact of missingness on the present study findings, are warranted. Sampling bias is a concern due to the magnitude of the participant loss over the study period, as these losses may lead to systematic distortions of the population under study and yield imprecise estimation in data analyses as a result. Research examining participant and non-participant differences from the original OCHS survey has reported that compared with participants in 2000, non-participants were more likely to be male (18% of males versus 13% of females refused to participate), from poorer families, and to have greater school or health problems. As a result of these findings, previous investigators have developed and evaluated attrition weights in an attempt to compensate for potential distortion of original sample characteristics due to loss [112]. In doing so, an attempt to recreate the original survey characteristics was made, and potential differences between participants and non-participants were evaluated for significance. Application of attrition weights was then undertaken, with weighted and unweighted regression analyses using a number of demographic and health variables, including SES, child and parent functioning, health service use, of original OCHS participants. When compared with those of original OCHS participants, application of attrition weights to characteristics of the 2000

respondents resulted in similar parameter estimates [112], indicating that the differences among participants and non-participants were minimal with respect to the follow-up characteristics examined. Consistent with these data, the present study's examination of key independent variables among participants and non-participants with respect to availability of BMI data of respondents in 2000 yielded minimal differences between groups. Moreover, losses were greater among lower SES participants with poorer mental health. Current knowledge suggests that inclusion of these respondents, were the data available, might be expected to further strengthen the findings of this thesis as both depression and obesity occur more frequently among lower SES groups [113-115]. Thus, while it is possible that loss to follow-up has impacted the study's findings, it is more likely to have led to an underestimation, rather than an overestimation, of the association between early psychopathology and later overweight as reported above.

## CHAPTER 6 - LIMITATIONS

This study is subject to several limitations. First, as noted above, the OCHS did not obtain self-report data from children 4 to 11 years of age. As children have been shown to be able to report on their depressive symptoms, these data would have been useful to consider with respect to the relationship between childhood depression and adult BMI. Studies comparing child self-report with parental report of child depressive symptoms[108, 109] have shown that parents may underestimate the magnitude of their child's distress, indicating that the omission of child self-report depressive data may have underestimated the frequency of depression among children in this study. Second, as the OCHS did not include weight or height data in the initial 1983 survey, we were unable to account for the child or adolescent's BMI at the time of baseline assessment. As a result, the temporal relationship between psychopathology and weight cannot be determined. However, studies that have controlled for baseline weight, in older adolescent populations or with shorter study duration, have reported similar findings[30, 32]. Third, the OCHS did not collect data regarding participant ethnicity. Inclusion of this data would have been important as race and ethnicity have been shown to contribute to the genetic and environmental influences which may affect weight gain[114, 116]. Fourth, the overall amount of explained variance in adult BMI that was due to psychopathology, although statistically significant, was not large in scale. However, increased adult body weight is associated with numerous poor medical outcomes, such that even small proportionate decreases can have important public health implications. Finally, while we were able to account for the presence of depression in adulthood, we were unable to include the presence of either adult ADHD or conduct symptoms in the examination of the relationship

with the early-onset of these disorders and later body weight. Thus it is possible that the presence of conduct symptoms lifelong, as compared with those present in the child and adolescent period exclusively, is a contributing factor to adult weight.

# CHAPTER 7 - CONCLUSIONS

This thesis confirms that childhood onset psychopathology is an independent predictor of adult overweight. With respect to depressive illness, the primary novel finding of this study is that boys less than 12 years of age with increased depressive symptoms are at risk of future overweight. Further, previous reports of a gender differential pertaining to risk of future overweight among depressed adolescence are confirmed: depressive symptoms in adolescence predict increased adult body mass among girls. In addition, this thesis extends current knowledge of the relationship between early-onset disruptive disorders and adult overweight, determining that conduct disorder symptoms, rather than ADHD symptoms, drive this relationship for both affected girls and boys.

Taken together, these data strongly suggest an important relationship between depression and conduct disorder in childhood and adult overweight. These observations are associated with substantial public health implications as present understanding of the factors contributing to obesity and their accessibility for intervention to prevent obesity are limited. Research examining the trajectories of affected children is needed to understand the mechanism of the relationship between affective and behavioural self-regulation with eating behaviours and weight gain, as this study suggests that early identification of psychiatric illness may present key opportunities for targeted prevention of obesity.

# CHAPTER 8 - ETHICAL CONSIDERATIONS

This thesis is based on the secondary analyses of data originally collected during the OCHS research project. Thus, although participant consent was obtained for data collection to achieve the aims of the OCHS study, specific consent was not obtained in order to analyze the data for the benefit of answering the questions of this thesis.

Central to the ethical concerns about secondary use of data is that of the potential for harm to the individual subjects and the lack of informed consent. As the OCHS researchers would not have been able to predict the use of data for this thesis at the time of data collection, they were unable to fully inform OCHS participants about this potential use of data. Since full disclosure of information is a requirement of informed consent, it is not possible to get informed consent for unanticipated uses of data.

Homan [117] argues that were future researchers to contact the original subjects for consent to re-use data, the original researchers would be forced to breach their subjects' privacy by identifying them for this later contact. Possibly, the original researcher(s) could contact the individuals in this circumstance. It is also possible, however, that some participants of the OCHS may no longer recall their involvement with the study, due to their young age at the time of data collection.

Further, Law [118] notes that in discussing these issues, the ethical obligations to good science, and to the benefit of the community at large, must also be considered. Law argues that if the respect for human dignity is to mean that individuals are important and should be treated as such, then researchers should make as much use of the data as possible in order to reduce the burden on research subjects, particularly where research

involves the use of vulnerable populations. In addition, as the OCHS was paid for by research grants funded by the taxpayer, Law suggests that the harm sustained by the taxpaying community should be offset by ensuring the maximal use of the data collected in order to achieve an appropriate offsetting benefit [118].

In summary, the secondary analysis of existing research data, as presented in this thesis, provides opportunities for the generation of new knowledge. It may be aligned with the ethical principles of research by minimizing research burden and optimizing potential benefits from the data collected. It may be useful to consider revisions to current consent procedures to introduce the concept of potential future data use for consenting individuals. Doing so may raise awareness of this possibility in participants' minds and allow questions regarding data use and anonymity to be addressed as fully as possible at the time of consent.

## CHAPTER 9 - REFERENCES


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