THE EFFECTS OF PRENATAL EXPOSURE TO ALCOHOL, TOBACCO AND OTHER RISKS ON CHILDREN'S HEALTH, BEHAVIOUR AND ACADEMIC ABILITIES

by

MARY ANNE GEORGE

B.A., Acadia University, 1966
M.L.S., The University of British Columbia, 1989

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE STUDIES

Individual Interdisciplinary Graduate Studies Program

We accept this thesis as confirming to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

April 2001

© Mary Anne George, 2001
In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the head of my department or by his or her representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of [Signature]
The University of British Columbia
Vancouver, Canada

Date April 24, 2001
Abstract

Maternal behaviours during pregnancy may contribute to unhealthy child development. Previous research has linked adverse outcomes to prenatal exposure to heavy alcohol use, to tobacco use, and to socioeconomic background. Health professionals have been responsive because of the preventable nature of these risks.

This research examined the impact on children from diverse backgrounds who had been exposed prenatally to varying amounts of alcohol and tobacco, or both. It further assessed the additive effects of these risks.

The Vancouver Island Pregnancy Follow-up Study is population-based. It examined the health, academic abilities and behaviours of 8-year old children born over a 1-year period in a pre-defined area of British Columbia (n=3,659). It attempted to find the total randomly selected sample (n=403), with the result that 65.7% families (n=265) participated, 25.8% were not located, 5.5% refused, and 3.0% were not available. The data sources were children, who were tested on their academic abilities using the WRAT-3, and their parents and teachers who were interviewed regarding the child’s health, behaviour and school performance.

Results with respect to academic abilities showed that only reading scores were associated with prenatal alcohol exposure. Reading and spelling ability scores were associated with the combination of being prenatally exposed to alcohol and having a father with low education. Poorer health ratings were associated with prenatal alcohol exposure, with the combination of pre- and postnatal tobacco exposure, and with lower socioeconomic background. All three independent variables were associated with behaviour scores. Children of heavy drinkers had higher scores on the total behaviour scale and on five subscales. Prenatal tobacco exposure was associated with higher Conduct Disorder scores.

The findings are consistent with other longitudinal studies. In the absence of other risk factors, there was little evidence of associations between prenatal exposure to moderate alcohol use or risk level and academic abilities, health ratings, or behavioural problems. It may be productive to take ecological approaches to understanding children’s behavioural, academic and health problems in the context of their socioeconomic conditions and their exposure to alcohol prenatally and to tobacco both prenatally and postnatally.
Table of Contents

Abstract .................................................................................................................. ii

List of Figures ....................................................................................................... vi

List of Tables ......................................................................................................... vii

Acknowledgments ................................................................................................. ix

Chapter I  Introduction ......................................................................................... 1
  1.1 Introduction ................................................................................................. 1
  1.2 Definitions ................................................................................................. 5

Chapter II  Literature Review ............................................................................. 6
  2.1 Introduction and methods ........................................................................... 6
  2.2 Prenatal effects of alcohol .......................................................................... 8
    2.2.1 Physical and health effects .................................................................... 11
    2.2.2 Cognitive and behavioural effects of children prenatally exposed
        to alcohol .................................................................................................. 16
        2.2.2.i Cognitive development, academic abilities or learning problems .... 16
        2.2.2.ii Behavioural effects of prenatal alcohol exposure ......................... 31
    2.2.3 Summary and discussion of prenatal alcohol exposure research ........ 39
  2.3 Prenatal and postnatal exposure to tobacco .............................................. 49
    2.3.1 Physical effects of prenatal tobacco exposure .................................... 51
    2.3.2 Cognitive and behavioural effects of prenatal tobacco exposure ........ 57
        2.3.2.i Behavioural effects of prenatal tobacco exposure ......................... 58
        2.3.2.ii Cognitive development, academic abilities or learning problems .... 77
    2.3.3 Summary and discussion of prenatal tobacco exposure research ........ 89
    2.3.4 Postnatal exposure to tobacco .............................................................. 93
  2.4 Socioeconomic background ......................................................................... 104
  2.5 Other potentially confounding factors ....................................................... 110
    2.5.1 Other maternal and child factors .......................................................... 112
    2.5.2 Other drugs .......................................................................................... 113
  2.6 Summary ..................................................................................................... 116
  2.7 Theoretical guides ....................................................................................... 120

Chapter III  Research Questions and Methods ................................................. 127
  3.1 Research Questions ..................................................................................... 127
  3.2 Methods ...................................................................................................... 130
    3.2.1 Ethics review ....................................................................................... 130
    3.2.2 Stages of data collection ..................................................................... 131
    3.2.3 Population and sample ...................................................................... 132
3.2.3. Study population and procedures for locating subjects
3.2.3.ii Study sample
3.2.3.ii (a) Refusal rate
3.2.3.ii (b) Teachers' participation

3.2.4. Variables and measures
3.2.4.ii Independent Variables
3.2.4.ii (a) Prenatal alcohol exposure
3.2.4.ii (b) Prenatal and postnatal tobacco exposure
3.2.4.ii (c) Socioeconomic background

3.2.4.ii (b) Academic abilities
3.2.4.ii (c) Behaviour

3.2.4.iii Other variables

3.2.5. Study instruments and means of administration
3.2.5.ii Parents' questionnaire
3.2.5.ii Teachers' questionnaire

3.2.6. Analytic procedures

Chapter IV Results
4.1 Sample
4.1.2 Participation in the follow-up study
4.1.2 Demographic characteristics of sample participating at Stage 3
4.2 Independent and dependent variables
4.2.1 Independent variables
4.2.1.ii Alcohol use during pregnancy
4.2.1.ii Tobacco use during pregnancy
4.2.1.iii Socioeconomic status
4.2.2 Outcome variables: academic abilities, health and behaviour
4.2.2.ii Academic ability scores of study sample
4.2.2.ii Health
4.2.2.iii Behaviour
4.3 Relationship between independent and dependent variables
4.3.1 Academic Abilities
4.3.1.ii Prenatal alcohol exposure and WRAT-3 scores
4.3.1.ii Prenatal tobacco exposure and WRAT-3 scores
4.3.1.iii Socioeconomic background and WRAT-3 scores
4.3.1.iv Comparing risk levels of a combination of independent variables on WRAT-3 scores
4.3.1.iv (a) Comparisons of academic scores according to level of risk
4.3.1.iv (b) Comparisons between the most at-risk groups and least at-risk groups
List of Figures

Figure 2.1 Conceptualization of the interacting variables influencing birth outcomes ............................................. 121
Figure 2.2 Schematic representation of summary of relationships among permissive and provocative maternal risk factors underlying FAS/ARBDs (alcohol-related birth defects) ........................................................................................................ 122
Figure 3.1 Conceptual model of relationships between independent variables (prenatal alcohol exposure, prenatal tobacco exposure and socioeconomic status) and outcome variables (academic abilities, health and behaviour) ........................................................................................................ 129
Figure 4.1 Relationships and correlation coefficients between independent variables (socioeconomic background, tobacco use and alcohol use during pregnancy) and academic abilities as measured by WRAT-3, including p values ............................................. 195
Figure 4.2 Correlation coefficients (bivariate analyses) between independent variables (alcohol and tobacco exposure during pregnancy and socioeconomic background) and health, as measured by parents' rating of child's health and number of visits to medical professionals, including p values ........................................................................................................ 205
Figure 4.3 Correlation coefficients (bivariate analyses) between maternal education, prenatal and postnatal exposure to smoking and child's health ........................................................................................................ 210
Figure 4.4 Correlation coefficients (bivariate analyses) between independent variables (socioeconomic background, tobacco use and alcohol use during pregnancy) and behaviour, as measured by the Teachers' Behaviour Rating Scale, including p values ........................................................................................................ 216
List of Tables

Table 2.1 Studies of cognitive and behavioural outcomes associated with prenatal alcohol exposure, listed in alphabetical order by first author. 44
Table 2.2 Studies of cognitive and behavioural outcomes associated with prenatal tobacco exposure, listed in alphabetical order by first author. 96
Table 3.1 Selected maternal demographic variables of study population of women with live births in central and northern Vancouver Island, 1990-91 data collection. 134
Table 3.2 Methods of attempting to locate subjects, with refusal and participation rates. 138
Table 3.3 Distribution of T-ACE risk levels for population (Stage 1), random sample (Stage 2) and sample found at Stage 3. 145
Table 3.4 Data collected during home interview regarding alcohol consumption. 146
Table 3.5 Sources of data for dependent variables at Stage 3 data collection. 150
Table 3.6 Variables, variable type and source of data collection. 171
Table 4.1 Frequency and percentage of parents in sample with various demographic and lifestyle characteristics. 177
Table 4.2 Correlation coefficients (Spearman’s rho) between T-ACE risk as measured at Stage 1, T-ACE risk as measured at Stage 2 and alcohol use (frequency times quantity) during pregnancy, including p values. 179
Table 4.3 Number and percentage of women who reported levels of drinking. 181
Table 4.4 Number (and percentage) of smokers by trimester and categorized according to amount of daily smoking. 182
Table 4.5 Results of WRAT-3 scores (n=252), including mean, minimum and maximum scores, standard deviation, correlations between reading, spelling and arithmetic, and compared with U.S. national standardized scores. 184
Table 4.6 Correlational relationships (Spearman’s rho) between WRAT-3 scores on reading, spelling and arithmetic tests, comparisons with teachers’ ratings of reading and arithmetic and with parents’ assessments of their child’s difficulties with these subjects. 186
Table 4.7 Parents’ ratings of their child’s health, their own health and their youngest and oldest children’s health, on a 5-point scale, and correlations among these ratings. 187
Table 4.8 Number of children with specific chronic illnesses or conditions. 189
Table 4.9 Frequency of child’s visits with various health professionals in the past year, including mean number of visits. 190
Table 4.10 Correlational relationships, including p values, among four measures of health: rating by parents, visits with various medical and nurse professionals, amount of time child has been in good health in recent months, and school absenteeism. 191
Table 4.11 Correlational relationships among three measures of behaviour: Parents’ Behaviour Rating Scale, Teachers’ Behaviour Rating Scale, and parents’ responses to single-item question on behavioural problems. 193
Table 4.12 Frequency of categorical variables used in ANOVA. 201
Table 4.13  Contrasts between scores on WRAT-3 tests for reading, spelling and arithmetic for children exposed to high, medium or low risks of maternal alcohol consumption, T-ACE risk and fathers' education level ............................................. 203

Table 4.14  Teachers' Behaviour Rating Scale ratings, according to T-ACE risk scores (Stage 2 administration), including mean, standard deviation (S.D.) and range of scores according to each T-ACE risk level .................................................................................................................. 217

Table 4.15  Teachers' Behaviour Rating Scale ratings, according alcohol use levels, including mean, standard deviation (S.D.) and range of scores according to each alcohol level ................................................................................................................. 218

Table 4.16  Correlation coefficients (Spearman's rho) and F tests between Parents' and Teachers' Behaviour Rating Scales for total behaviour score and each of the subscales, according to T-ACE risk (Stage 1 administration) and to alcohol consumption during pregnancy .................................................................................................................. 219

Table 4.17  ANOVA results for Teachers' rating scale using both T-ACE risk (Stage 1) and alcohol consumption during pregnancy, by gender .................................................................................................................. 221

Table 4.18  Comparisons of Teachers' Behaviour Rating Scale scores between children of abstainers and those prenatally exposed to heavy drinking and to social drinking levels .................................................................................................................. 223

Table 4.19  Test statistics for Parents' and Teachers' rating of behaviour subscale Conduct Disorder scores, and combined risks of prenatal tobacco exposure, by each trimester, and current second-hand smoke exposure, for total sample, boys only and girls only, including F test result, degrees of freedom (df) and p value .................................................................................................................. 228

Table 4.20  Correlation coefficients (Spearman's rho) and F tests for total scores on Teachers' Behaviour Rating Scale and total scores on Parents' Behaviour Rating Scale and each of five socioeconomic indicators .................................................................................................................. 230

Table 4.21  ANOVA F test coefficients and p values for associations with teachers' rating for total Behaviour score and subscales and three socioeconomic indicators, household income, and mothers' and fathers' occupation levels .................................................................................................................. 231

Table 4.22  Number and percentage of children who experienced major worries during their lifetime, according to income category of parents .................................................................................................................. 235

Table 4.23  Number of children who experienced major worries, according to cause of the worry and income category of parents .................................................................................................................. 236

Table 4.24  Scores of children exposed to risks of both tobacco use during 2nd and 3rd trimester and T-ACE risk, compared with those with no tobacco exposure and low T-ACE risk .................................................................................................................. 239
Acknowledgments

Many dedicated, talented and patient people have contributed to this research: those who discussed theoretical issues relating to women and lifestyles; those who provided essential funding; those who offered practical and methodological advice based on their many years of experience; those who carried out the essential tasks of a large project; the hundreds of families who willingly participated as subjects; and those who were simply supportive.

Five people served as members of my doctoral supervisory committee and each deserves my special gratitude. Dr. Lawrence Green served as Supervisor for the initial years of this research and, on his departure to his homeland, passed the torch to Dr. Robert Armstrong. I greatly appreciate both supervisors being available whenever I called upon them. Also on the Committee from its beginning were Dr. Heather Clarke and Dr. Judith Ottoson. When Dr. Ottoson was offered an academic position elsewhere, I appreciated Dr. Julianne Conry’s willingness to step in mid-way through the project. Dr. Green, Dr. Armstrong, Dr. Clarke, Dr. Ottoson and Dr. Conry gave willingly of their time. They contributed intellectually to the research design and gave editorial assistance and suggestions regarding methods and analyses to the project and its reporting. They provided mentorship from their vast knowledge and experience to my doctoral education. Gathered from the fields or disciplines of Health Promotion, Medicine, Nursing, Adult Education and Educational Psychology, this multidisciplinary team of advisors has shaped this project and my education in numerous ways. I am deeply grateful to each of them.

I would like to thank three groups of people for their roles in the initial stages of this research a
decade ago. The current research would not have been possible without the prior work of Principal Investigators, Dr. Robert Armstrong, Dr. Geoffry Robinson and Dr. Christine Loock, who conceptualized a strengthened role for primary care physicians in preventing alcohol-related birth defects. They designed and conducted the original research on Vancouver Island, collecting data that is the foundation of the present study. I thank them for the study. Secondly, Lisa Lund and Norma Lupton contributed in many capacities, including project co-ordination, data entry and interviewing on that original 1990-1991 data collection. Their obvious dedication to this work and to their particular tasks left a collection of excellent data with which to work. Lisa Lund and Norma Lupton were also valuable memory banks for the current project. I thank them both for an untiring willingness to answer questions about work they had done 10 years earlier. Finally, I would like to thank Dr. Chris Lalonde, now of the University of Victoria, for his patience as the keeper of the data for many years and for his contributions in analyzing and interpreting the data.

Major financial support for this study was provided by the Scottish Rite Charitable Foundation, an important contributor to research on the prevention and treatment of disabilities. The Foundation contributed three years of funding under their “major grants” awards that was invaluable to the success of this project. A doctoral scholarship from the Lion’s Gate Medical Research Foundation and a Joint Studentship award from the B.C. Health Research Foundation and the B.C. Centre for Excellence in Women’s Health allowed me the opportunity to dedicate full-time efforts during various stages of the research. I am most appreciative of the financial and in-kind support provided by each of these groups.
Hundreds of families contributed by participating as subjects in this study. In 1990-1991, 403 women answered questions about themselves and their newborns, and of these, 265 participated nine years later by completing questionnaires and giving permission for their children to be tested and their children's teachers to be contacted. I appreciate their time and effort and the trust they had in the project. I am also grateful to the hundreds of teachers who willingly participated and took the time during their professional lives to complete a questionnaire about a student in their class, and in some cases, more than one student. I also appreciate the school boards on Vancouver Island and a local professional teachers' association, that agreed to teachers' participation.

People who are employed in our health systems were also helpful in the follow-up of subjects. Two public health nursing managers, Allison Cutler and Marg Wooton, as well as other public health nurses assisted by helping to notify subjects of our interest in contacting them. Among the public health nurses who contributed to the present study were Katie Hine and Norma Lupton, both involved as interviewers during the 1990-91 data collection. I appreciate the interest and effort from all the public health nursing staff who contributed to this study.

Staff at the University of British Columbia and at the Ministry of Health were helpful in permitting the use of B.C.'s linked database to assist in locating subjects, after all other avenues of finding the 403 women of the 1990-1991 study had been exhausted. In particular, I would like to thank Dr. Allan Thomson, Ron Strohmaier and Al Cassidy. Forty subjects were found through the Linked Database, each one important to the study.
I thank the 13 parents and 6 teachers who kindly agreed to pre-test questionnaires, all taking time from their already busy schedules.

The interest of staff and colleagues at two U.B.C. centres, the Institute of Health Promotion Research (IHPR) and the Centre for Community Health and Health Evaluation Research (CCHHER) has also contributed to the success of this project. Dr. Green, former Director of IHPR and Dr. Armstrong, Director of CCHHER, were supportive in offering space to carry out the work, generous with their time and patient in discussing questions raised by my research. Administrative and executive assistant staff, Mary Sun, Allison Bell and Lisa Lund, helped with the onerous tasks of paying the bills or scheduling meetings for a group with exceptionally full calendars. I thank each of them for helping to keep the project running smoothly.

Many others have contributed their particular skills to the project, that from time to time needed very skilful people. Sherry Batdorf, Debra Cowan, Donna McNeill, Sherry Miyamoto, JoAnne Palin and Maureen Shiner served as excellent interviewers, interested in collecting the most reliable data. They drove to subjects’ homes, often many miles from their own homes and difficult to find, to interview women and their children, always maintaining a professional attitude, good humour and patience. As well as interviewing, Sherry Miyamoto contributed to the study by spending many hours methodically and efficiently entering the data into database format. May Lee, and her supervisor Dr. Ying McNab, contributed their expertise as statisticians. In addition, six undergraduate students, Sara Sturrock, Jon Grenke, Colleen French, Meredith Burgon, Mary George and Marcia George, helped throughout the project with various tasks.
essential to the progress of the research.

I also thank two editors, Joy Davidson and Jane Srivastava.

Finally, I acknowledge and thank my two daughters Marcia and Mary George, my parents Edouard and Phyllis Gautschi and my sisters Jane Underwood and Marcia Rioux, all of whom were supportive and encouraging with their friendly urging and good humour.
Chapter I Introduction

1.1 Introduction

Maternal behaviour during pregnancy may contribute to unhealthy fetal and child development. This research examined two maternal behaviours, alcohol and tobacco use, during pregnancy. Previous research has linked heavy alcohol use with fetal alcohol syndrome and tobacco use with various health problems for neonates. This has concerned health professionals in Canada and elsewhere where alcohol and tobacco are commonly used by women. Health policy makers and practitioners have been responsive, particularly because of the preventable nature of these risks to healthy child development.

It is known that excessive alcohol use during pregnancy can result in a range of disabilities and academic, health or behavioural problems (Abel, 1998b). The association between alcohol and adverse birth outcomes had been suspected for at least the past century, but until 1941, no attention had been given by the scientific community to links between environmental or lifestyle factors and malformations in human embryos (Naeye, 1992b). Our scientific knowledge regarding alcohol as a teratogen has developed only over the past 30 years after French (Lemoine et al., 1968) and American researchers (Jones & Smith, 1973; Jones et al., 1973; Ulleland, 1972) reported on patterns of malformations in infants born to mothers who drank excessively during pregnancy. Various case studies described children who were severely affected by alcohol (Armstrong, 1998) with little analytic control in the study design of other confounding risk behaviours or social environments. From these case and longitudinal studies following children severely affected, it is known that prenatal alcohol exposure can result in a spectrum of adverse
effects, with Fetal Alcohol Syndrome (FAS) being the most extreme. Fewer or less severe effects have been termed Fetal Alcohol Effects (FAE) or more recently termed "partial FAS". Children with FAE often do not have the distinguishing facial features of those with full FAS, but they may have a range of behavioural and cognitive effects, such as attention deficits or difficulty understanding concepts, that in turn can cause secondary effects of social and behavioural problems. FAS incidence estimates, derived from data from a number of countries, range from 0.33 to 0.97 per 1,000 live births (Single et al., 1999; Abel, 1995) for western countries.

Since those early reports in the late 1960's and early 1970's, over 6,000 journal articles have reported animal or behavioural research describing the prenatal effects of alcohol, with the cumulative evidence leaving little doubt that alcohol has teratogenic effects. These studies have broadened our understanding of the effects of alcohol exposure but much remains to be learned. Unique patterns of alcohol use (ranging in quantity and frequency), the stages of pregnancy during which women consume alcohol and the individuality of each mother’s underlying health has made it difficult to complete the understanding of the effects of maternal alcohol use on humans. Because of the complex nature and the variety of the anomalies of alcohol-related birth defects, even diagnosis is not fully assured unless there is confirmation of the mother’s use. Twelve longitudinal studies in the English-language journals have reported the follow-up of alcohol-exposed children beyond newborn stage, and many of these followed children with FAS. Few longitudinal studies have followed children prenatally exposed to alcohol, but not having FAS. Prior to the present study, there has been only one Canadian longitudinal study (Fried, O’Connell & Watkinson, 1992; Fried, Watkinson and Gray, 1992; Fried & Watkinson, 1990;
Fried & Makin, 1987; Fried & O’Connell, 1987). Longitudinal studies on the outcomes associated with prenatal alcohol or tobacco exposure are needed since many of the behaviours or learning problems do not become evident many years after birth. An inability to understand concepts, and ability to do arithmetic are two such outcomes often associated with children with FAS that are not noticeable until early school-age.

Smoking tobacco during pregnancy has detrimental effects on the health of the mother, fetus, newborn and child. Edwards, Sims-Jones and Hotz (1996) found in their review of the literature that most international surveys indicated prevalence rates of smoking by pregnant women ranged from 25% to 40%. A 1996-1997 Canadian national survey found that 21.3% of children under age 3 had mothers who reported that they smoked during pregnancy, with the rate being smaller in British Columbia (18.6%) (Canada. Health Canada, 2000a). Data collected during the home interviews from the first stage of this present study (1990-1991) indicated that 37.5% of the women smoked at some time during their pregnancy.

Considerable evidence has shown the importance of socioeconomic inequalities in contributing to both child and adult poor health. Socioeconomic background was included in this study because the effects of the social and economic context in which children are raised may modify the effects of other risks including prenatal alcohol and tobacco exposure.

The study described in this thesis, referred to as the Vancouver Island Pregnancy Follow-up Study, examined the outcomes of children exposed to various levels of maternal alcohol and
tobacco use. It followed the children of an earlier study, the Vancouver Island Pregnancy Study (Armstrong et al., 2001a, 2001b, 1994) that was a population-based study testing the use of an alcohol screening tool by primary care practitioners and examining the prevalence of alcohol use amongst a general population. The purpose of the Vancouver Island Pregnancy Follow-up Study was to examine the outcomes of children exposed to various levels of maternal alcohol or tobacco use, or both, rather than study the specific sub-population of children with FAS. It was not a purpose of either study to determine the incidence of FAS or FAE in this population, nor was there any attempt in the Vancouver Island Pregnancy Follow-up Study to diagnose FAS or FAE.

Data from the first stage of this research (1990-1991 data collection) indicated that prior to pregnancy, 14.2% of women (n=3,059) were in a high risk category of alcohol use, 36.4% were in a medium risk category (Armstrong et al., 2001a), as measured with the alcohol screening tool T-ACE scale (Sokol et al., 1989). Approximately one-half (51.7%) of the women drank alcohol at some time during their pregnancies. Both frequent drinking of alcohol and binge drinking are considered to put the fetus at risk and data from this sample indicated that at least 6.5% of the women consumed five or more drinks during a day (considered binge drinking) on some occasions during pregnancy. These rates of use are considerably higher than those reported by a 1996-1997 national study, that found that 16.6% of children under the age of 3 years had mothers who reported that they drank alcohol during their pregnancies, and 14.9% of 3 year olds in British Columbia had mothers who reported drinking during their pregnancies (Canada. Health Canada, 2000a).
1.2 Definitions

This study focused on prenatal exposure to alcohol and to tobacco, referring to maternal use of alcohol and tobacco while the mother was pregnant. Pre-conception exposure because of paternal use of alcohol was not a topic of this study, nor was prenatal exposure to smoke from the fathers’ or others’ tobacco use. Unless otherwise noted, any reference to “prenatal alcohol exposure” or “prenatal tobacco exposure” refers to maternal use during pregnancy. Postnatal exposure to tobacco refers to maternal or others’ use of tobacco, that is, second-hand or environmental exposure of the same child.

Both definitional and measurement problems exist with the terms “moderate”, “social”, “light” or “heavy” alcohol use, since the terms do not have common usage in the research literature. For the purposes of this research, maternal drinking behavior is defined accordingly: abstainers (no use throughout pregnancy), social drinking (one or fewer drinks per day), and heavy drinking (2 or more drinks per day and/or any occasions of binge drinking, defined as at least 5 drinks per occasion). Both the 2 drinks per day cut-off for infrequent drinking and the definition of 5 drinks per occasion for binge drinking were often, but not always, found in the research literature. No women in this study said they drank between 1 and 2 drinks, that is 1 ½ drinks, therefore, all drinkers fall into the categories of either social drinkers (1 or fewer drinks) or heavy drinkers (2 or more drinks). The literature review uses the term “moderate” drinking, since it is often used in research studies, although number of drinks changes from study to study. It is consistent that the term “moderate” falls somewhere between abstainer and heavy drinking. The actual amount of alcohol referred to as moderate is given if it is defined in the literature cited.
2.1 Introduction and methods

The research literature on the topic of prenatal alcohol exposure is enormous, to the extent that the prolific writer Ernest L. Abel took 3 years to write his third book on the topic, rather than the planned one year because he “was unable to reconcile the many contradictions and new ideas that now characterize this literature” (Abel, 1998b, p.1).

The purpose of the Vancouver Island Pregnancy Follow-up Study was to examine the outcomes of children exposed to the risk behaviours of maternal alcohol or tobacco use, or both, rather than specifically study a sub-population of children with FAS. FAS, however, is included in the literature review because it informs the general topic of the effects of prenatal alcohol exposure. The present literature review focuses on the outcomes of prenatal alcohol exposure, prenatal tobacco exposure, and more briefly on socioeconomic background. It is selective, based on aspects most salient to the thesis, rather than a comprehensive review of all the effects of prenatal alcohol or tobacco exposure or on the associations between the socioeconomic gradient and health status.

With respect to prenatal alcohol exposure, the literature review for this thesis concentrates on studies describing the effects of a range of alcohol consumption, but emphasizes the impact of social or moderate alcohol consumption, rather than describing children with FAS or FAE. The majority of women in this research did not drink heavily and therefore the review focuses on the effects of moderate alcohol use. It focuses on human longitudinal studies. It includes longitudinal
studies following children with FAS or FAE because it was found that these informed the literature regarding the effects of prenatal alcohol use in general even though descriptions of children with FAS or FAE are not the focus of this thesis. Studies that were not longitudinal in design, but that inform the literature on outcomes of interest to this study, such as effects on academic performance, are included.

Systematic searches for pertinent literature were conducted using four electronic databases, MEDLINE, PsycINFO, Sociological Abstracts and ERIC. Because of the organizational structure of the particular database, and because of the relevance to the topics being searched, the date range differed slightly for each database. The date range searched for MEDLINE and for ERIC was from 1966 to present, for PsychINFO from 1967 to present and for Sociological Abstracts from 1963 to present. The majority of the literature was found through MEDLINE searches. Keywords used in the searches were: fetal alcohol, maternal smoking, prenatal alcohol, prenatal tobacco, maternal alcohol, pregnancy + alcohol use, pregnancy + tobacco use, cognitive, developmental, neuropsychological, socioeconomic, and SES. To ensure comprehensiveness of specific topics, searches were conducted when certain subjects were found to have less commonly used keywords (e.g., Conduct Disorder and tobacco). All longitudinal studies were included in the literature review for both the topics of prenatal alcohol exposure and for behavioural and effects of tobacco exposure. There was an attempt to be comprehensive in reporting on all longitudinal studies in the English-language literature on these topics. Cross-sectional studies were included only if there were pertinent to the topic and age-group of the study.
For reporting purposes, the review has been divided into two main topics, alcohol exposure and tobacco exposure. Section 2.2 covers the literature on prenatal alcohol exposure and Section 2.3 covers the literature on prenatal tobacco exposure, with each of these sections being further categorized according to physiological effects, cognitive development or learning problems and behavioural outcomes. Section 2.4 covers literature on socioeconomic background, followed by Section 2.5, that briefly describes the literature on a few other potentially confounding variables. Section 2.6 summarizes the previous sections. Finally, this literature review includes two theoretical perspectives, described in Section 2.7, that are useful in describing the possible relationships between various variables that could influence the specified outcomes.

2.2 Prenatal effects of alcohol

Alcohol is a known teratogen, with the most devastating outcome being fetal alcohol syndrome (FAS). FAS is manifested by a consistent pattern of anomalies that includes (1) physical growth deficiencies either pre- and postnatally, (2) observable facial anomalies (such as flattened philtrum, thin upper lip, specific disproportional eye positioning and narrow eye openings), and (3) central nervous system involvement (such as learning disability or behavioural problems). Fetal alcohol effects (FAE) is the term used when fewer than three of these components are present. FAE often goes undiagnosed. Children who do not have the obvious features of FAS can have troublesome lives because the cause of outcomes such as low academic performance or behavioural problems go undiagnosed or mis-diagnosed. Some children have alcohol-related defects, but their conditions do not warrant a diagnosis of either FAS or FAE.
Since the first reporting of the anomalies associated with prenatal alcohol exposure were published in the scientific literature in France (Lemoine et al., 1968) and in the U.S.A. (Jones & Smith, 1973), there have been repeated observations of the teratogenic effects of alcohol (Abel, 1998b; Abel & Hannigan, 1995a; Coles, 1994; Michaelis & Michaelis, 1994; Ernhart, 1991; Streissguth, 1991; Streissguth et al., 1989c; Coles et al., 1987; Ernhart et al., 1987; Little et al., 1986; Sokol et al., 1986; Streissguth et al., 1984; Rosett et al., 1983; Clarren, 1981; Clarren & Smith, 1978). Longitudinal studies have been conducted in Germany, Sweden, Canada and in at least five U.S.A. locations (Atlanta, Cleveland, Detroit, Pittsburgh and Seattle), with some of these following the children longitudinally for more than 2 decades. The studies can be divided into two categories, those attempting to describe the physical, behavioural, cognitive and social characteristics of people with FAS/FAE during various stages of life and those describing children who were exposed prenatally to moderate or lighter amounts of alcohol but rather than having FAS or FAE, the children were born with a range of outcomes.

For the most part, the results have been inconclusive, partially because the relatively short time in which research has been conducted (that is, approximately 30 years) has left little time for replication of work, particularly in the case of longitudinal studies. Methods and the inclusion of confounding variables have varied considerably, as have the measurements of both the independent variable of interest (alcohol consumption during pregnancy) and outcome variables.

Only one Canadian longitudinal study was found in the published literature. It described children whose mothers consumed light or moderate amounts of alcohol (Fried et al., 1992a, 1992b; Fried
The two longest running studies have been conducted in Germany and in Seattle. In Seattle, the research team has conducted two studies, one describing children with FAS or FAE, and the other examining the effects of those prenatally exposed to alcohol but not diagnosed as having FAS or FAE. The first study has followed a cohort of 92 subjects with FAS referred to a clinic in Seattle, or to the clinic of Dr. D.W. Smith in Vancouver (Streissguth et al., 1989c). The other Seattle study began as a population-based study, comparing children exposed to distinctly varying levels of exposure, but not necessarily diagnosed with full FAS. The German longitudinal study has followed people with FAS or FAE in the former West Germany since 1977 (Steinhausen, 1996; Spohr, 1996; Spohr & Steinhausen, 1996, 1987, 1984; Spohr et al., 1993). Subjects (n=158) who were the children of alcoholics, entered the study at various ages from newborn to age 11.5 years.

There have been numerous studies attempting to explain mechanisms underlying the teratogenity of alcohol (for example, see Schenker et al., 1990). Except for a brief discussion here, most of these will not be included in this review of the research. Animal research examining alcohol as a teratogen has focused primarily on the five general areas of placental dysfunction, nutritional deficiency, acetaldehyde (the primary metabolite of alcohol) toxicity, the role of prostaglandins (Randall et al., 1989; U.S. Department of Health and Human Services, 1990) and fetal hypoxia. Each of these has been observed or suggested as an etiological factor, but inconsistencies in the research results make a single mechanism unlikely. For example, placental dysfunction may have a role in fetal outcome but is unlikely to be the sole cause of pathophysiology, since incubated embryo exposed to alcohol also have been found to be affected (Pennington et al., 1983).
Maternal nutritional deficiency, often observed amongst alcoholics, has been studied as a possible mechanism or competing cause. The research in this area has been inconclusive, since the administration of supplements has been found to improve pregnancy outcomes in some studies but not in others (Weinberg, 1985; Rush et al., 1980; U.S. Department of Health and Human Services, NIAAA, 1990). With respect to the role of prostaglandins in alcohol teratogenesis, studies have shown a reduction in alcohol-induced fetal malformations by using a prostaglandin synthesis inhibitor (such as aspirin), but the inhibitor has not completely blocked the effects. Each of these mechanisms has been observed, although none appears to be the sole causal mechanism, so it is possible that either collectively they play a role, or that each manifests different features or outcomes.

2.2.1 Physical and health effects

As noted above, alcohol has been documented as a teratogen with characteristic physical anomalies of heavy exposure being growth retardation and facial dysmorphia and often major organ damage. Longitudinal studies have shown that the craniofacial dysmorphology may not be obvious in the newborn and the most severe of these characteristics are reduced as the child grows (Spohr, 1996). Most studies describing children with FAS are case studies of offspring of alcoholic mothers, including binge drinkers (Abel, 1998b; Armstrong, 1998).

Moderate use of alcohol during pregnancy has not been associated with the same physical outcomes. A meta-analysis (Polygenis et al., 1998) was completed in an attempt to determine whether first trimester moderate alcohol consumption was associated with fetal malformations.
Birth outcomes were compared between those exposed to moderate drinking levels (defined in that analysis as ≥2 drinks a week) and the offspring of abstainers (defined as less than 2 drinks a week). Although 24 studies met the inclusion criteria, only 7 had data that were extractable. Moderate alcohol consumption during the first trimester was not found to increase the risk of fetal malformations (Polygenis et al., 1998).

Few systematic studies have attempted to examine the extent of physical damage associated with moderate levels of drinking, at least beyond neonatal stages, except for studies examining the long-term effects on physical size. Results of studies on size at birth have been inconsistent, with some studies finding a statistically significant association between prenatal alcohol consumption and growth deficiencies (Plant, 1985; Barr et al., 1984) and others not observing such an association (Forrest et al., 1991; Larsson et al., 1985). Abel and Hannigan (1995b) re-analyzed the results of a prospective study and found a J-shaped relationship between alcohol use and birth weight. Mothers who abstained had smaller babies than those who were light drinkers, but the mothers who drank most heavily had children with the lowest mean birth weights. Lundsberg, Bracken and Saftlas (1997) argued that birth weight, being a mix of preterm birth and retarded growth, has been an inadequate outcome measure because low to moderate alcohol use may increase the risk of preterm delivery in spite of its apparent lack of association with low birth weight.

Results have been inconclusive with respect to long-term physical growth of young children who had been prenatally exposed to alcohol. Heavy alcohol intake has been associated with slower
growth (height or birth weight) pre- and postnatally. Swedish researchers (Aronson & Hagberg, 1998; Aronson et al., 1985; Kyllerman et al., 1985, 1983) found continued growth deficiency among children whose mothers were alcoholic during pregnancy, with children with FAS at age 5 years being leaner and shorter with no catch-up growth indicated. Coles et al. (1991) found that when those subjects with dysmorphia were removed from the sample, the growth deficits in others prenatally exposed to alcohol were not statistically significantly different than those not prenatally exposed. The Seattle studies found that children diagnosed with FAS, and who were dysmorphic, continued to be growth deficient (Streissguth et al., 1985a) and that moderate alcohol exposure was related to growth deficiency initially but diminished with age during the infancy period (Barr et al., 1984). In the Seattle longitudinal study of children not diagnosed with FAS, physical size at age 7.5 years was not found to be associated with prenatal alcohol exposure (Sampson et al., 1994; Streissguth et al., 1990). This was consistent with the finding of a longitudinal study in Ottawa, in which children prenatally exposed to two drinks per day caught up in size at 12 or 24 months, in spite of being small-for-age earlier (Fried & O’Connell, 1987). Both the Seattle study and the Ottawa study had samples of predominately middle class mothers. In a comprehensive study with respect to size or growth of young children, Greene et al. (1991b) found that weight and height at birth were inversely related to drinking during pregnancy. Self-reports of 2 or more drinks per week throughout pregnancy were found to decrease birth weight by 76 grams. A small but statistically significant association with length was found for the same consumption level only during the first trimester. As the children aged, some catch-up in weight and height was observed. Because their results differed according to whether alcohol use was measured using a screening tool or by pre- or post-natal recall of alcohol use, the researchers summarized their
findings as being “inconclusive” (Greene et al., 1991b, p. 911). These findings were inconsistent with studies in Pittsburgh (Day et al., 1999, 1993, 1991), Buffalo (Russell et al., 1991) and France (Larroque & Kaminski, 1998) that found prenatal alcohol exposure to have significant negative effects on height at preschool or school ages.

Discriminating between dysmorphic and non-dysmorphic children may clarify the results. It appears that those studies that included children born dysmorphic showed that these children continued to be small for age throughout childhood, while the results for studies that included non-dysmorphic children did not show continued growth deficiency by school-age. In addition, differences in characteristics of the sample and in the timing of the alcohol use may explain at least some of the inconsistency (Day et al., 1999). In particular, Day et al. (1993) noted that persistent growth deficits have been found in low income populations, whereas those samples with more socially and economically advantaged subjects found that their cohorts had caught up in growth over time. Barrison and Wright (1984) found that the interactive effects of moderate prenatal alcohol use, particularly around the time of conception, and prenatal tobacco use and lower social class background, influenced low birth weight.

Besides physical growth retardation, other physical effects have been studied for their associations with prenatal alcohol exposure. Visual and auditory impairments have been so commonly observed in children with FAS or FAE that it has been suggested that ophthalmological and auditory examinations be routinely given for those who have been diagnosed with FAS (Abel, 1998b; Stromland, 1985). Children with FAS have often required corrective lenses, usually
resulting from abnormal curvature of the lens (Abel, 1998b). At least three types of hearing loss have been associated with children with FAS (Abel, 1998b), including conductive (resulting from middle ear problems and occurring in more than 75% of children with FAS), sensorineural (resulting from auditory nerve damage and found in ≈28% of children with FAS) and central hearing loss, found frequently in children with FAS (Church et al., 1997b). The incidence of central hearing dysfunction is unknown, but Church et al. (1997b) found in a study of 12 children with FAS, all showed clinically significant central hearing impairments.

No research literature was found regarding the general health status of elementary school-aged children who were prenatally exposed to alcohol. Many specific health problems have been described in the case study reports of children with FAS or FAE. For example, Johnson et al. (1981) observed an increased incidence of life-threatening bacterial infections as well as a propensity for minor infections in their review of 13 documented cases of FAS. Five of 13 patients had at least one episode of pneumonia, two had meningitis and one had sepsis. Following a comprehensive immunologic evaluation of the children with FAS and comparing the results with an age-matched control group of children with intrauterine growth retardation without FAS, it was suggested by the researchers that an impairment of the immune system may explain an increased susceptibility to infection.

Vorhees (1986) hypothesized an ordering of teratogenic outcomes related to alcohol, with dysmorphological anomalies being the most sensitive to exposure, followed by birth weight and lastly cognitive outcomes. It has been suggested that behaviour may be more sensitive than
physical features as an indicator of prenatal alcohol exposure (Mattson & Riley, 1998; Landesman-Dwyer et al, 1981; Shaywitz et al., 1980). Two of the longest longitudinal studies have been conducted in Seattle and after many years of research on children with FAS or FAE as well as those moderately affected by prenatal alcohol exposure, the researchers concluded that neither physical growth nor facial morphology were as sensitive markers as the broad range of neurobehavioural outcomes (Streissguth et al., 1994a). Timing and dose of alcohol intake also have been found to be important, with some critical periods important to the development of different organs.

2.2.2 Cognitive and behavioural effects of children prenatally exposed to alcohol

Both cognitive development and behavioural problems of children prenatally exposed to alcohol have been well documented in the research literature over the past 30 years. Although many researchers have described learning problems and behavioural effects in the same studies, these two outcomes are treated separately in this literature review. The studies cited in this section are listed in Table 2.1, pages 44-48.

2.2.2.i Cognitive development, academic abilities or learning problems

The research literature consistently describes associations between FAS and lower I.Q. scores. Studies describing small cohorts of children with FAS have consistently included language acquisition and expressive and receptive language deficits among the cognitive developmental problems. As noted above, various types of hearing loss can result from prenatal alcohol exposure. Hearing loss in preschool and school-aged children could adversely affect language,
speech and intellectual development and cause distractibility and hyperactivity (Church et al., 1997b).

The Seattle longitudinal study that followed children with FAS found that the degree of intellectual impairment and the severity of the mother's alcoholism were correlated. At follow-up, home environment was not found as a mediating factor, as the intellectual impairment was sustained regardless of home conditions (Streissguth et al., 1985a). Testing at later ages and comparing with non-alcohol-exposed and minimally alcohol-exposed adolescents with similar I.Q. scores showed that those with FAS had more difficulties in processing speed and accuracy, declarative learning and cognitive flexibility and planning (Carmichael Olson et al., 1998).

A German longitudinal study (Spohr, 1996; Steinhausen, 1996; Spohr and Steinhausen, 1996, 1987, 1984; Steinhausen et al., 1994, 1993; Spohr et al., 1993) tested children (n=68) at preschool ages, early school age (6-12 years) and at late school age (≥13 years) using a battery of psychiatric, behavioural and psychological assessments and intelligence tests including the Wechsler Intelligence Scale for Children-Revised (WISC-R). They found that early school-aged children severely affected by prenatal alcohol exposure were all well below normal on intelligence tests with a large proportion of the sample classified as being mentally retarded. These effects persisted over time, in contrast to dysmorphia, that reduced over time. At the latest testing (ages 12-14 years), 17 of the children attended specialized schools and the majority of children had difficulties in mathematics, logical conclusions, visual perception, spatial relations and short-term memory.
A Swedish study followed 21 children born to alcoholic mothers, from birth to age 14 years, comparing them to controls matched by age, sex, birth weight, gestational age and living area (Aronson & Hagberg, 1998; Aronson et al., 1985; Kyllerman et al., 1985; Olegard et al., 1979). Ten of the 21 children had FAS characteristics. Children with the characteristics of FAS had statistically significantly lower I.Q. scores, as measured on the WISC-R, than either the controls or those in the study group without signs of FAS. There was no significant difference in I.Q. scores between those reared in foster parents’ homes and in biological parents’ homes.

These three longitudinal studies in Seattle, Germany and Sweden were consistent in their observations of low I.Q. scores amongst children with FAS. In the following cross-sectional studies, specific variables, such as outcomes on memory, or the effects of timing of alcohol exposure according to trimester of exposure, were studied.

Coles et al. (1991) compared the 5-year old offspring of women who continued to drink throughout pregnancy with children whose mothers stopped drinking during the second trimester of pregnancy and with a control group whose mothers never drank during pregnancy. The sample was drawn from a predominantly black urban population. The children of those who continued to drink showed significant deficits in areas of intellectual functioning such as sequential processing (short-term memory and encoding) and mental processing. Using the Kaufman Assessment Battery for Children (K-ABC) for assessment, both prenatally alcohol exposed groups showed deficiencies in pre-math and reading skills, compared to those whose mothers never drank.
Mattson et al. (1996) tested verbal learning and memory by comparing children diagnosed with FAS (n=20) to a control group matched for mental age and to another control group of the same physical age. Assessing the children with the California Verbal Learning Test-Children's Version (CELT-C) to test immediate and delayed recall and recognition memory on verbal tasks, they found that the children with FAS had profound verbal learning and memory deficits in comparison to either control group. Children with FAS learned fewer words indicating difficulty with immediate recall, had more difficulty with delayed recall and made more errors of various kinds in the tasks. They were less able to remember verbal information they had learned, indicating that memory may be more impaired in terms of encoding rather than retrieval. The researchers suggested two possible explanations, that the encoding deficit may be related to attentional or impulsivity factors or that this deficit in encoding, in the absence of deficit in retrieval, is unique to children with FAS.

In studies in San Diego, Mattson et al. (1999, 1998, 1997; Mattson & Riley, 1998) compared three groups of children aged 5 to 16 years, those who had been diagnosed with FAS, those whose mothers were alcoholic during pregnancy but who had not been diagnosed with FAS because of the absence of physical features and matched controls. Both the alcohol-exposed groups showed statistically significantly lower I.Q. scores than the control group both on the overall scores and on the subscales although the non-dysmorphic group had slightly higher scores than those with FAS. It was also observed that the two alcohol-exposed groups were more impaired, relative to the controls, on tests of language, verbal learning and memory, academic skills, fine-motor speed and visual-motor integration. Because of this observed consistent pattern
of these neurological deficits in the two alcohol-exposed groups, the authors concluded that the
degree of deficit existed independent of the physical anomalies of FAS. Compared with the
control group, the alcohol-exposed groups were impaired on some, but not all of the memory
tasks, implying that they were not globally impaired. They showed impairment on verbal fluency
but not on implicit memory tasks (tests of unconscious recall of previously performed tasks).
These results on memory are consistent with two other studies that found a relationship between
prenatal alcohol exposure and deficits in either or both verbal and non-verbal memory (Uecker &

In another cross-sectional study, the neuropsychological performance of 10 preschool-aged
children with FAS in Saskatchewan was compared to that of a control group. The children with
FAS displayed deficits in verbal, performance, language and motor skills, but no deficits were
displayed in visual perception, quantitative or memory skills. The failure to find statistically
significant differences between the control group and the group diagnosed with FAS on both
quantitative skills and on memory skills differs from other studies (Jansen et al., 1995).

In one of the few studies in which various intellectual and neuropsychological tests were
administered to a cohort of British Columbian children, Conry (1990) compared a sample of 19
aboriginal school-aged children diagnosed with FAS or FAE with controls matched for age and
gender. The children, aged 6.4 to 18.5 years, lived in an isolated, economically depressed
community. Scores on intelligence tests were significantly lower for the children with FAS
compared with FAE and with the controls. The children with FAS also had significantly lower
test results on most neuropsychological tests, including reaction time, finger tapping, grip
strength, finger localization and motor speed and precision, while those with FAE showed
significantly lower scores only on grip strength.

These longitudinal and cross-sectional studies and others (for example, Smith & Eckardt, 1991;
Iosub et al., 1981; Majewski, 1981) all observed considerably lower I.Q. scores for children with
FAS and most observed problems with memory and with verbal learning. Some of the studies
observed the same effects for children with FAE. Although all indicated lower scores on the tests
of intelligence, there has been a lack of consistency on the level and areas of deficits and some of
the exposed children tested within the normal range. For example, although the German cohort of
children of alcoholic mothers scored lower than normal, in fact, 24 (34.3%) of the children scored
in the normal range on the I.Q. test, another 34% scored in the borderline range and 31% scored
with varying degrees of mental retardation (Steinhausen, 1996). In his comparison of various
studies of I.Q. scores amongst children diagnosed with FAS, Steinhausen (1996) observed a wide
range amongst the scores of the various cohorts, so that, for example the proportion with below
70 I.Q. scores ranged from 19% to 60% amongst 8 studies. Although mental retardation has
been observed to be one of the most consistent characteristics of FAS, it is not an invariable
outcome, one of the possible reasons being that “none of [the] studies was very rigorous in design
with respect to their criteria for identifying FAS or eliminating other causes” (Abel, 1998b, p.
128). Even the more rigorous studies differ on psychometric tests used for assessment, the
country of the children, living circumstances of children (for example, isolated B.C. community,
foster homes, schools for the mentally retarded) and in the ages at which children were tested,
making general conclusions difficult.

Each of the studies cited above has contributed to the description of characteristics of school-aged children diagnosed with FAS/FAE or who had alcoholic mothers. More recently, researchers have become interested in testing children who were exposed to more moderate levels of alcohol exposure. The results have been inconsistent. One study found improved performance related to pregnancy and pre-pregnancy maternal alcohol consumption (Forrest et al., 1991). Fried et al. (1992b) and Greene et al. (1990, 1991a) found no adverse outcomes on I.Q. assessments when testing 5 to 6 year olds who had been exposed prenatally to moderate amounts of alcohol. Jacobson et al. (1998, 1993a, 1993b; Jacobson & Jacobson, 1994) found a small amount of the variance in infants' I.Q. scores could be explained by prenatal alcohol exposure. Larroque and Kaminski (1998) found lower scores on tests of cognitive development after exposure to at least three drinks per week. These studies are described in more detail below.

The only study that found a positive outcome of alcohol exposure during and prior to pregnancy was completed in Scotland and assessed 18-month old children (n=592). After controlling for confounding factors, it was observed that for full-term babies, those whose mothers drank during pregnancy had better performance scores on the Bayley scale (Forrest et al., 1991). Alcohol consumption did not exceed 100 grams absolute alcohol. This is of interest given the J-shaped relationship that Abel and Hannigan (1995b) found between low birth weight and prenatal alcohol exposure, as noted above.
The Seattle Longitudinal Prospective Study on Alcohol and Pregnancy (Sampson et al., 1989; Smith & Eckardt, 1991; Streissguth, 1994b; Streissguth et al., 1994a, 1994b, 1993, 1990, 1989a, 1989b, 1989c, 1989d, 1986a, 1981) has been one of the enduring studies with repeated follow-up of babies born during a one-year period, 1975-1976. It began with prenatal interviews of pregnant women who were receiving prenatal care at two hospitals. The women (n=1,529), who were predominantly white, married, middle-class women, were interviewed about their use of alcohol, tobacco, caffeine and other drugs. Subsequently, a cohort of approximately 250 heavier drinkers and smokers and 250 non-smokers who abstained during pregnancy or drank infrequently were selected from the original sample for follow-up studies. The high risk group (mothers who drank more heavily and smoked) was over-sampled and the low risk drinking group was stratified by tobacco use. Follow-up assessments of the children were conducted at ages 1, 8 and 18 months and 4, 7 and 14 years. Most relevant to this thesis were the results of the Seattle data collection at age 7.5 years (Streissguth et al., 1994a; Streissguth et al., 1993; Streissguth et al., 1990). Data were collected using a battery of tests, including I.Q. and achievement tests, neuropsychological tests, memory, reaction and attention time, and physical measurement. In addition, both teachers and parents rated health, ability to socialize and other behaviours. Assessing with the Wechsler Intelligence Scale for Children-Revised (WISC-R), it was observed that children exposed to daily alcohol use during the middle trimester had mean I.Q. scores 7 points lower than the controls and that the effect of alcohol was exacerbated by lower father education and by a larger number of children in the family. Binge drinking prior to pregnancy had the greatest influence on academic achievement at age 7.5, compared to binge drinking during pregnancy or with frequent drinking prior to or during pregnancy. Children whose mothers binge drank (≥5
drinks on one occasion) in the month prior to pregnancy had deficiencies in arithmetic and reading, but not spelling, when tested using the WRAT-R. Decrements of scores of 1-3 months in the arithmetic and reading subscale were associated with binge drinking. No statistical evidence of threshold level of prenatal drinking was observed and the effects could not be explained by any of the 150 covariates included in the analyses, including parents' education, maternal smoking or nutrition during pregnancy (Streissguth et al., 1993). At age 11 years, arithmetic scores were the most affected by prenatal heavy alcohol exposure, and the low arithmetic scores did not improve with age as the testing at age 14 showed (Streissguth et al., 1994a, 1994b).

Another U.S.A. study (Jacobson et al., 1998, 1996, 1993a; Jacobson and Jacobson, 1994) examined dose-response effects of prenatal alcohol exposure, since the results of previous studies had been inconsistent. African-American pregnant women attending prenatal clinics in inner-city Detroit were recruited between 1986 and 1989. The researchers included an over-representation of those drinking at moderate to heavy levels. Prenatal exposure to binge drinking (≥5 drinks per occasion on an average of at least once per week) more than doubled the risk of obtaining low scores on cognitive development assessments at ages 6.5, 12 and 13 months. The researchers observed a dose-response relationship for prenatal alcohol exposure when testing at 13 months on the Bayley MDI scale for prenatal alcohol exposure, but did not find a dose-response relationship with scores on the Psychomotor Development Index (Jacobson et al., 1993a). Below the threshold level of 4 drinks per day, little effect of prenatal alcohol exposure was observed. The researchers controlled for numerous demographic, and prenatal, neonatal and postnatal variables (including use of tobacco, marijuana and other drugs during pregnancy) and concluded that: “As
with previous studies, after control for potential confounders, only 1 to 2% of the variance in infant outcome was uniquely attributable to prenatal alcohol exposure” (Jacobson et al., 1993a, p. 182). When the analyses were performed for a higher risk group (offspring of women over 30 years and higher alcohol exposure), prenatal exposure explained up to 7% of the variance in developmental outcome. Further analyses were conducted taking into account outliers and potential problems with summary measures (for example, one mother drank daily while the majority drank no more than two times per week). They observed functionally significant deficits in cognitive development in children diagnosed with FAS as well as in the offspring whose mothers drank intermittently but heavily.

The results of that Detroit study were consistent with those of a Pittsburgh study (Russell et al., 1991), although testing was completed at 6 years of age for the latter research. Children (n=175) whose mothers had more than one indication of problem drinking were compared with children whose mothers reported fewer indications of problem drinking on a questionnaire self-administered during pregnancy. Statistically significant lower scores on tests of verbal and language scales (measured by Wechsler Preschool and Primary Scale of Intelligence and the Token Test) were observed amongst those whose mothers had more indications of problem drinking, although no relationship was observed between prenatal alcohol exposure and performance on a psychomotor test.

The only Canadian longitudinal study found in the literature is the Ottawa Prenatal Prospective Study (OPPS) that began in 1978 and includes women (n=250) who volunteered to participate
after media solicitation (Fried et al., 1999, 1997, 1992a, 1992b; McCartney et al., 1994; Makin et al., 1991; Fried, 1989a; Kristjansson et al., 1989; Fried & Makin, 1987; Fried & O'Connell, 1987). The researchers observed the children of predominately middle-class, low risk women who were prenatally exposed to alcohol, cigarettes and marijuana. The cohort was assessed repeatedly from ages 1 to 12 years. At ages 2 and 3 years of age, decreased language comprehension was observed, but at ages 5 to 6 years, there were no statistically significant differences in general cognitive development or language between the moderately exposed children and those not exposed. The OPPS researchers suggested that their failure to confirm a relationship between prenatal alcohol exposure and cognitive outcomes at the later ages may be because their sample had relatively lower levels of consumption compared to other studies. Women averaged less than one drink a day with only four of their subjects drinking more than 3 drinks per day.

A study of the children of Cleveland women who drank moderately during pregnancy had similar results to the OPPS study, although the backgrounds of the populations of the two studies differed considerably (Greene et al., 1991a, 1990; Sokol et al., 1981). The Cleveland women (n=359) were disadvantaged socioeconomically and were recruited over a 33-month period when presenting at a general Cleveland hospital. Their offspring were tested at various ages (6 months, 1, 2, 3 years and 4 years 10 months) using age-appropriate assessment tools to measure cognitive development, including the Bayley Scale, Stanford-Binet Intelligence Scale and the Wechsler WPPSI. The researchers used several indices to measure maternal alcohol use, assessed the children at five separate times and applied multiple analyses, but were unable to find an inverse
relationship between prenatal exposure and cognitive development tests when the only child with FAS was removed from the analyses. Prenatal exposure to moderate alcohol use was not found to have a statistically significant relationship with lower language scores or with general cognitive measures, and they found no evidence of adverse effects on cognitive development in the absence of fetal alcohol syndrome. Interesting, they did find a significant relationship between prenatal alcohol use and birth weight, supporting Vorhees' (1986) hypothesis, noted above, that the ordering of teratogenic responses to alcohol means that birth weight is a more sensitive outcome than cognitive development. They concluded that home environment, even within a predominantly disadvantaged cohort, was more predictive of lower cognitive development scores than either prenatal alcohol or tobacco exposure (Greene et al., 1991a).

Another attempt to study the effects of moderate prenatal alcohol exposure was conducted with 4½ year olds in France. Prenatal exposure of three drinks per week (1.5 oz. of absolute alcohol) was significantly related to lower scores on the McCarthy scales of cognitive development, after controlling for potentially confounding variables (Larroque & Kaminski, 1998).

The French results were consistent with the Seattle study but inconsistent with the Ottawa and Cleveland longitudinal studies cited above where children were tested at preschool or early school age with respect to the relationship between exposure and cognitive development. The number of heavy drinkers in the Seattle and French studies and rates of attrition at follow-up may have contributed to inconsistency among the four studies. In summary, rates of consumption of ≥1.5 oz. or more of absolute alcohol per day have been found to be associated with general cognitive
function amongst infants and young children (Larroque & Kaminski, 1998; Jacobson et al., 1996, 1993a, 1993b; Jacobson & Jacobson, 1994). Below an exposure level of 1.5 oz. per day, two studies found no adverse outcomes with respect to cognitive development (Greene et al., 1991a; Fried & Watkinson, 1990) while the Seattle study observed adverse outcomes (Streissguth et al., 1989a, 1998b).

Goldschmidt et al. (1996) observed a dose-response relationship between prenatal alcohol exposure and academic abilities in one of the few prospective, longitudinal studies examining differences in children whose mothers drank at varying levels during pregnancy. There was a continuum of alcohol use among the mothers (n=595), although most were light or moderate drinkers. All were from lower-socioeconomic backgrounds and were high school educated. At the average age of 6.5 years, the academic abilities of children who were exposed to alcohol during the second trimester of pregnancy were tested, using the Wide Range Achievement Test-Revised (WRAT-R) to assess arithmetic, reading and spelling skills. After controlling for I.Q. scores, significant deficits in achievement were predicted by prenatal alcohol exposure. The results showed a dose-related relationship for the arithmetic subtest, and in contrast, a threshold effect for the relationship between alcohol exposure at the second trimester and reading and spelling achievements. The threshold occurred at ~1 drink per day in the second trimester. This study brought new observations regarding the effects of prenatal alcohol exposure on academic abilities, perhaps explaining the inconsistency with previous observations in studies that either grouped varying levels of exposure or were not specific in differentiating the type of effect according to academic subject.
To summarize, a number of longitudinal studies in U.S.A. cities and in Sweden, West Germany and Ottawa, as well as cross-sectional studies have been conducted to examine associations between prenatal alcohol exposure and general cognitive development or specific learning deficits. Most of these studies (e.g., in Germany, Seattle, Sweden and San Diego) found that children diagnosed with FAS have statistically significantly lower I.Q. scores than others prenatally exposed to alcohol but without the FAS diagnosis and than those not exposed to alcohol. Studies have shown that even some of children diagnosed with FAS have I.Q. scores within the normal range.

Many studies have observed that children heavily exposed to alcohol have deficits in memory (Mattson et al. 1999, 1998, 1997; Mattson & Riley, 1998; Mattson 1996; Spohr & Steinhausen, 1996, 1987, 1984; Spohr et al. 1993; Smith & Eckardt, 1991; Coles et al., 1991; Iosub et al., 1981; Majewski, 1981). In contrast, one study (Jansen et al., 1995) found no deficit on memory skills. Children heavily exposed to alcohol have been observed to have deficits in specific abilities, including reading abilities (Goldschmidt et al., 1996; Coles et al., 1991), math or arithmetic (Goldschmidt et al., 1996; Kopera-Frye et al., 1996; Spohr & Steinhausen, 1996, 1987, 1984; Spohr et al. 1993; Coles et al., 1991; Streissguth et al., 1990), verbal learning (Mattson, et al. 1999, 1998, 1997; Mattson & Riley, 1998; Goldschmidt et al., 1996; Uecker & Nadel, 1996, Streissguth et al., 1994, 1998; Russell et al., 1991) and reading skills (Goldschmidt et al., 1996; Coles et al., 1991).

Two studies identified the impact of binge drinking on I.Q. scores or cognitive development.
assessments (Jacobson et al., 1998, 1996, 1993a, Jacobson & Jacobson, 1994; Streissguth et al., 1990) including binge drinking that occurred just prior to pregnancy (Streissguth et al., 1990).

Studies examining children exposed to moderate alcohol use differ in that two of the three published studies found no adverse outcomes. The Cleveland longitudinal study (Greene et al., 1991a, 1990) drew its sample from a socially disadvantaged U.S. urban setting and the Ottawa longitudinal study drew its sample from a middle class Canadian sample (Fried et al., 1999, 1997, 1992a, 1992b; McCartney et al., 1994; Makin et al., 1991; Fried, 1989a; Kristjansson et al., 1989; Fried & Makin, 1987; Fried & O'Connell, 1987), but neither was able to find statistically significant differences between those exposed to moderate alcohol use those not exposed groups in general cognitive development or language skills. The results of the Seattle study, that had a sample similar to the Ottawa sample, found statistically significant associations between moderate alcohol exposure and test results of cognitive development.

Methodological issues, levels of alcohol exposure, or differences in populations that have not been controlled may contribute to the inconsistency of results. Children of alcoholics, heavy drinkers (that is, more than three drinks per day) and binge drinkers are more likely to have lower scores on assessments of academic abilities. Children prenatally exposed to light or moderate drinking are more likely than those prenatally exposed to heavy drinking to have test scores similar to those of children not exposed.
2.2.2.2 Behavioural effects of prenatal alcohol exposure

In spite of nearly 30 years passing since FAS was first described, we have had to rely, for the most part, on descriptive and case studies for our understanding of human behaviour related to FAS (Abel, 1998b; Armstrong, 1998). Many of the longitudinal studies cited above that followed children from the neonatal stage through to school age attempted to describe both learning difficulties and behavioural problems. As with the review above on learning abilities or cognitive development, the studies are divided for the purposes of this review according to those focussing on children with FAS or FAE and those focussing on behavioural problems of people prenatally exposed to any amounts of alcohol. The most frequently reported, and specifically studied, behavioural characteristics of young children with FAS and FAE are attention deficits, hyperactivity and impulsivity (Abel, 1998b), cited as the "hallmark features of prenatal alcohol syndrome" (Mattson & Riley, 1998, p. 287).

Results have been inconsistent from studies of infants tested for irritability, hypersensitivity or poor habituation, in spite of the use of the same neonatal assessment tool (Brazelton Neonatal Behavioral Assessment Scale) being used. Abel (1998b) reviewed the research literature on neonatal behavioural outcomes, finding eight studies, of which most found no statistically significant effect of prenatal alcohol exposure on any of these three outcomes. Of the eight studies, only one study observed an effect on habituation (Streissguth et al., 1983), two studies observed an effect on lower arousal (Jacobson et al., 1984; Streissguth et al., 1983) and two studies observed an effect on orientation (Richardson et al., 1989; Coles et al., 1985). Measurement problems may have been the basis of the inconsistencies. In particular,
measurement of behavioural outcomes have often relied on subjective observations and the measurement of timing, duration and quantity of alcohol consumption has relied on self-reports since no biological markers exist (Abel, 1998b). Only some of these measurement problems are overcome in testing older children for behavioural problems, since more sensitive testing procedures are available for older children and other measures of alcohol consumption have been used in a limited number of studies.

Assessments of children beyond neonatal age are more relevant to the present thesis. The literature found to be consistent with respect to observing attention deficits or hyperactivity for children diagnosed with FAS, but inconsistent with respect to those effects in children without the characteristics of FAS but who were prenatally exposed to alcohol. Longitudinal studies were conducted by researchers in Germany, Sweden, Ottawa and various U.S. cities, including Atlanta, Cleveland, Detroit, Seattle and Pittsburgh. Cross-sectional studies also were conducted comparing children with FAS to other groups to determine differences in attentional deficits.

In a Seattle longitudinal study, in which 92 people diagnosed with FAS were assessed, it was observed that by preschool age behavioural problems included hyperactivity, inattentiveness and impulsivity. Over half (58%) of the subjects were classified as having maladaptive behaviour. Using the Vineland Adaptive Behavior Scales, specific behaviours found to be prevalent amongst the subjects included poor concentration and attention (77%), social withdrawal (62%), impulsivity (57%), dependency (53%), teasing/bullying (53%), having periods of high anxiety (51%), and stubbornness or sullenness (50%) (Streissguth et al., 1989c).
The German longitudinal study described above (Steinhausen, 1996; Steinhausen et al., 1994, 1993; Spohr et al., 1993; Spohr & Steinhausen, 1987, 1984) described above has followed people with FAS or FAE (n=158) in the former West Germany since 1977, testing preschool, early school-aged (6-12 years) and late school-aged (≥13 years) children using behavioural assessments (Child Behavior Checklist), psychological examinations (Columbia Mental Maturity Scale) and psychiatric assessments. Subjects entered the study at various ages from newborn to age 11.5 years. The early school-aged children diagnosed with FAS showed hyperkinetic disorders on psychiatric testing and attention deficit and social problems according to the parents’ and teachers’ ratings. Hyperkinetic disorder was the most frequently diagnosed problem, persisting throughout the various assessments at different ages, leading the researchers to conclude that “hyperactivity and distractibility seem to be the major handicap for a normal school career of these children” (Spohr & Steinhausen, 1987, p. 13).

The results of Swedish researchers who followed a cohort of 24 children of alcoholic mothers were consistent with the Seattle and German longitudinal studies. Young children, regardless of whether they had physical characteristics of FAS, were observed to have attention deficits and hyperactivity (Aronson et al., 1985; Kyllerman et al., 1985, 1983). Follow-up assessments at ages 12-14 years showed that the children continued to have difficulties with attention (Aronson & Hagberg, 1998).

The results of the Atlanta longitudinal study differed from the Swedish, Seattle and German studies, described above, in that attentional problems but not hyperactivity were observed. In the
Atlanta longitudinal study (Brown et al., 1991; Coles et al., 1991) three groups of offspring were compared; those whose mothers drank throughout pregnancy (n=25), those whose mothers stopped drinking during the second trimester (n=22) and those whose mothers did not drink alcohol during pregnancy (n=21). All women were African-American and of low socioeconomic status. No differences in impulsivity or hyperactivity were observed, but those whose mothers drank throughout pregnancy showed less ability in sustaining attention, and were more often described by their teachers (although not their parents) as showing behavioural problems and difficulties because of inattention.

In a later study by Coles et al. (1997), children (n=149) with attention deficit hyperactivity disorder (ADHD) were compared with three groups; children diagnosed with FAS, children who were prenatally exposed to alcohol but who did not have dysmorphic characteristics and a control group of children not exposed to alcohol prenatally. The mean age was 7.6 years and all were African-American and of low socioeconomic status. As well as testing intellectual abilities, the children's behaviour was assessed both with conventional instruments, such as the SNAP and the Child Behaviour Checklist (both parent and teacher versions), and a more specific measure of neurocognitive functioning reflecting a four-factor model (focus, sustain, encode and shift) of attention developed by A.F. Mirsky. Coles et al. (1997) found differences between the two alcohol-exposed groups and children with ADHD. Children with ADHD performed more poorly on the conventional assessments of attentional problems and conduct disorder than the two alcohol-exposed groups, in spite of the three groups being equally impaired intellectually. The researchers were able to distinguish behavioural differences and, in particular, in the patterns of
inattention between the alcohol-exposed groups and the children with ADHD. Children with ADHD were best identified by their inability to focus and sustain attention, while those with FAS were identified by difficulties with visual/spatial skills and flexibility in problem-solving. The study's design could be distinguished from many others in this area since it was not based on case reports, nor was its sample drawn from people referred for psychiatric assessment. Children in this longitudinal study were living with birth or adoptive mothers or other relatives, had all been selected from the same teaching hospital, and had been selected for a study of prenatal alcohol exposure or when they were diagnosed as having ADHD.

The results of Coles et al. (1997) were inconsistent with those of Nanson and Hiscock (1990) who studied attentional problems, comparing three groups, children diagnosed with FAS/FAE (n=20), those diagnosed with attention deficit hyperactivity disorder (ADHD) and an equal number of controls (not ADHD and not exposed to alcohol). Most of the subjects were aboriginal and all lived in Saskatchewan. Parents' rating scales (Connors Abbreviated Parent Teacher Questionnaire, the SNAP and the Child Behaviour Checklist) and assessment instruments (WPPSI or WISC-R short form) were used. The results indicated that the children with FAS/FAE were similar with respect to attention deficits and social behaviour to those with ADHD, although those with FAS/FAE were considerably more impaired intellectually.

In an early study of 15 children, the school records of children aged 6.5 to 18.5 years who had been heavily exposed to alcohol during pregnancy were examined (Shaywitz et al., 1980). It was found that for all but one of the subjects, hyperactivity was noted and all but two had been
referred for special education by the time they were in first grade, with the other two being referred by third grade.

All the above studies focused on samples of children with FAS or FAE. Studies were also found that examined the behavioural outcomes resulting from a range of prenatal alcohol exposure levels.

In the Seattle longitudinal study (Sampson et al., 1989; Streissguth et al., 1989a, 1998b), described above, it was found that classroom behaviours and abilities most negatively associated with prenatal alcohol exposure were cooperation, impulsivity, retention of information, paying attention, finishing tasks, relating experiences and formulating ideas. The covariate that attenuated the correlation but did not fully explain the variance was paternal education. Several other covariates were included in the model, such as maternal tobacco and caffeine use, nutrition, maternal education and birth order (Sampson et al., 1989; Streissguth 1989a, 1989b, 1989d). Compared to the control group, overall activity was not significantly associated with prenatal alcohol exposure, indicating that hyperactivity did not contribute to the attentional deficits. The results were similar at two assessment ages, 4 and 7.5 years (Streissguth et al., 1986a; Streissguth et al., 1984). At age 11 years, hyperactivity and attentional problems were observed amongst those who had been prenatally exposed to binge drinking (Carmichael Olson et al., 1992) and attentional problems were observed again at age 14 years. Two-thirds of the sample who had poor performance on vigilance tests at age 14 years had previously been rated below average on attention by their teachers, compared to 26% of the remainder of the sample, leading the authors
to conclude that neurobehavioural “alcohol effects are not attenuating with age” (Streissguth et al., 1994a, p. 96).

Using the same cohort, Landesman-Dwyer et al. (1981) attempted to distinguish between the effects of alcohol and tobacco exposure by categorizing the mothers into four groups according to whether they used tobacco/alcohol, used tobacco/not alcohol, used alcohol/not tobacco and used neither tobacco nor alcohol. They categorized alcohol use into three groups, moderate, occasional and non-drinking, and tobacco use dichotomously (smoked or did not smoke). None of the women was alcoholic or an alcohol abuser. They tested children for attention span, activity level, fidgetiness and social compliance during naturalistic home setting observations. Consistent with the findings of Streissguth et al. (1994b, 1986a, 1984), described above, researchers observed the offspring of moderate drinkers, defined as mean 0.45 oz. absolute alcohol per day, to be less attentive, less compliant to parents' commands and more fidgety during mealtimes than either the non-drinking group or the occasional drinking group.

The results of these Seattle studies are inconsistent with three longitudinal studies in Ottawa, Cleveland and Pittsburgh. In a sample reasonably similar to the Seattle study, that is middle-class predominately Caucasian women, the Ottawa longitudinal study found no relationship between prenatal alcohol use and attention in a study of children repeatedly assessed at ages newborn to 12 years (Fried et al., 1998, 1997, 1992; Fried & Watkinson, 1990; Fried & Makin, 1987). In a distinctly different sample of children of predominately black, disadvantaged women in Cleveland, the results were similar in finding no association between prenatal alcohol exposure and sustained
attention, as measured by a vigilance task, leading the researchers to conclude that “if there is an
effect of prenatal alcohol exposure on vigilance task performance in young children, that effect is
small” (Boyd et al., 1991, p.55). The Pittsburgh study sample (Leech et al., 1999) was similar to
the Cleveland study sample, with half the population being African-American and all from
socioeconomically disadvantaged backgrounds. At age 6 years, they found no statistically
significant difference between the alcohol exposed and non-exposed groups with respect to
attentional processes. Interesting, lower I.Q. scores (as measured by the Stanford-Binet scale),
male gender and adult male in the household predicted more errors of commission, indicating
impulsivity, while lower I.Q. scores, younger child age, maternal work or school status and higher
maternal hostility predicted more omission errors indicating inattentiveness. Unfortunately for
purposes of comparisons, these factors have not been measured or independently assessed in all
other studies examining prenatal alcohol exposure. As described earlier, the Ottawa and
Cleveland longitudinal studies also differed in results from the Seattle study with respect to
cognitive development and academic achievement.

Apart from the longitudinal studies, or the studies particularly focused on attentional problems,
hyperactivity or distractibility, there are two cross-sectional studies worth noting briefly because
of their contribution to the study of psychosocial problems of children prenatally exposed to
alcohol. Both studies focused on people with FAS or FAE or who had been exposed to heavy
heavy alcohol use. Roebuck, Mattson and Riley (1999) compared 32 children heavily exposed to
alcohol (including 19 diagnosed with FAS) with controls matched for age, gender and ethnicity in
an effort to understand psychosocial functioning of children with and without the diagnostic
features of FAS. Both the children with FAS and those heavily exposed to alcohol but without the physical features of FAS were observed to be impaired in psychosocial functioning.

Finally, the first study to determine the prevalence of youth with FAS in the criminal justice system was completed recently in British Columbia (Fast et al., 1999). After assessing all youth who had been remanded for a forensic psychiatric or psychological assessment, it was observed that 23% had an alcohol-related diagnosis, with 1% diagnosed with FAS and 22% diagnosed with FAE. Since this represented a disproportionately large number within the British Columbia juvenile justice system, the researchers suggested that the learning and behavioural problems associated with FAS and FAE may increase youth's susceptibility to criminal behaviour. It could also be suggested that learning or behavioural problems may increase the susceptibility to being apprehended or charged with criminal offenses.

2.2.3 Summary and discussion of prenatal alcohol exposure research

Research over the past 30 years has repeatedly used case studies to describe the physiological, behavioural and learning problems associated with FAS. The outcomes for children with FAS are devastating with respect to health, cognitive development and behavioral problems. Case studies, longitudinal research and animal studies have established alcohol as a teratogen. Many studies of children with FAS have very small samples. For studies not describing FAS specifically, but rather the long-term effects of any dose of prenatal alcohol exposure, the varied methods of assessing alcohol consumption have rendered it difficult to conduct a meta-analysis in which data could be combined (Forrest et al., 1992), although one meta-analysis has been attempted
regarding physical malformations (Polygenis et al., 1998).

The scientific knowledge regarding the outcomes of exposure to varying doses of alcohol, with different patterns of use and at different times during pregnancy, is developing but could not be regarded as conclusive. It appears from the research on physical outcomes of moderate prenatal alcohol exposure, at least in studies of children who were not dysmorphicologically affected, that if the children were disadvantaged by growth retardation, catch-up occurred by school age.

Central nervous system damage is one of the elements of FAS, including sustained damage, as observed in longitudinal studies that have been conducted in Germany, Sweden, Seattle and Pittsburgh. Pertinent to the present study was the research literature on the behavioural and learning problems found in children, other than those diagnosed with FAS or FAE. Another Seattle longitudinal study, as well as longitudinal studies in other U.S. cities and in Ottawa, have provided data from larger samples on moderate alcohol exposure during pregnancy. These studies have also provided comparisons between exposed and non-exposed groups within the same cohort and comparisons between alcohol exposed groups and groups of children with other diagnoses such as Attention Deficit Hyperactivity Disorder.

Attention deficit, hyperactivity and impulsivity have been the most often described behavioural characteristics of children with FAS or FAE in the case study reports. This led two research teams (Coles et al., 1997, 1991; Nanson & Hiscock, 1990) to conduct comparative studies on children with ADHD and with FAS. Since the results were not entirely consistent, more work is
needed on this topic.

Most of the studies observed no relationship between behavioural problems and moderate prenatal alcohol use, including longitudinal studies in Ottawa (Fried et al., 1992a, 1992b; Fried & Watkinson, 1990; Fried & Makin, 1987), in Pittsburgh (Leech et al., 1999), in Cleveland (Greene et al., 1991a, 1990; Boyd et al., 1991) and in Detroit (Russell et al., 1991). Comparing these results with those of attentional problems, impulsivity or hyperactivity may suggest the existence of a threshold effect. Indeed, this was observed in a study of infants under 1 year of age in Detroit wherein scores on tests of psychomotor development were lower after exposure to 4 drinks per day. The results of these studies are inconsistent with those of two research teams (Streissguth et al., 1994b, 1993, 1989a, 1998b, 1986a, 1981; and Landesman-Dwyer et al., 1981) who studied children from the Seattle cohort, one using standardized assessment instruments and the other using observational methods. These Seattle studies both observed deficits in distractibility, restlessness, lack of persistence and attentional problems, with one of the studies (Streissguth et al., 1994a, 1994b) showing these characteristics persisting until at least age 14 years.

With respect to intellectual development or learning problems, the same pattern of research results holds. The case-study reports of children with FAS or FAE described low I.Q. scores, although the range was large, so that some children with FAS or FAE came within normal range on intelligence tests. For those not diagnosed with FAS or FAE, the results of studies of preschool and school-age children were inconsistent. The Cleveland study (Greene et al., 1990, 1991a)
showed no relationship between abilities and exposure, concluding that the confounder of home environment was more predictive of low test scores than was prenatal alcohol exposure. Deficits in abilities in mathematics or arithmetic were observed in studies in Atlanta (Coles et al., 1991), San Diego (Mattson et al., 1999; Mattson et al., 1997; Mattson et al., 1996), Seattle (Streissguth et al., 1989a, 1989b) and Pittsburgh (Goldschmidt et al., 1996). The latter study specifically studied the relationships between abilities and exposure, finding a linear dose-related relationship between low arithmetic scores and prenatal alcohol exposure. Similarly, deficits in language abilities (including spelling and reading) were found in studies in Atlanta, Ottawa (at age 2-3 years), San Diego, Pittsburgh and Seattle. Not all studies found these deficits in mathematical or language skills. Re-assessment or more precise testing is needed before conclusions can be drawn. For example, the Ottawa study found that there were deficits in arithmetic scores at ages 2-3 years, but that these deficits no longer existed at re-assessment at ages 5-6 years. Either the earlier assessment was insufficient or, as in the case of physical growth retardation, the children caught up after initial deficits. More precise examination of results led researchers in the Pittsburgh study to find threshold effects on spelling and reading scores, contrasting with the linear effect found on arithmetic scores (Goldschmidt et al., 1996).

The studies of prenatal exposure to alcohol, as reflected from following children with FAS, indentify adverse effects on cognitive abilities, although many children with normal I.Q. scores have been documented. As Forrest et al. (1992) noted after reviewing the literature, the evidence regarding any adverse effects of moderate levels of prenatal alcohol consumption, beyond the neonatal stage is unconvincing. They suggested that the lowest potential threshold level for
prenatal alcohol effects to be 165 grams per week (that is, about 3 drinks per week) in the studies reviewed at that time (Forrest et al., 1992). From the work of Goldschmidt et al. (1996), it may be more productive to examine different types of effects, or to examine additive effects controlling for covariates including socioeconomic status.

Of the longitudinal studies found in the literature, five (Sweden, Germany, Detroit, one of the French studies and one of the Seattle studies) followed children with FAS or FAE exclusively and did not describe specifically the socioeconomic background of these children. It appears that the subjects were included in the studies after presenting at a clinic or other medical care facility. In five other longitudinal studies (Roubaix in France, Atlanta, Cleveland, Detroit, Pittsburgh), researchers selected their samples from socially and economically disadvantaged urban areas, often inner city areas near the clinics in which the research took place. Two other longitudinal studies (Ottawa and Seattle) had samples of women who were predominantly white, middle-class women with higher education levels. Caution should be taken in drawing conclusions from studies with homogeneous samples, especially given the numbers of samples on this topic that have been described as low income or living in socioeconomically disadvantaged areas.
## Table 2.1 Studies of cognitive and behavioural outcomes associated with prenatal alcohol exposure, listed in alphabetical order by first author.

<table>
<thead>
<tr>
<th>Authors, country, sample size and ages of testing</th>
<th>Study description</th>
<th>Results: behavioural outcomes</th>
<th>Results: cognitive outcomes or learning problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aronson and Hagberg, 1998; Aronson, Hagberg &amp; Gilbert, 1997; Aronson, Kyllerman, Sabal, Sandia &amp; Olegard, 1985; Kyllerman, Aronson, Sabal, Karlberg, Sandia &amp; Olegard, 1985; Kyllerman, Aronson and Olegard, 1983; Olegard, Sabal et al., 1979 Sweden (n=30) ages: neonate to 14 years</td>
<td>Longitudinal study of children of alcoholic mothers, comparing with matched controls.</td>
<td>Hyperactivity, distractibility, perception disorders and short attention span, that continued throughout childhood and to latest follow-up at age 14 years.</td>
<td>FAS group had lower I.Q. and perceptual delay in early years, with no significant I.Q. difference between those reared in foster parents' home and in biological parents' homes. Six of the 24 children attended schools for the mentally retarded and 11 had some type of special education.</td>
</tr>
<tr>
<td>Boyd et al., 1991 - see Greene et al., below.</td>
<td>Study 1: Comparison of three groups: women who drank throughout pregnancy, women who stopped during pregnancy and women who never drank during pregnancy.</td>
<td>On scores of pre-math and reading: offspring of women who never drank during pregnancy were better than groups whose mothers stopped during pregnancy, or whose mothers continued to drink through pregnancy.</td>
<td></td>
</tr>
<tr>
<td>Conry, 1990 Canada (BC) (n=15 with FAS and n=10 with alcoholic mothers) ages 6.4 to 18.5 years</td>
<td>Cross-sectional study of children with and without diagnosis of FAS or FAE in isolated native community. Comparing three groups: children with FAS, children without FAS born to alcoholic mothers; and controls.</td>
<td>Neuropsychological testing: FAS group significantly lower on reaction time, finger tapping, grip strength and motor speed and precision. FAE group significantly lower only on grip strength.</td>
<td>I.Q. testing: FAS group significantly lower on all components of I.Q. tests, but FAE group were not, comparing to controls.</td>
</tr>
<tr>
<td>Study Details</td>
<td>Study Design</td>
<td>Key Findings</td>
<td>Additional Findings</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------</td>
<td>--------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Fried, Watkinson &amp; Watkinson, 1992b; Fried, Watkinson &amp; Gray, 1992a; Fried &amp; Watkinson, 1990; Fried &amp; Makin, 1987; Fried &amp; O'Connell, 1987;</td>
<td>Ottawa Prenatal Prospective Study - longitudinal study of children prenatally exposed to marijuana, cigarettes and alcohol: cognitive and language assessment. Middle-class, low risk women.</td>
<td>No relationship between prenatal alcohol exposure and attention deficits.</td>
<td>Prenatal exposure to low doses of alcohol resulted in lower cognitive scores and lower language skills at ages 2 and 3 years, but this was reduced to no significant difference by age 5, 6 years.</td>
</tr>
<tr>
<td>Greene, Emhart, Ager, Sokol, Martier and Boyd, 1991a; Green et al, 1991b; Boyd, Emhart, Greene, Sokol, Martier, 1991; Greene, Emhart, Martier, Sokol, Ager, 1990; Sokol, Miller, Debanne, Golden, Collins, Kaplan &amp; Martier, 1981;</td>
<td>Longitudinal study of offspring of socio-economically disadvantaged women, moderate alcohol use.</td>
<td>At ages 4 year 10 mos., prenatal alcohol exposure not found to be associated with attention deficit, as assessed on vigilance task.</td>
<td>No relationship between cognitive abilities and maternal drinking in absence of FAS, when tested at various ages. Home environment a better predictor of low scores on cognitive assessments.</td>
</tr>
<tr>
<td>Goldschmidt, Richardson, Stoffer, Geva and Day, 1996; Leech, Richardson, Goldschmidt and Day, 1999</td>
<td>Longitudinal study testing for relationship between prenatal alcohol exposure and academic achievement, in cohort of children prenatally exposed to moderate drinking levels, from lower socioeconomic backgrounds.</td>
<td>No significant effects observed of prenatal exposure on attention deficits or hyperactivity.</td>
<td>Linear (dose-related) relationship for arithmetic deficits; threshold effects for spelling and reading.</td>
</tr>
<tr>
<td>Study</td>
<td>Sample Description</td>
<td>Findings</td>
<td>Conclusions</td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Jacobson, Jacobson, Sokol et al., 1998, 1993a, 1993b</td>
<td>U.S.A. (inner city Detroit) (n=480) ages: 6.5, 12 and 13 months</td>
<td>Possible threshold effect on test of psychomotor development, since scores reduced only below higher levels of exposure (4 drinks/day).</td>
<td>Deficits in development in infants heavily exposed to alcohol (&gt;5 drinks per occasion at least once weekly), especially in children whose mothers were older than 30 years. Dose-response relationship on Bayley tests of development at 13 months.</td>
</tr>
<tr>
<td>Kyllerman, Aronson, Sabal, Larberg, Sandia and Olegard - see Aronson et al. above</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landesman-Dwyer, Ragozin and Little, 1981</td>
<td>U.S.A. (Seattle) (n=128) age: 4 years</td>
<td>Children of moderate drinkers were found to be less attentive, more fidgety and less compliant with parents, compared to occasional maternal drinkers and non-drinkers.</td>
<td></td>
</tr>
<tr>
<td>Larroque and Kaminski, 1998</td>
<td>France (n=160, with over-representation of heavy drinkers) age: 4.5 years</td>
<td>Lower scores on McCarthy scales, after controlling for confounders, for those exposed to ≥1.5 oz. absolute alcohol (3 drinks) per week. Verbal, quantitative and performance perceptive scales related to prenatal exposure.</td>
<td></td>
</tr>
<tr>
<td>Leech et al. - see Goldschmidt et al., above</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nanson and Hiscock, 1990</td>
<td>Canada (Saskatchewan) (n=29 FAS, 20 ADHD, and 20 controls)</td>
<td>Comparing groups to understand relationship between FAS and Attention Deficit Hyperactivity Disorder (ADHD).</td>
<td>Children with FAS/FAE were considerably more impaired intellectually.</td>
</tr>
<tr>
<td>Study</td>
<td>Design Description</td>
<td>Findings</td>
<td>Summary</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Mattson, Goodman, Caine, Delis &amp; Riley, 1999; Mattson and Riley, 1999; 1998; Mattson, Riley, Grambling, Delis &amp; Jones, 1998, 1997; Mattson, Riley, Delis, Stern, Gramling and Jones, 1996; Roebuck, Mattson and Riley, 1999, 1998; Roebuck, Simmons, Richardson et al., 1998; Thomas, Kelly, Mattson and Riley, 1998; U.S.A. (San Diego) ages: 3-16 years</td>
<td>Various cross-sectional comparative studies examining differences between those exposed to heavy alcohol use prenatally (children with and without physical features of FAS) and controls. Studied memory, cognitive and neuropsychological development.</td>
<td>Children exposed to heavy use of alcohol had significant impairments in psychosocial functioning, regardless of whether they had facial anomalies characteristic of FAS. Lower I.Q.'s found in children exposed to heavy alcohol use, including those without physical features required for diagnosis of FAS; both those with and without physical features showed impairment on tests of language, verbal learning and memory, academic skills, fine-motor speed and visual-motor integration.</td>
<td>Children heavily exposed to alcohol had deficits on tests of memory (verbal fluency tasks) and on other cognitive development tests.</td>
</tr>
<tr>
<td>Roebuck et al. - see Mattson et al., above</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russell, Czarnecki, Cowan, McPherson and Mudar, 1991 U.S.A. (Detroit) (n=175) age: 6 years</td>
<td>Longitudinal study, comparing those whose mothers indicated more than one drinking problem with those whose mothers indicated less drinking problems, on a self-administered questionnaire.</td>
<td>No relationship between prenatal alcohol exposure and performance on a psychomotor test.</td>
<td>Significantly lower scores on language and verbal scales of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) and on Token Test.</td>
</tr>
<tr>
<td>Shaywitz, Cohen, and Shaywitz, 1980 U.S.A. (Connecticut) (n=15) ages 6.5 to 18.5 years</td>
<td>Retrospective study of children heavily exposed to alcohol prenatally</td>
<td>Hyperactivity evident on school records for all but one of the subjects.</td>
<td>All but two of the subjects referred to special education by grade 1.</td>
</tr>
<tr>
<td>Study Details</td>
<td>Study Description</td>
<td>Outcome Measures</td>
<td>Additional Information</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------</td>
<td>------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Spohr, 1996; Spohr &amp; Steinhausen, 1996, 1987, 1984; Spohr, Willms &amp; Steinhausen, 1993; Steinhausen, 1996; Steinhausen, Willms &amp; Spohr, 1994, 1993</td>
<td>Longitudinal study of psycho-pathology, behavioural and cognitive outcomes of children with FAS or FAE.</td>
<td>Psychopathology, including hyperkinetic disorders, emotional and sleep disorders and other abnormal habits that remained over time. At age 3-4 years, attention deficit, hyperactivity, and distractibility were prevalent; over time affected children remained &quot;abnormal&quot; in psychiatric testing. Males had more severe psychiatric problems than girls. Older ages: social and attention problems persisted.</td>
<td>Large proportion of sample were considered mentally retarded and did not change considerably over time, although morphological damage decreased over time. At latest testing (ages 12-14 years) 17 of the children attended specialized schooling; difficulties in mathematics, logical conclusions, visual perception, spatial relations and short-term memory.</td>
</tr>
<tr>
<td>Streissguth, 1996, 1994a; Streissguth, Sampson and Barr et al, 1989; Streissguth, Clarren &amp; Jones, 1985a; Carmichael Olson et al., 1998</td>
<td>Children and adults with FAS described.</td>
<td>Deficits in attention and memory tasks.</td>
<td>Intellectual impairments, physical dysmorphia correlated with level of mothers' alcoholism. Difficulties in processing speed and accuracy, declarative learning and cognitive flexibility and planning.</td>
</tr>
<tr>
<td>Streissguth, Barr et al., 1994b, 1990, 1989d, 1989a; Streissguth, Bookstein, Sampson &amp; Barr 1993, 1989b; Streissguth &amp; Ladue, 1985b, Streissguth, Martin, Martin &amp; Barr, 1981; Streissguth, Bar, Martin &amp; Hermon, 1980</td>
<td>Seattle Longitudinal Prospective Study on Alcohol and Pregnancy, beginning with predominantly middle class women who gave birth during the one-year period 1975-1976.</td>
<td>At age 7.5 years: deficits in distractibility, over-persistence, reassurance-seeking and poor organization. At age 11 years: distractibility, restlessness and lack of persistence. Age 14 years: attention problems persisted.</td>
<td>At age 7.5 years: deficit on I.Q. scores, decrements of 1-3 months on arithmetic and reading scores. Binge drinking prior to pregnancy had the largest effect on academic performance. At ages 11 and 14 years, arithmetic scores remained low amongst the children of heavy drinkers.</td>
</tr>
</tbody>
</table>

48
2.3 Prenatal and postnatal exposure to tobacco

Prenatal tobacco exposure has well-documented, profound, adverse consequences on the health of the fetus and neonate. Data have been collected on this topic for at least 65 years (Sontag and Wallace, 1935) and over those years there have been ample research findings, reviews of the literature (U.S. Department of Health and Human Services, Office on Smoking and Health, 2001, 1970; Anderson, 1997; Edwards et al., 1996; Rush & Callahan, 1989; Kleinman & Kopstein, 1987; Landesman-Dwyer & Emanuel, 1979) and meta-analyses (Windham et al., 1999; Strachan & Cook, 1997; Kramer, 1987) giving credence to these associations. Some of the physical effects last long into childhood with increased morbidity and mortality being observed amongst children prenatally exposed to tobacco. These physical outcomes, especially in relationship to the fetus and neonate, have been widely accepted because of comparable animal research, the replication of the epidemiological data and plausible mechanisms. As well, at least 23 human studies have linked behavioural problems and cognitive deficits with prenatal tobacco exposure, some with very large samples. The results of these latter studies appear to be less well-established, as compared with the research of neonatal or childhood physical morbidity and mortality associated with prenatal tobacco exposure, or as compared with behavioural problems associated with teratogens such as alcohol. A review of the literature on this topic follows.

Various longitudinal studies, some with very large samples, have been conducted in a number of countries, including the United Kingdom, Finland, the Netherlands, New Zealand, Australia, Canada and the United States. For example, the British National Child Development Study (NCDS) began with the study of every baby born in England, Scotland and Wales (n=16,000)
during a one-week period in March 1958 (Davie et al., 1972) with a follow-up at age 7 years. The Finnish Cohort Study followed 1,763 children who were prenatally exposed to tobacco from birth to age 14 (Rantakallio & Koeranen, 1987; Rantakallio, 1983). Three longitudinal studies have taken place in the United States: 30,000 children were followed up to age 7 years (Naeye, 1992b; Naeye & Peters, 1984; Hardy & Mellits, 1972), a cohort of Washington state children has been followed since the late 1970s (Streissguth et al., 1984) and the U.S. National Longitudinal Survey of Youth (NLSY) studied the offspring of their original cohort with 2,256 children ages 4 to 11 years who had been surveyed in 1986 (Weitzman et al., 1992). In New Zealand, 1,265 urban children have been followed at annual intervals since their birth in 1977 (Fergusson, 1999; Fergusson & Lloyd, 1991), while in Australia, a cohort of 5,342 children has been followed since their birth in the early 1990's (Williams et al., 1998). A cohort (n=1,377) is being studied in the Netherlands but reporting has only reached the age of 3 years (Orlebeke et al., 1999). In Canada, Fried and his colleagues have followed 250 children in the Ottawa area for many years, those children now being in their early teenage years (Fried et al., 1999, 1998, 1997, 1992a, 1992b; Fried, 1993; Fried & Watkinson, 1990; Fried & Makin, 1987). Also in Canada a national longitudinal study, completed biennially and now in its third cycle of data collection, has produced data that may prove useful, but to date has not been used to report on the effects of prenatal tobacco exposure (Canada. Statistics Canada, 1997).

Following is a review of the literature describing the effects of prenatal tobacco exposure, with special attention to longer term effects that are applicable to the current study of children who are 8 and 9 years old.
2.3.1 Physical effects of prenatal tobacco exposure

Extensive research has been reported on the effects of prenatal exposure to tobacco on the physical health of the fetus and newborn.

At the prenatal stage, evidence was found of a causal link between tobacco exposure and fetal growth and survival of the fetus (U.S. Department of Health and Human Services, Office on Smoking and Health, 2001, 1979; Ness et al., 1999; Lieberman, 1994; Naeye, 1992b; Kline et al., 1987; Kramer, 1987; Shiono et al., 1986). Risks to the fetus that have been observed include abruptio placenta, preterm rupture of the membrane and ectopic pregnancy possibly resulting in premature birth and spontaneous abortion (Castles et al., 1999; DiFranza & Lew, 1995; Armstrong et al., 1992; Kramer, 1987). At the newborn stage, there has been evidence of low birth weight, lung and respiratory problems and Sudden Infant Death Syndrome after prenatal tobacco exposure (Strachan & Cook, 1997; ACOG Technical Bulletin, 1994; McGee & Stanton, 1994; McDonald et al., 1992a; Fingerhut et al., 1990; Kleinman et al., 1988; Kline et al., 1987; Lumley et al., 1985; Sexton & Hebel, 1984; Fergusson et al., 1981; Abel, 1980; Harlap & Davies, 1974; Colley et al., 1974).

Strong evidence links prenatal tobacco use and low birth weight (U.S. Department of Health and Human Services, Office on Smoking and Health, 1979; Brooke, 1989; Kramer, 1987; Sexton & Hebel, 1984) that may have consequences for mortality and morbidity. An intervention trial observed improved birth weight outcomes when smoking was reduced during pregnancy (Sexton & Hebel, 1994). Brooke et al. (1989) investigated the effects of various socioeconomic and
lifestyle risks and conditions concluding that the main cause of low birth weight was maternal smoking during pregnancy and that social and psychological factors had little or no direct effect on birth weight. A dose-response relationship was established (Hebel et al., 1988) although it has been observed that stopping smoking by the 8th month of pregnancy was as predictive of outcome as dose (Hebel et al., 1988). To gain precision in measuring prenatal tobacco exposure, British researchers categorized people according to the brand (low or high yield cigarettes) and the quantity smoked during pregnancy. They adjusted both carbon monoxide yield and number of cigarettes smoked in an attempt to find a threshold for birth weight. They found that both yield and quantity were important in determining low birth weight, but brand smoked (determining carbon monoxide yield) to have more effect on determining the threshold than quantity smoked. They observed a threshold for birth weight loss at 13 cigarettes/day and 15 mg/cigarette carbon monoxide (Peacock et al., 1991).

Several researchers, attempting to determine the long lasting effects of the neonate weight differences, examined whether children whose mothers smoked during pregnancy, and consequently were born low birth weight, continued to have retarded growth later in childhood and early adulthood (Vik et al., 1996; Eskenazi & Bergmann, 1995; McGee & Stanton, 1994; Day et al., 1992; Rona et al., 1985; Naeye & Peters, 1984; Rantakallio, 1983; Fogelman, 1980; Dunn et al., 1976; Butler & Goldstein, 1973; Davie et al., 1972; Hardy & Mellits, 1972; Goldstein, 1971). Results of many of these studies showed small but significant differences in favour of the offspring of nonsmokers with respect to weight and height, even when controlling for various confounding variables such as child’s gender and length at birth, age of mother and socioeconomic
factors. The research has not been conclusive, however, since other researchers found that initial physical differences between exposed and non-exposed groups diminished by ages 8 months (Barr et al., 1984), age 12 months (Nafstad et al., 1999), age 18 months (Day et al., 1992), age 3 years (McGee & Stanton, 1994; Fox et al., 1990), age 9 years (McGee and Stanton, 1994) or age 14 years (Rantakallio, 1983) after adjusting for other maternal and paternal factors (such as paternal smoking) or duration of breastfeeding or initial birth weight differences. The differences between the two groups (non-exposed and exposed) appeared to be extensions of deficits in fetal growth rather than postnatal growth retardation. Many studies that involved re-analyses of longitudinal studies in which data were collected years ago did not have the advantage of testing specific dose responses. Children of heavy smokers were found to be significantly shorter than non-exposed children at age 5 years, but even this difference disappeared when birth weight and gestational age were controlled. Vik et al. (1996) found that by age 5 years, children of smokers had a complete catch-up in weight and a partial catch-up in height. It appeared that the reduction in birth weight took place in the second or third trimester of pregnancy (Vik et al., 1996; Butler & Goldstein, 1972).

The longer term effects of low birth weight may persist in the area of behavioural problems (McCormick et al., 1996) and cognitive development (Breslau et al., 1994). Breslau et al. (1994) compared randomly selected groups of low birth weight children and normal birth weight children, using two disparate populations, an urban disadvantaged one and a suburban middle-class population. At age 6 years, the I.Q. scores of the four groups were compared, with a gradient of mean scores found: the disadvantaged, urban, low birth weight group had the lowest I.Q. scores,
Controlling for maternal education and socioeconomic status, those born with low birth weight had lower I.Q. scores than those born with normal birth weight. These researchers did not extend their study to suggest causal relationships for the low birth weight, such as prenatal tobacco or alcohol exposure or other lifestyle factors, but the importance of their research was the suggestion that adverse neonatal health conditions may persist in cognitive development at early school age.

McCormick et al. (1996) found more behavioural problems amongst children born with low birth weight, although they also suggested that considerable portions of the adverse outcomes could be modified by environmental changes.

Lassen and Oei (1998) reviewed nine studies on the physical development of children prenatally exposed to tobacco and concluded that the evidence has been consistent on reduced height after prenatal tobacco exposure, in spite of the differing variables controlled by the researchers. They also concluded that: “it can be seen that the deficits, although they appear to be stable and relatively long term, are small and may be of little functional importance” (Lassen & Oei, 1998, p. 641).

Most of the studies included in Lassen and Oei’s (1998) review and in the present review controlled for various confounding variables and were found to be precise in the level and patterns of tobacco use measured. Unfortunately, very few studies controlled for alcohol consumption.
It has been suggested that the mechanism relating to delayed fetal or childhood growth amongst those prenatally exposed to tobacco is foetal hypoxia that may result from increased carboxyhemoglobin levels, vasoconstriction of the blood supply to the placenta, or attenuated blood oxygen unloading (Fergusson, 1999; Orlebeke et al., 1999; Lassen & Oei, 1998; Milberger et al., 1996; Fergusson et al., 1993; Morrow et al., 1988; Naeye & Peters, 1984; Abel, 1980; Lehtovirta & Forss, 1978; Longo, 1976; Denson et al.; 1975; Colley al, 1974). Investigators have debated whether the appetite suppressing effects of nicotine influences birth weight, but it appears from the literature that other mechanisms are responsible for at least some of the deficits since the birth weight effects persisted even after caloric intakes were increased amongst smokers in some research studies (Kramer, 1987).

In addition to height and weight deficits for which there has been considerable research, some other health problems may persist well beyond the newborn stage, so that children whose mothers smoked during pregnancy continued to be at risk for ear infections, asthma, allergies and respiratory tract illnesses in general (Stathis et al., 1999; Fried & Watkinson, 1990; Moessinger, 1989; Taylor & Wadsworth, 1987; Rantakallio, 1983, 1978; Fogelman, 1980). On the other hand, high blood pressure found in newborns whose mothers smoked during pregnancy was not found to persist at ages 9 or 18 years (Williams & Poulton, 1999). Fogelman (1980) found that asthma or wheezy bronchitis persisted well into the teenage years. Medical histories of 16-year-olds revealed that the offspring of women who smoked heavily (>10 cigarettes daily) during pregnancy were significantly more likely to have these conditions. The relationship between asthma or wheezy bronchitis and prenatal tobacco exposure was confusing, as those who were exposed at
medium levels (10 cigarettes daily) were the least likely to have these conditions, compared to the heavily exposed group and the non-exposed group. Rantakallio (1983) found that the children at age 14 years were more prone to respiratory illnesses if they had been prenatally exposed to tobacco and that there were statistically significant differences between the exposed and non-exposed in rates of mortality up to 14 years.

In an earlier study by Rantakallio (1978) found statistically significantly higher rates of mortality from age 28 days to 5 years, more and longer hospitalizations and more visits to doctors were not noted in those prenatally exposed to tobacco, but the differences between the exposed and non-exposed groups were clearest in those under the age of one year. Also examining mortality rates amongst the offspring of smokers, a Swedish researcher examined the relative risk of post-neonatal death and early childhood death (ages 1 to 8 years) amongst children whose mothers smoked (Hofvendahl, 1995). After controlling for birth weight, there was no higher risk for death during the late neonatal age, but that there was an increased relative risk (1.35) for death during the post-neonatal and post-infancy ages, that is, up to about 4 years of age, but that there was no increased risk between ages 5 to 8 years. Hofvendahl (1995) controlled his analysis for various factors, including socioeconomic status.

These apparent causal links have led researchers to speculate about other physiological or chemical alterations that may in turn be the underlying mechanisms for cognitive and behavioural effects of prenatal exposure to tobacco (Fergusson, 1999; Eskenazi & Trupin, 1995; Rantakallio et al., 1992). During critical periods, fetal oxygenation and placental circulation may affect central
nervous system development (Niemelä & Jarvenpää, 1996, Naeye, 1992b). Interest in behavioural problems also may have increased because estimates of a high number of hyperactive children in North American children coincided with increased tobacco use by women over recent decades (Denson et al., 1975).

2.3.2 Cognitive and behavioural effects of prenatal tobacco exposure

Various researchers have examined the possible association between behavioural and cognitive outcomes and prenatal tobacco exposure. Maternal smoking during pregnancy has been implicated as a risk factor for increased behavioural and cognitive problems (Brennan et al., 1999; Leech et al.; 1999; Orlebeke et al., 1999; Trasti et al., 1999; Fried et al., 1998, 1997, 1992a, 1992b, Lassen & Oei, 1998; Wakschlag et al., 1997; Milberger et al., 1996, Fergusson et al., 1993; Weitzman et al., 1992; Makin et al., 1991; Fried & Watkinson, 1990; Sexton et al., 1990; Fried & Makin, 1987; Naeye & Peters, 1984; Streissguth et al., 1984; Nichols & Chen, 1981; Hardy & Mellits, 1972). In addition to evidence provided by longitudinal studies in various countries (mentioned above), researchers have examined specific behaviours such as attention deficit hyperactivity disorder, impulsivity or motor hyperactivity (Conners et al., 1996; Milberger et al., 1996; Fried et al., 1992a), mental development (Trasti et al., 1999), conduct disorder (Wakschlag et al., 1997) or increased numbers of behavioural problems (Fergusson et al., 1993; Weitzman et al., 1992). In Vancouver, Dunn et al. (1977, 1976) studied the intellectual and neurological maturation of 6 ½ year olds whose mothers smoked during pregnancy.

To follow is a review of the results of these longitudinal and cross-sectional studies, first describing
the research with respect to behavioural outcomes and then with respect to cognitive outcomes. 

Table 2.2, on pages 96-103 at the end of this section, summarizes each of the studies cited.

2.3.2.i Behavioural effects of prenatal tobacco exposure

Twenty-four studies were found that examined the relationship between children's or young adults' behaviour and prenatal tobacco exposure. There was an attempt to be comprehensive and no other studies were found on the relationship between behaviour and prenatal tobacco exposure. The studies found were both retrospective and prospective and examined general behaviour as children aged; cross-sectional studies examined specific behaviours such as attention problems or impulsivity. Eleven studies were consistent in demonstrating a link between prenatal tobacco exposure and development of externalizing behaviours, such as aggressive or antisocial behaviour, conduct disorder or criminal behaviour (Weissman et al., 1999; Brennan et al., 1999; Gibson & Tibbetts, 1998; Williams et al., 1998; Wakschlag, 1997; Orlebeke et al., 1999, 1997; Milberger et al., 1996; Fergusson et al., 1993; Rantakallio et al., 1992; Weitzman et al., 1992; Rantakallio 1983). There were two studies that compared those diagnosed with ADHD to controls, after collecting data retrospectively on prenatal tobacco exposure (Landesman-Dwyer et al., 1981; Denson et al., 1975). The studies have demonstrated consistently the link between prenatal tobacco exposure and behavioural problems, from early age to adulthood, involving inattention, impulsivity or externalizing behaviour, with conduct disorder in later years and delinquency and violent criminal behaviour in adulthood.
General behavioural measures

A study investigating the relationship between prenatal tobacco exposure and behavioural problems of children was conducted by Weitzman et al. (1992) who followed 2,256 U.S. children ages 4 to 11 years using data from the National Longitudinal Survey of Youth (NLSY). A strength of this research was the investigators’ differentiation of varying amounts and timing of tobacco exposure. Amount of smoking were divided dichotomously (>1 pack a day or ≤1 pack a day) and timing was categorized into three exposure periods (prenatal, postnatal or both pre- and postnatal exposure). Behaviour was measured by the use of the Behavior Problem Index (BPI), an adaption of the subscales of the Child Behavior Checklist (CBCL) (Achenbach & Edelbrock, 1979; Achenbach, 1978). The results indicated a dose-response relationship with children whose mothers smoked heavily (≥1 pack a day) after pregnancy, or both during and after pregnancy, having higher scores indicating behavioural problems. The odds ratio for extreme behaviour problem associated with both pre- and post-natal exposure was 1.41 if the mother smoked less than one pack a day (p<.01) and 1.54 if she smoked 1 pack a day or more (p<.05). This relationship was not shown for children who were exposed only prenatally, however, the sample was small (n=19) for mothers who reported smoking ≥1 pack during pregnancy but not after pregnancy. The dose-response relationship was unclear for those women who smoked only during pregnancy, since children whose mothers smoked less (<1 pack a day) showed higher behavioural problem scores than those whose mothers smoked more.

Children exposed to smoking only postnatally, or both pre- and postnatally, showed significantly higher scores on many subscales of behaviour assessments, including antisocial behaviour,
anxiousness or depression, hyperactivity and being headstrong. These results indicated a dose-response. A limitation to drawing conclusions from this research was that there were very few people who smoked a pack or more of cigarettes a day only during pregnancy, without continuing the habit after pregnancy. The results suggested that these effects are more likely to follow from passive smoking after the child is born than after prenatal exposure alone.

This study is of interest to the present thesis because of the age group studied and important because it is one of the few studies that controlled for simultaneous prenatal alcohol exposure and various demographic and psychological variables. Prenatal alcohol exposure was treated as a dichotomous variable according to whether the mother had one or more drinks of alcohol per week. It is possible that this was insufficiently precise as a measure of prenatal alcohol exposure, insofar as there has been some evidence suggesting that the offspring of abstainers fare worse at least for the outcome of birth weight of neonates than those who drink occasionally (Abel & Hannigan, 1995b; Forrest et al., 1991; Lumley et al., 1985).

Fergusson et al. (1993) attempted to replicate the research of Weitzman et al. (1992), using different behavioural rating scales. They addressed some of the limitations of the earlier study, namely the measurement of maternal smoking by self-report and the need for clearer differentiation between pre- and postnatal exposure. They conducted a prospective, longitudinal study, collecting data from a cohort of 1,265 New Zealand children at ages 8, 10 and 12 years. Data collection and analyses included statistical control of a long list of potentially confounding family, social and parental variables. Their results were consistent with those of Weitzman et al. (1992), suggesting
that there may be a dose-response relationship of pre- and postnatal exposure to tobacco for disruptive behaviour problems at pre-adolescent age. The duplication of the results of Weitzman et al. (1992) led Fergusson et al. (1993) to conclude that the results “are generally supportive of the hypothesis that smoking during pregnancy may lead to small but statistically detectable increases in rates of problem behaviour in childhood” (Fergusson et al., 1993, p. 821).

Fergusson et al. (1993) found small but significant differences between those not exposed and those whose mothers smoked ≥1 pack daily during and after pregnancy on the three dependent variables of conduct disorder, attention deficit and disruptive behaviour. Unfortunately, alcohol use during pregnancy was not included in their analyses, although the researchers did collect data on history of alcohol problems.

A well-designed New Zealand study (McGee & Stanton, 1994) examined the relationship between prenatal smoking and height, behaviour and cognitive development of children (n=1,037) at ages 3 to 9 years. They included a wide range of potentially confounding factors, including health, perinatal and family adversity and child rearing practices. They tested attention deficit and hyperactivity, measured by parent and teacher rating scales. The only significant relationship they found with respect to behaviour was more behavioural problems at age 5 years, as rated by mothers.

A group of Vancouver researchers conducted a prospective study to examine the neurological and intellectual development at age 6 ½ years of children prenatally exposed to tobacco, comparing
those who had been born prematurely and small for gestational age, those born full-term with low
birth weight, and controls (Dunn et al., 1977, 1976). They observed statistically significant
differences on behavioural scales in favour of those not prenatally exposed, but they were
ambiguous about the variables controlled and the types of behaviour measured and there was no
mention of data collection regarding alcohol use.

**Externalizing behavioural problems:**

As mentioned above, study results were consistent in observations of an association between
prenatal tobacco exposure and externalizing behaviours, such as aggressive or antisocial behaviour,
conduct disorder or criminal behaviour (Weissman et al., 1999; Brennan et al., 1999; Williams et
al., 1998; Orlebeke et al., 1999, 1997; Gibson & Tibbetts, 1998; Wakschlag, 1997; Milberger et
al., 1996; Fergusson et al., 1993; Rantakallio et al., 1992; Weitzman et al., 1992; Rantakallio
1983).

The most recent study found on this topic examined three-year olds (n=672) from a low-income
U.S. urban population (Day et al., 2000). Children were assessed by maternal ratings using three
standard tests, the Toddler Behavior Checklist, SNAP Checklist and Routh Activity Scale.

Statistically significant effects of prenatal tobacco exposure on children's behaviour were found,
with increased scores on subscales for Oppositional Behavior, Immaturity, Emotional Instability,
Physical Aggression and Activity. Of all the subscales of the Toddler Behavior Checklist, the
largest effect of prenatal tobacco exposure was observed on Oppositional Behaviour. Impulsivity
and peer problems were found to be associated with the combination of pre- and post-natal
exposure. The researchers noted that the effect observed was associated predominantly with third trimester smoking, a time other researchers (Slotkin, 1998) found nicotinic receptors to be formed. Day et al. (2000) also found current tobacco use by mothers predicted only attention problems. For preschoolers, no effects of prenatal alcohol exposure were observed on behaviour, except for a positive effect of first trimester exposure on immaturity. As well as being the most recent study, it is one of the few that accounted for prenatal alcohol exposure.

Orlebeke, Knol and Verhulst (1999, 1997) used a large sample (n=1,377) of 2- and 3-year-old twins in the Netherlands to examine the effects on behaviour of those prenatally exposed to tobacco. They divided their sample according to those who were first-born and those who were second-born in each family, and adjusted their analyses for the possible confounding effects of birth weight, socioeconomic status, maternal age and type of feeding. Measuring behaviour using the CBCL behavioural rating scale (Achenbach & Edelbrock, 1979; Achenbach, 1978), they observed a statistically significant difference between prenatally exposed and non-exposed children on externalizing behavioural problems (t=2.56, p<.01 for first born children, t=3.69, p<.001 for second born children) but no difference on internalizing behaviours (e.g., being withdrawn, depressed, anxious). The enhanced externalizing scores for those whose mothers smoked was primarily attributable to higher aggression (t=2.37, p<.05 for first born, t=3.43, p<.001 for second born), oppositional (t=2.42, p<.05 for first born, t=3.56, p<.001 for second born) and overactive (t=2.15, p<.05 for first born, t=2.73, p<.005 for second born) scores. The effect of prenatal tobacco exposure was the same for boys and girls, even though boys had higher external behavioural scores. Orlebeke, Knol and Verhulst (1999, 1997) controlled specifically for method
of feeding during infancy because of research showing that breast-fed children have an advantage on neurological development and that mothers who smoke during pregnancy tend to bottle feed their infants (Lanting et al., 1994). As in the case of most other studies, Orlebeke, Knol and Verhulst (1999, 1997) did not control for prenatal alcohol exposure.

Another study, important because of its more precise measurement of nicotine exposure, found differences between the maternal ratings of 5-year-old children according to whether the children were pre- and postnatally exposed to tobacco or not exposed. A statistically significant higher number of children who were both pre- and postnatally exposed were rated by their mothers as being more active, compared to those who were only prenatally or only postnatally exposed. There was a dose-response relationship of current smoking exposure, so that children of mothers who smoked a pack a day or more had nearly twice the risk of “active” behaviour, compared to the children of nonsmokers (Eskenazi & Trupin, 1995). The importance of this study was the researchers’ attempt to overcome the lack of precise measurement of dosage used by other researchers. As well as maternal interviews, they measured serum cotinine, a metabolite of nicotine to assess levels of exposure. They also differentiated pre- and postnatal exposure. Unfortunately, they did not describe the mothers’ behaviour rating scale. They did include prenatal alcohol exposure as a potentially confounding variable, but did not describe whether they measured timing, duration or level of alcohol exposure.

Williams et al. (1998) also observed a link between externalizing behaviours and prenatal tobacco exposure among their Australian cohort of 5,342 children whose age averaged 5.5 years. They
found a clear dose-response relationship between higher levels of prenatal tobacco exposure and higher rates of externalizing behaviour problems, using the CBCL (Achenbach & Edelbrock, 1979; Achenbach, 1978) to measure behaviour patterns. They concluded that at that age, postnatal tobacco exposure accounted for 16% of the variance, while prenatal tobacco exposure accounted for 25% of the variance, even after controlling for various confounding factors including socioeconomic status.

A well-controlled study conducted in the U.S.A. followed the children of 50 smokers and 97 non-smokers for 10 years (Weissman et al., 1999). They found an increased risk that males whose mothers smoked during pregnancy had four times the risk (relative risk=4.10, p<.01) of being diagnosed with Conduct Disorder before adolescence and three times the lifetime risk (relative risk=3.17, p<.05). They also found that females whose mothers smoked during pregnancy had five times the risk of drug abuse or dependency (relative risk=5.21, p<.05). Although these researchers acknowledge the covariance of alcohol and tobacco use during pregnancy, they merely mention that alcohol was examined as a potential interactive variable, as was coffee consumption.

Inattention, impulsivity and attention deficit hyperactivity disorder:

Consistency was also found in the results of seven separate studies linking the specific behavioural outcomes, attention problems and impulsivity, with prenatal exposure to tobacco. Five teams of U.S. researchers (Day et al., 2000; Leech et al., 1999; Milberger et al., 1996; Naeye & Peters, 1984; Streissguth et al., 1984), Canadian researchers (Denson et al., 1975) and British researchers (Nichols & Chen, 1981) have examined these relationships, some using cohorts from normal
populations or prenatal clinics and others examining the backgrounds of those with attention deficit problems. One study (Landesman-Dwyer et al., 1981) found results inconsistent with these studies.

Day et al. (2000) found impulsivity to be associated with the combination of both pre- and postnatal tobacco exposure, in their study of 3-year olds from a low-income, urban U.S. population (n=672). Postnatal exposure, but not prenatal exposure, predicted attention problems. Day et al. (2000) accounted for prenatal alcohol exposure in their analyses, as well as many other variables that could potentially affect behaviour.

Naeye and Peters (1984), using the Boston site (n=12,150) of the U.S. Collaborative Perinatal Study, found hyperactivity and shortened attention span scores for 7-year old children whose mothers smoked during pregnancy. Lower attention span scores were attained by children prenatally exposed either moderately (1-10 cigarettes daily) or heavily (over 10 cigarettes daily). A dose-response was found for hyperactivity, with significantly higher levels of hyperactivity found in children heavily exposed. One strength of the study was its control of genetic and child-rearing practices through the pairing of children in the same family, only one of whom was subjected to prenatal tobacco exposure. Unfortunately, the study did not control for prenatal alcohol exposure.

Milberger et al. (1996) studied 140 boys, aged 6-17 years, with attention deficit hyperactivity disorder (ADHD), comparing them to a normal cohort. Their results suggested that maternal smoking during pregnancy is a risk factor for ADHD, even when controlling for socioeconomic
status, parental I.Q. and parental ADHD status (Milberger et al., 1996). ADHD was measured according to DSM-III-R criteria and mothers were considered to be smokers if they smoked at least a pack a day for at least 3 months during pregnancy. The limitation of this study is that smoking status was measured retrospectively by maternal recall and there was no control in the analyses of either prenatal alcohol use or postnatal tobacco use. Most other studies consider half a pack a day to be "heavy" smoking.

Leech et al. (1999) studied attention and impulsivity problems associated with prenatal exposure to various substances, including tobacco. Their cohort consisted of 783 children from an urban (Pittsburgh) prenatal clinic, selected in 1983. They found that prenatal tobacco exposure predicted inattention when they tested the children at age 6 years. They controlled for various demographic and social environmental factors, noting that it was difficult to separate the effects of pre- and postnatal tobacco exposure because of the high correlation between the two stages of exposure.

Streissguth et al. (1984) also showed prenatal exposure to tobacco was statistically significantly associated with poor attention and poor orientation amongst a cohort of 452 four-year-olds who were part of a longitudinal prospective study in Seattle, described previously. Although the main interest of the researchers was the effects of prenatal alcohol exposure, they also collected data on the use of tobacco and other drugs during pregnancy and reported on the effect of prenatal tobacco exposure at least in their first few years of reporting. They tested vigilance, reaction time and inattentiveness. Children of mothers who were heavy smokers scored statistically significantly lower on a test of vigilance measuring both errors of commission (indicating impulsivity) and
errors of omission (indicating inattention) and for poorer orientation (that is, not on task). The exposed children were not affected in their reaction time. These researchers used the same tests for children prenatally exposed to alcohol and the findings were statistically significant when the tests for alcohol exposed children were adjusted for tobacco exposure, or visa versa, the tests for tobacco exposed children were adjusted for alcohol exposure. The findings for all tests were controlled for maternal education, prenatal nutrition and caffeine exposure and child’s birth order. This study was one of the few found in which prenatal alcohol use was controlled. In addition, they measured nicotine exposure more accurately than many of the retrospective studies by computing the nicotine use from the number of cigarettes smoked daily multiplied by nicotine in the brand. Another important aspect of the study design was the selection of subjects from a population of children considered normal, that is, they were not selected because of abnormalities.

In contrast to the above studies, Landesman-Dwyer et al. (1981) did not find the same results as Streissguth et al. (1984), described above, even though they tested the offspring of the same middle-class cohort from Seattle. The measures to test behaviour differed between the two studies. The smoking variable was treated dichotomously, according to whether the mother smoked during the fourth month of pregnancy. The methods of measuring behaviour at age 4 years were naturalistic observations in the home by the researchers and mothers’ perceptions of behaviour. Results showed no difference between the exposed and non-exposed groups in the observations of behaviour, such as fidgeting, focused attention at various times such as during story time or at mealtime. Maternal smoking was related to only a few temperament measures (such as persistence or intensity). The authors suggested that their results may have been different.
from the studies that did not measure or control for alcohol (such as Dunn et al., 1977; Butler & Goldstein, 1973; and Nichols & Chen, 1981). On the other hand, their results also differed from those of Streissguth et al. (1984) (see above) who were especially interested in measuring alcohol consumption during pregnancy.

The poorer orientation and attention that Streissguth et al. (1984) found was consistent with the results of Canadian researchers Denson et al. (1975). They compared 20 (18 boys, 2 girls) children diagnosed with “hyperkinetic reaction” with two matched control group, one described as normal and one with dyslexia. Subjects were ages 5 to 15 years. Both current smoking history and retrospective data on smoking during pregnancy were collected during interviews with mothers. The results showed statistically significant differences between the groups. The hyperkinetic group were exposed to smoking both prenatally (at twice the rate as the control groups) and postnatally (at three times the rate as the control groups). Unfortunately, no data were reported on prenatal alcohol use.

Nichols and Chen (1981) also found poor orientation and attention deficits amongst the children of smokers. They reported the extensive work of the U.S. National Collaborative Perinatal Project (NCPP) in which 300 prenatal and postnatal variables were examined in a cohort of 29,887 children at ages 4 and 7 years. Maternal smoking during pregnancy was among the 10 most important variables found to reflect later hyperactivity and impulsivity. After controlling for socioeconomic and other factors, their results showed that those who were prenatally exposed to tobacco had statistically significantly higher results on tests of poor orientation and attention.
In the Ottawa Prenatal Prospective Study, predominately middle-class subjects volunteered for a study in which they were interviewed many times during and after pregnancy, their medical records were examined and their offspring (n=250) were tested at various ages for behavioural outcomes of prenatal exposure to tobacco, marijuana or alcohol. In infancy, prenatal cigarette exposure was found to be associated with increased tremors and poorer auditory habituation (Fried & Makin, 1987). At ages 4 to 7 years, prenatal cigarette smoking was found to be associated with increased activity level and increased errors of commission (that measure impulsivity) in auditory tasks, and to a lesser degree, in visual tasks (Kristjansson et al., 1989). Because of the correlation between pre- and postnatal tobacco exposure, prenatal marijuana exposure, family income and maternal education, the analyses controlled for these variables. Kristjansson et al. (1989) found only a relationship with errors of commission, while in the Seattle study that had a cohort with similar socioeconomic background, both errors of commission and errors of omission (measuring attention) were associated with daily tobacco use during pregnancy (Streissguth et al., 1984). While not identical in their results, the two studies indicate problems with vigilance and impulsivity in children prenatally exposed to tobacco. The Ottawa researchers noted that attention and impulsivity problems appeared to be more pronounced amongst children prenatally exposed to tobacco than to either moderate alcohol exposure or marijuana exposure.

One further report of interest from the Ottawa research compared children pre- and postnatally exposed to tobacco on learning deficiencies (reported below) and also on mothers’ reports of their child’s behaviour (Makin et al., 1991). Using a parents’ behavioural scale (Conners Parent Questionnaire), children who were exposed both pre- and postnatally to tobacco rated higher on all
scales than those of the nonsmoking group, indicating more behavioural problems.

Conduct disorder:

Conduct disorder has been described as a “devastating condition” both because of the harm youth inflict on others and on property and because of the risk of other forms of psychopathology (Loeber et al., 1995). The results of a recent study suggested that maternal smoking during pregnancy was strongly linked with conduct disorder in male offspring (Wakschlag et al., 1997). The researchers controlled many confounders considered to be potential risk factors for conduct disorder, including socioeconomic status, low birth weight, pregnancy complications, family factors (such as marital status), psychopathological characteristics of the biological parents, parenting styles and demographic variables. The sample was a cohort of 177 U.S. boys, ages 7 to 12 years, referred to a clinic. Prenatal alcohol and use of one or more illicit drugs were treated dichotomously according to whether they were used. Results of a bivariate analysis showed that mothers who smoked more than half a pack of cigarettes daily during pregnancy were significantly more likely to have a child diagnosed with conduct disorder, as measured by DSM-III-R criteria. Furthermore, when a logistic regression was conducted, smoking more than half a pack daily, socioeconomic status and maternal antisocial personality were independent predictors of conduct disorder. Regression analyses adding all the significant independent predictors indicated that smoking more than half a pack daily during pregnancy, maternal age, little parental supervision and harsh discipline were each significant independent predictors. Interestingly, use of alcohol or illicit drugs, or substance abuse were not shown to be independent predictors.
Loeber et al. (1995) concluded that ADHD predicted an early onset of conduct disorder and that low socioeconomic status, oppositional behaviour and parental substance abuse were key factors in contributing to the progression to conduct disorder, when controlling for various other factors. Unfortunately, only current history of paternal and maternal alcohol and drug use were measured.

**Delinquency and criminal behaviour:**

Related to the research on conduct disorder are studies linking maternal smoking during pregnancy and juvenile delinquency and criminal behaviour among adult male offspring. Four studies were found, three from Scandinavia and the other from the U.S.A.

Brennan et al. (1999) studied 4,169 males born 1959-1961 in Copenhagen in a prospective longitudinal study. Mothers self-reported on the quantity of tobacco used during their third trimester of pregnancy and on the use of various prescription drugs during pregnancy, such as antihistamines, diuretics, antiepileptics, psychopharmaceuticals, antibiotics, analgesics, hormone treatment. History of alcohol use was not included in the data collection. The criminal records were checked when the male offspring of these women were 34 years old. Results indicated a dose-response relationship between arrests for nonviolent and violent crimes and amount of smoking by the mother during pregnancy. The relationship persisted when related variables, such as paternal criminal history, were controlled during the analysis.

A population-based cohort (n=12,058) born in northern Finland in 1966 was the study population for two studies. Both studies excluded female children because of their low level of arrest or
recorded criminality. Data on alcohol consumption were not collected, because "here it was a fairly minor problem among Finland women in 1966" with only 2.7 litres per capita sold annually and a ratio of 11:1 or 12:1 male:female consumption for many years (Rantakallio et al., 1992, p. 1112). Smoking behaviour was categorized into three groups: none, stopped before pregnancy and smoked daily throughout entire pregnancy. Rantakallio et al. (1992) examined delinquency at age 22 years, showing the incidence of delinquency amongst males (N=5,966) in the cohort was 10.3% amongst those prenatally exposed to tobacco and less than half that amount (4.6%) for their non-exposed counterparts. A weak relationship with respect to timing was observed, so that those whose mothers stopped smoking in the first trimester had a slightly lower rate of delinquency. The association between prenatal exposure and delinquency remained even after controlling for various possible social, family and demographic confounders. The researchers concluded that a clear association between prenatal tobacco exposure and juvenile crime existed, and could not be explained by other social or demographic variables.

Using the same cohort, Rasanen et al. (1999) studied the relationship between criminal behaviour and prenatal tobacco exposure. Comparing sons of mothers who did not smoke during pregnancy with those whose mothers smoked throughout the pregnancy, the latter group had more than double the risk of having committed a violent crime or having repeatedly committed crimes by age 28 years. The same relationship was not shown for nonviolent crimes.

A further contribution was made by Gibson and Tibbetts (1998) who used the cohort from the NCPP, the longitudinal U.S. study mentioned above, to examine the behaviours of a cohort of 832
inner-city Philadelphian Afro-American youths born between 1959 and 1966. They found that the combined effect of prenatal exposure to tobacco and low Apgar scores (1 minute) had a significant influence in predicting offending behaviour, measured according to whether they had criminal history in police records between the ages of 10 and 22 years. There was an additive effect, the independent effect of either variable alone was not found to be predictive of offending behaviour. Unlike the Scandinavian studies, youth of both genders were included. Prenatal alcohol use was omitted from the study report.

These studies of older children may be less relevant to the present thesis, but the results were included in this review because of the emerging pattern of behaviours from preschool to adulthood. The results may suggest that possible effects may persist throughout childhood and continuing into adulthood, or they may suggest that similar behaviours are found at various ages amongst those prenatally exposed to tobacco. They could suggest that effects at later ages are the cumulative product of other effects at earlier ages, or that the same effects are expressed in different ways at different ages. Wakschlag et al. (1997) found a relationship with higher levels of prenatal exposure to tobacco and conduct disorder amongst boys in adolescent years (ages 12 to 17). Rantakallio et al. (1992) found an association between prenatal tobacco exposure and juvenile delinquency. Rasanen et al. (1999) found a relationship between prenatal exposure to tobacco and criminal behaviour up to age 28 years. Brennan et al. (1999) found the same relationship to criminal behaviour amongst subjects at age 34 years. The results of these studies were consistent, even controlling for a variety of potentially confounding personal, family and social variables. One of the studies (Rasanen et al., 1999) did not discriminate the smoking behaviour according to dose,
another did not measure a dose-response gradient (Rantakallio et al., 1992). The other two studies were consistent in their findings that increased dosage was related to the behaviours under study. Wakschlag et al. (1997) found that prenatal exposure to more than half a pack daily was associated with increased risk for conduct disorder in boys. Brennan et al. (1999) found that women who smoked more than 20 cigarettes a day were more likely to have male offspring who were arrested during adulthood for nonviolent or violent crimes.

One further study was included in this review, but not mentioned above because of the unique outcome variables examined, namely, affective and personal functioning. The researcher found no significant differences in exposed and non-exposed children at age 10 years on teachers’ and parents’ ratings of depression, happiness, school social behaviour, self-esteem and peer-rated popularity (Lefkowitz, 1981).

To summarize, the 24 human studies reviewed showed considerable, although not complete consistency, both in their results and in the types of behavioural problems found to be associated with prenatal exposure to tobacco. The results were consistent in Australia, New Zealand, and in North American and European countries, although many of the studies that measured inattention or impulsivity took place in North America, while those that examined delinquency and crime took place in Scandinavia and the U.S.A. The consistency between the research of two studies in particular (Fergusson et al., 1993 and Brennan et al., 1999) led one of the researchers to write a commentary on the relationship between prenatal tobacco exposure and antisocial behaviour (Fergusson, 1999). Observing the strength of the studies in the large representative samples in
both Denmark and New Zealand, the commentary noted the consistency in showing increased risk for externalizing behaviours that extend over a life-time and the resiliency in the relationships in spite of controlling for many social, family and individual factors. Behaviours appeared to be specific antisocial behaviours and not reoccurrence of the same behaviour over different times. He suggested further that the evidence meets the criteria used as evidence of causal relationships (Susser, 1973), including replicability of results. Fergusson (1999) also stated that it would be unwise to draw strong conclusions at this point given that underlying mechanisms have not been fully established, that genetic confounding could be possible, and these need further examination.

Not mentioned by Fergusson was the fact that prenatal exposure to alcohol has been found to be associated with inattentivity, impulsivity and other outcomes, including secondary consequences such as incarceration for delinquency, to which prenatal tobacco has been associated in the above studies. Maternal alcohol use and maternal tobacco use during pregnancy have been found to covary, as do maternal education, socioeconomic status and other variables (see below). Unfortunately less than half the reviewed studies attempted to control for prenatal alcohol use and many of these were brief in their reporting of measurement and treatment of this confounding variable. Rantakallio et al. (1992) point out that this may not be a problem since their large cohort was unlikely to drink alcohol, given the prevalence of alcohol use among women in Finland in the 1960's. It may be that this tradition of non-use of alcohol at the time of data collection existed in other countries as well, although this was not the case in Canada and the U.S.A. where some of the studies did take alcohol use into consideration. Even without direct measures and analytic control of alcohol, the consistency of results may provide opportunities to draw conclusions about the
relationship between prenatal exposure to tobacco and behaviour, especially respecting attention, impulsivity and externalizing behaviours in general, leading to more aggressive behaviours upon approaching adulthood. There was only one exception to the consistency of results, that being one of the reports of the Seattle study of 4-year olds (Landesman-Dwyer et al., 1981) that included alcohol use in its data collection. In that analyses, no association was observed between prenatal tobacco use and attention problems.

2.3.2.ii Cognitive development, academic abilities or learning problems

Studies that tested cognitive development and academic abilities associated with prenatal tobacco exposure found diverging results. Many studies failed to find a relationship between exposure and mental development (Trasti et al., 1999; Niemelä & Jarvenpää, 1996; Eskenazi & Trupin, 1995; McGee & Stanton, 1994; Baghurst et al., 1992; Roelveld et al., 1992; Fergusson & Lloyd, 1991; Lefkowitz, 1981; Hardy & Mellits, 1972). Others found statistical significance on at least some tests when measuring the differences between exposed and unexposed groups when children were tested many years postnatally (Fried et al., 1998, 1997, 1998b; Olds et al., 1994a; Sexton et al., 1990; Naeye and Peters, 1984; Rantakallio, 1983; Nichols & Chen, 1981; Fogelman, 1980; Butler & Goldstein, 1973). The studies are reviewed below.

Preschool age

Trasti et al. (1999) used various age-appropriate tests to assess the motor and mental abilities of randomly selected Scandinavian children (n=376), half of whom had been prenatally exposed daily to tobacco. No measure of dose was recorded. At age 13 months, both groups performed equally
well on the Bayley Scales of Infant Development. At age 5 years, cognitive development was not found to have an association, when measured by the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-R) after controlling for maternal education. A small adverse effect on balance at age five years was observed. It is possible that the lack of measurement of dose could have influenced the results. Alcohol use during pregnancy was not measured.

Similarly in Australia, Baghurst, Tong, Woodward and McMichael (1992) failed to find an association between exposed and non-exposed children (n=548), followed from ages 1 to 4 years, after adjusting the analyses for socioeconomic status, home environment and mother's intelligence. The children were tested using the Bayley Scales of Infant Development and McCarthy Scales of Children's Abilities for various indicators of cognitive development, including memory, problem-solving abilities, language and speech development and motor performance. Unfortunately, dosage of exposure was not reported and women were considered non-smokers if they had ≤5 cigarettes during their pregnancy. Alcohol use during pregnancy was recorded and treated as a confounding variable.

A Finish study (Niemelä & Jarvenpää, 1996) also found no statistically significant difference between tobacco exposed (prenatally) and not exposed groups of 4 and 5 year-old children on test scores of cognitive development, after adjustment for confounding variables. They reiterated the importance of lifestyle and social background, indicated by maternal education and parental factors, as determinants of children’s cognitive development. Unfortunately, neither dosage of tobacco nor prenatal alcohol use was mentioned in reporting the study.
A U.S. study that had the most precise and valid measure of nicotine exposure (measurement of maternal serum cotinine levels during pregnancy) compared 5-year old children of women who smoked only prenatally or only postnatally or both pre- and postnatally. Assessments used were the Raven Progressive Coloured Matrices (measuring nonverbal reasoning and the ability to form comparisons and organize spatial perceptions) and the Peabody Picture Vocabulary Test (measuring receptive vocabulary). Scores for the three groups were not statistically significantly different when the analyses included confounding variables such as prenatal alcohol exposure, preschool attendance, parental education and various other factors (Eskenazi and Trupin, 1995).

The four studies cited above all failed to find a significant relationship between prenatal tobacco exposure and deficits in learning or cognitive development. These studies were inconsistent with the following three studies that found associations.

Olds, Henderson and Tatelbaum (1994b) found that the 3- and 4-year old children of mothers who smoked had statistically significantly lower scores on the Stanford-Binet test of intelligence than those not prenatally exposed to tobacco. Their sample (n=400) was considerably different than studies described above in that it was comprised of women from a semi-rural area of New York state who entered the study at the 30th week of pregnancy and who were predominantly poor, unmarried or teenagers. In addition, the researchers defined prenatal smoking exposure as ≥10 cigarettes daily throughout pregnancy, differing from the two studies above that defined smokers with considerably less precision. Olds et al. (1994a) further developed their work by evaluating the effects of an intervention in which there were nurse home visitations during pregnancy or
during the first two years of the child's life. These interventions during or after pregnancy had a positive influence in reducing the adverse effects of prenatal exposure to tobacco, a somewhat similar conclusion to that of Baghurst et al. (1992) who found that adjusting their analyses for variables that were related to stimulating home environments was found to alter the association between prenatal exposure and cognitive development. Another important aspect of this study (Olds et al., 1994a, 1994b) was the examination of timing of tobacco exposure. Separate analyses of covariance were conducted for exposure beginning at gestational mean age of 17 weeks, at 34th week of gestation, and at postnatal exposure at age 4 years. The children's scores were measured at between ages 3 and 4 years. All three exposed groups had lower scores than the non-exposed group, with the largest difference found between the non-exposed and those exposed starting at the 34th week of gestation and the smallest difference noted between the non-exposed children and exposed only postnatally.

Sexton, Fox and Hebel (1990) also found a relationship between prenatal tobacco use and cognitive development, as tested at age 3 years. They used one of the same scales as Baghurst et al. (1992), the McCarthy Scales of Children's Abilities, as well as the Minnesota Child Development Inventory. They also defined smoking as ≥10 cigarettes daily. Interesting, theirs was not a comparison of those exposed and those not exposed, rather, it compared the offspring of those who stopped smoking at, or prior to, the 18th week of gestation. On the general scale and all subscales, the children of those who continued to smoke had significantly lower test scores. The researchers carefully considered the social, educational and other background variables.
In the only Canadian longitudinal study, children who were born between 1980 and 1983 to predominantly low-risk middle-class women in the Ottawa area were studied (n=698), examining prenatal exposure to alcohol, tobacco and marijuana. Results have been reported for cognitive effects at various ages, from 12 months to 12 years. Prenatal tobacco exposure was observed to be associated with lower mental scores and altered responses to auditory items at ages 1 to 2 years (Gusella & Fried, 1984), with poorer language development and lower cognitive scores at ages 3 to 4 years (n=190) (Fried & Watkinson, 1990) and with lower cognitive and receptive language scores at ages 5 to 6 years (n=136) (Fried et al., 1992b), after controlling for confounding factors including parental education, prenatal marijuana exposure and to moderate amounts of alcohol. Children were administered a battery of tests, including at ages 3 to 4 years the Reynell Development Language Scales, the Pegboard Test and Tactile Form Recognition Task and at ages 3, 4, 5 and 6 years, the McCarthy Scales (Children’s Abilities, General Cognitive and Verbal Subscale) and the Peabody Picture Vocabulary Test. Smoking was categorized according to none, light or heavy (>15 mg nicotine a day, or approximately one package per day). Home environment was controlled as a variable in the analyses, since it was considered to be related to cognitive development. The verbal subscale of the McCarthy Scales was primarily responsible for discriminating the exposed and non-exposed groups for both 3 and 4 year olds. A negative dose-response performance was observed, with the heavily exposed group having poorer verbal skills than either of the other groups, both with the 3 and 4 year olds and with the 5 and 6 years olds. The researches noted that, at least for the 5 and 6 year olds, the smoking exposed and the non-exposed groups were significantly different, but the former group means were still above the norm for their respective ages.
In summary, the three studies (Olds et al., 1994a, 1994b; Sexton et al., 1990; Fried & Watkinson, 1990; Gusella & Fried, 1984) that defined smoking as ≥10 cigarettes daily found a relationship between cognitive development at preschool age and prenatal tobacco exposure, while four other studies (Trasti et al., 1999; Niemelä and Jarvenpää, 1996; Baghurst et al., 1992) that did not measure dosage or were vague about their measurement of prenatal tobacco exposure did not find a relationship between exposed and non-exposed groups. In contrast, the study (Eskenazi and Trupin, 1995) that had the most precise measurement of nicotine exposure failed to find a dose-response relation between prenatal exposure and cognitive development when confounding variables were accounted for in the analyses.

School age and beyond (ages 6 to 23 years)

Studies of children between the ages of 6 and 12 years also showed contradictory results, with three studies (Fried et al., 1998, 1997, 1992b; Naeye & Peters, 1984; Nichols & Chen, 1981) showing some lower intellectual functioning, while other studies (McGee & Stanton, 1994; Roeleveld et al., 1992; Fergusson & Lloyd, 1991; Rantakallio, 1983; Lefkowitz, 1981; Hardy & Mellits, 1972) observed no differences between exposed and non-exposed children in general intellectual functioning after confounding factors were included in the analyses. Although the general test showed no differences, some areas of test scores discriminated the exposed from the non-exposed. Those who used assessments with subscales testing different components of academic abilities had some consistency in their results, as children exposed prenatally appear to be effected in their language abilities, but only one study showed deficits in arithmetic or mathematics test scores.
Three groups of researchers (Naeye & Peters, 1984; Nichols & Chen, 1981; Hardy & Mellits, 1972) each analysed and reported on the intellectual functioning of children at age 7 years who were part of the 12-site U.S. Longitudinal National Collaborative Perinatal Project (NCPP) in which 58,000 pregnancies were followed prospectively beginning in 1959. Naeye and Peters (1984) tested the children from the Boston site (n=12,150), administering the Wide Range Achievement Test (WRAT) assessment of spelling, reading and arithmetic. In an attempt to overcome the criticism that child-rearing practices and genetic factors might be potential confounders, children from the same family and gender were matched, with only one sibling from each family having been prenatally exposed to tobacco. Children whose mothers smoked throughout the pregnancy had significantly lower scores on the reading and spelling subtests, although the differences were slight with only 3% lower spelling scores and 4% lower reading scores than those of the children of non-smokers. There was no difference between the children of smokers and non-smokers on the arithmetic scores. As noted above when discussing research with the same cohort with respect to behavioural outcomes of prenatal tobacco exposure, Naeye and Peters (1984) were unable to control for alcohol exposure. Their analyses showed that reading and spelling were associated with a wide range of other variables including maternal age, family income, maternal and paternal education, birth order and gender.

These results contradict two other studies using different sites of the NCPP. Hardy and Mellits (1972) found no significant difference between the group exposed to ≥10 cigarettes daily and the non-exposed group (n=88) in general intellectual functioning when tested at ages 4 and 7 years. They used the WRAT as an assessment tool, and did find scores on the spelling and reading
subscales to be significantly different between the two groups. Nichols and Chen (1981) initially found significant differences in results on all components of “minimal brain damage,” that is, learning difficulties, hyperkinetic impulsive behaviour (hyperactivity, impulsivity, short attention span and emotional lability) and neurological signs (e.g., coordination, gait, reflexes) in children whose mothers smoked 20 cigarettes daily or who smoked heavily (≥40 cigarettes daily). When multivariate analyses were conducted controlling for socio-environmental factors, only hyperkinetic impulsive behaviour was found to be a risk for those who were prenatally exposed to tobacco (Nichols & Chen, 1981). Women who smoked more than 20 cigarettes daily were 28% more likely to have children with hyperactivity-impulsivity.

Similar to the American study, a large retrospective British study, the National Child Development Study, followed all 16,000 children born during a 3-week period in 1958 in Scotland, England and Wales (Fogelman & Manor, 1988; Fogelman, 1980; Butler & Goldstein, 1973; Davie et al., 1972). Doses were categorized as none, “medium” (10 cigarettes per day) or “heavy” (>10 cigarettes per day). Reading ability scores were significantly different between the exposed and non-exposed groups at age 7 years (Davie et al., 1972), and again at age 11 years (Butler and Goldstein, 1973). At age 7 years, differences equivalent to 4 months of reading age were found between the heavily exposed and the non-exposed groups (Davie et al., 1972). At age 11, there was no dose-response shown in reading scores, but statistically significant differences were found between the exposed and non-exposed groups. Mathematics scores did not differ between the two groups at ages 7 and 11 years. At age 16 years, an association was observed between tobacco exposure and both reading and mathematics (Fogelman, 1980). At the older age, a small dose-response effect was
observed, with those exposed to 10 or fewer cigarettes scoring lower than those not exposed and those whose mothers smoked “heavy” doses scoring lower than those whose mothers smoked at “medium” levels. Analyses at each of these ages controlled for various confounding factors, including gender, birth weight, gestational age, social class (based on father’s occupation) at birth and at age 16 years and number of siblings. Prenatal alcohol exposure was not included in the list of potentially confounding variables.

The same cohort was followed again to find that at age 23 years the prenatally exposed group did not achieve the same educational levels as their non-exposed counterparts, even after controlling various confounding factors such as social class (Fogelman and Manor, 1988). The researchers concluded that the relationship was observed to be even stronger at age 23 years than earlier. This may not be surprising, given that the exposed group from the same cohort had been doing relatively poorly on at least some academic subjects at ages 7, 11 and 16 years (Fogelman, 1980; Butler and Goldstein, 1972, 1973). This is the only study found to date to indicate that depressed intellectual development has persisted over a very long term.

In the Canadian longitudinal study, mentioned above when discussing preschool children, testing for cognitive effects also was completed at ages 9 to 12 years (n=131) (Fried et al., 1998, 1997). Results showed a dose-dependent association between prenatal tobacco exposure and lower language and reading scores, after analyses controlled for confounding variables. This is similar to the researchers’ observations at earlier ages. The interesting more recent finding was that lower reading scores were particularly auditory-related aspects of the 7 assessment tools used, so that
exposure appeared to have less influence on nonverbal auditory performance than on higher language functioning. This led the researchers to conclude that "for reading, the phonological rather than the orthographic sphere was more affected" and that prenatal tobacco exposure alters a range of behaviours dependent on auditory functioning (Fried et al., 1997, p. 182). Significant differences between the exposed and non-exposed groups were not found on the reading subscale of the WRAT assessment. The researchers assessed only language and reading abilities and omitted arithmetic or mathematics in their testing. Their methods used only some of the subtests of the assessment tools, for example, only the reading subtest of the WRAT test.

A retrospective study (McGee & Stanton, 1994) of New Zealand women (n=1037) self-reporting their tobacco use was unable to establish a relationship between prenatal exposure and children's language skills or general cognitive development. Smoking was categorized according to dose-related levels. Any initial effect found in the relationship was lost when many confounding factors were added to the analyses, with the exception of a weak relationship between prenatal exposure and I.Q. scores at age 5 and reading at age 9, both only for girls.

Another New Zealand longitudinal study (Fergusson & Lloyd, 1991) also showed no relationship between daily prenatal tobacco exposure and general tests of intelligence, reading, writing and mathematical abilities for children tested at ages 8 to 12 years, after the analyses were adjusted for confounding variables. Children exposed to at least 20 cigarettes daily scored significantly lower on the tests. Analyses also showed that relatively disadvantaged home environments were more likely to influence score results than prenatal exposure to tobacco. This was one of the few studies
found in which considerable effort went towards recording dosage, timing (exposure at each trimester) and frequency of exposure. Alcohol use was not included in the data collection.

U.S. researcher Lefkowitz (1981) tested children at age 10 years and found no significant difference between the offspring of smokers and non-smokers, leading her to conclude that if these children survive the neonatal period, they will not suffer long-term effects with respect to intellectual functioning.

Linking data collected during a retrospective longitudinal study of a cohort of children born in two northern states in Finland with a cross-sectional study of children with mental retardation, cerebral palsy or epilepsy, it was observed that neither the number of handicapped children nor the numbers of handicaps differed between the exposed and non-exposed groups (Rantakallio & Koiranen, 1987). The same researcher examined the total cohort (n=1819) at age 14 years, finding that those exposed prenatally to tobacco had on average poorer school performance than those not exposed (Rantakallio, 1983). Controlling for various confounding factors led to the conclusion that although prenatal smoking exposure did have an effect on mental development, various other socio-biological factors were also considered to be risk factors, including indirect exposure through paternal smoking, and that many of these other risk factors are co-linear with maternal smoking during and after pregnancy.

In another European cross-sectional study of 322 children with mental retardation who were admitted for care anytime up to age 15 years, prenatal tobacco exposure was not observed to be a
risk factor (Roeleveld et al., 1992).

As mentioned, in the discussion on studies of younger children, there is also inconsistency in the results regarding overall intellectual functioning amongst older children and adolescents who were exposed to tobacco prenatally. The inconsistency could be a function of measurement since some of the studies that observed no differences between the exposed and non-exposed may have included very low levels of exposure in their "exposed groups." Some consistency, although tentative, may be emerging from these studies with respect to types of deficits in intellectual functioning. In six of the studies, deficits in reading or language were observed, in some even when overall intellectual functioning did not discriminate the exposed and non-exposed groups (Fried et al., 1998, 1997, 1992b; McGee & Stanton, 1994; Naeye & Peters, 1984; Fogelman, 1980; Davie et al., 1972; Hardy & Mellits, 1972; Goldstein, 1971). For example, McGee and Stanton (1994) found that confounding variables accounted for any initial relationships they observed between intellectual functioning and prenatal tobacco exposure, except for a relationship, albeit weak, between prenatal exposure and I.Q. scores at age 5 and reading at age 9, both only for girls. Both Naeye and Peters (1984) and Hardy and Mellits (1972) found that spelling and reading scores, but not arithmetic scores, discriminated the exposed and non-exposed groups when using the WRAT to assess the children's abilities at age 4 or 7 years. Fried et al. (1998, 1997) only tested reading or language abilities during later testing of the Ottawa cohort, that is, ages 9 to 12 years. They observed lower test scores in these areas associated with prenatal tobacco exposure, especially on auditory-related aspects of the reading tests. Fried et al. (1998, 1997) attempted to be more precise in their testing of various components of language and reading abilities, finding,
for example, that more complex tasks such as reading comprehension caused more difficulty for exposed groups compared to non-exposed groups. They also noted that altered auditory-dependent aspects of reading caused more problems for the exposed groups, leading them to conclude that altered auditory-based behaviours also discriminated the exposed and non-exposed in testing they had completed during earlier ages of the same cohort (Fried et al., 1998, 1992b, 1990). Children 6 to 11 years old were tested specifically using a central auditory processing task, and it was observed that prenatal tobacco exposure was associated linearly with poorer performance, leading to the conclusion that “the consequences to the child with impaired auditory processing capabilities may be reflected in difficulties in learning and behaviour that have been linked to in utero exposure to cigarettes” (McCartney et al., 1994, p. 275).

Only one study (Fogelman, 1980) observed deficits in mathematics scores when testing 16 year olds amongst a tobacco-exposed group although there was no reporting of deficits in arithmetic amongst younger groups of the same cohort (Butler and Goldstein, 1973; Davie et al., 1972).

2.3.3 Summary and discussion of prenatal tobacco exposure research

Consistent evidence was found for an association between prenatal tobacco exposure and fetal and neonatal growth. In addition to retarded growth, the health issue that was most consistently found to be associated with prenatal tobacco exposure was respiratory problems, persisting into childhood.

With respect to behavioural outcomes, studies consistently found an association between prenatal
exposure and attentional problems, hyperactivity or impulsivity. These same behavioural characteristics were found well into childhood and adolescence. At later ages, conduct disorder and criminality were found to be associated with prenatal tobacco exposure.

With respect to academic abilities, there was also consistency in the research literature regarding outcomes, in that language, reading or spelling scores in various assessments were found to be lower for those who had been prenatally exposed to tobacco, while mathematics or arithmetic scores, if tested at all, were rarely found to be lower.

The inconsistency in the results of these studies might be, for the most part, caused by weaknesses in the research designs. For example, an early study that did not find a relationship between exposure and inattention in 4-year olds had insufficient numbers of heavy smokers (Landesman-Dwyer et al., 1981). Another barrier to gaining better understanding of the effects of prenatal exposure has been the difficulty in discriminating pre- and postnatal exposure since very few women smoke during pregnancy and then stop at the birth of their child.

Few studies were found in which prenatal alcohol exposure and prenatal tobacco exposure were treated as interactive variables, rather, most analyses adjusted for the effects of the other variable. Some longitudinal studies have included prenatal alcohol exposure, prenatal tobacco exposure and other drugs used during pregnancy such as cocaine or marijuana, in examining outcomes on children in Pittsburgh (Leech et al., 1999), in Seattle (Streissguth et al., 1984) and in Ottawa (Fried et al., 1999, 1998, 1997, 1992a, 1992b; Fried, 1993; Makin et al., 1991; Fried & Watkinson, 1990).
The importance of examining the prenatal use of these drugs in the same longitudinal studies is that alcohol, at least, has also been found to be related to attentional problems, hyperactivity and impulsivity, as well as to lower scores on assessments of academic abilities. Any research examining the outcomes of prenatal tobacco exposure that does not take into consideration the effects of alcohol (or vice versa) may be suspect in its conclusions since the use of alcohol and tobacco covary. Researchers of the Pittsburgh and Ottawa longitudinal studies appeared to fully understand the potential risks of the alternative drugs under study. This may not have been the case in data collections in earlier studies in which data were collected regarding prenatal tobacco use well before there was any understanding of the potential risks of prenatal alcohol exposure; for example, the British National Child Development Study, 1958 Cohort (Butler & Goldstein, 1973; Davie et al., 1972; Goldstein, 1971).

Rush and Callahan (1989), in their review of prenatal tobacco exposure, criticized the majority of researchers for not adequately controlling for socioeconomic variables, that are related to both the dependent (developmental outcomes) and independent variable (prenatal tobacco exposure). Inconsistencies were found with respect to analytic control of additional variables, some of which have been observed to be correlated with prenatal tobacco use (e.g., as seen below, low maternal education or alcohol use during pregnancy). Thus, there is the possibility that some results were spurious. Reviewers of the research literature (Rush & Callahan, 1989; Landesman-Dwyer & Emanuel, 1979) conclude that the observed abnormalities cannot be assumed to be caused by parental cigarette smoking given that so little attention has been given to the differences in sociodemographic and psychological backgrounds between those who smoke during pregnancy.
and those who stopped during pregnancy or who have never smoked. Landesman-Dwyer and Emanuel (1979) suggested that researchers should have controlled for the variables of parental intelligence and psychological status. No more recent reviews have been found and it appears from the literature review for this thesis that this criticism still holds, likely because of the major methodological problems with the analytical comprehensiveness of any study including assessments of many demographic and environmental variables in a single study.

In spite of the criticisms, patterns in the research were found to emerge, especially with respect to behaviour. The research on cognitive development was less consistent, except in the case of language development or reading skills that may be related in turn to auditory development. In a number of studies examining cognitive outcomes, any initial relationship found between prenatal tobacco exposure and deficits in areas of cognitive development were no longer found to be significant when confounding factors, particularly mother's intelligence or mother's education or other socioeconomic status indicators were included in the analyses (Trasti et al., 1999; Niemelä and Jarvenpää, 1996; Eskenazi and Trupin, 1995; Eskenazi and Bergman, 1995; McGee and Stanton, 1994; Fergusson et al., 1993; Baghurst et al., 1992).

To further underline the argument about the importance of other variables, interventions have been found to overcome the relationship between poor cognitive development scores and prenatal exposure to tobacco. Olds et al. (1994a) found during a randomized clinical trial that intellectual impairments observed in children prenatally exposed to tobacco were offset by a comprehensive prenatal home-visitation program that concentrated on improving lifestyle behaviours (such as diet...
and reducing smoking during pregnancy) of women who smoked. Lifestyle behaviours have been found to be correlated with maternal education (see discussion below).

Therefore, any conclusions regarding prenatal tobacco exposure and cognitive effects would have to be made with caution, considering whether the outcomes are influenced by maternal education and related factors such as early childhood stimuli at home. Any conclusions regarding prenatal tobacco exposure and behavioural effects should also be considered cautiously, given that all researchers have not controlled for prenatal alcohol exposure, that is associated with attentional problems and hyperactivity. Longitudinal research in which the histories of both alcohol and tobacco use during pregnancy is part of the data collection and analyses (e.g., Fried in Ottawa and Streissguth in Seattle, along with their colleagues) should be given more weight when making conclusions about long-term effects of prenatal tobacco exposure.

2.3.4 Postnatal exposure to tobacco

Two reviews of the literature (Windham et al., 1999; Rush & Callahan, 1989) and a meta-analysis (Windham et al., 1999) on the effects of passive smoke (that is, not by the mother during pregnancy) on children's physical development conclude that postnatal exposure to environmental tobacco smoke has an effect equivalent to prenatal exposure in reducing birth weight. Second-hand smoke by exposure to paternal smoking throughout the life of the child was found to be a risk factor in a Finnish study (Roeleveld et al., 1992; Rantakallio, 1983). A group of 14-year olds (n=12,068), all of whom had been prenatally exposed to tobacco, was matched with a non-exposed group according to age, marital status of mother, parity and place of residence. Exposure to
paternal smoking carried nearly as strong an association with retardation in mental and physical
development as did exposure to prenatal maternal smoking (Rantakallio, 1983). Children who had
been exposed prenatally to tobacco smoke had on average poorer school performance than those
not exposed, but other socio-biological factors, including paternal smoking, were also risks for
slower mental development (Rantakallio, 1983).

In another study, groups were categorized according to whether their mothers smoked at 17 weeks
gestational age, 34 weeks gestational age and postnatally at age 4 years. Compared to a non-
exposed control group, the children's I.Q. scores (at average age 3 and 4 years) were lower for all
three groups, with the largest difference between exposed and non-exposed being the smoking
exposure at the 34th week of gestation and the smallest being postnatal exposure (Olds et al.,
1994a, 1994b).

Several other researchers have included postnatal exposure in their studies of the effects of
prenatal tobacco exposure with inconsistent results. Causal relationships have been established
which show that second-hand smoke has influenced the health and well-being of exposed children
(Brondum et al., 1999; Gergen et al., 1998, Strachan & Cook, 1998; Brooke et al., 1989).
Postnatal second-hand smoke was found to be an important risk factor for growth (Rona et al.,
1985) and for respiratory problems (Stein, 1999).

With respect to behaviour and postnatal tobacco exposure, Williams et al. (1998) followed a large
cohort of Australian children (n=5,342), finding that at 5 years of age, postnatal tobacco exposure
accounted for 16% of the variance in externalizing behavioural problems, while prenatal tobacco exposure accounted for 25% of the variance, even after controlling for various confounding factors including socioeconomic status.

The results of other research on this issue have been inconsistent, as indicated during the review above on prenatal tobacco exposure. This is not surprising given the varied methods of defining levels of tobacco exposure, measurement of outcomes and analytic control of confounding variables.
<table>
<thead>
<tr>
<th>Authors, country and age of study sample</th>
<th>Controlled variables</th>
<th>Prenatal alcohol exposure measurement</th>
<th>Results: behavioural outcomes</th>
<th>Results: cognitive outcomes or learning problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baghurst, Tong, Woodward and McMichael, 1992</td>
<td>Socioeconomic, mother’s intelligence (tested), home environment, pre-pregnancy smoking, clinical characteristics, prenatal alcohol use, diet</td>
<td>none</td>
<td>No relationship between exposed and non-exposed groups on Bayley or McCarthy Scales, after adjustment for socioeconomic background and mother’s intelligence</td>
<td></td>
</tr>
<tr>
<td>Brennan, Grekin, Mednick, 1999</td>
<td>Maternal rejection, socioeconomic status, maternal age, pregnancy and delivery complications, use of prescription drugs during pregnancy, paternal criminal history, parental psychiatric hospitalization</td>
<td>none</td>
<td>Dose-response relationship between amount of maternal smoking during pregnancy and arrests for nonviolent and violent crimes and in particular persistent criminal behaviour (rather than adolescent arrests only).</td>
<td></td>
</tr>
<tr>
<td>Davie, Butler and Goldstein, 1972; Butler and Goldstein, 1973; Fogelman, 1980; Fogelman and Manor, 1988; Goldstein, 1971</td>
<td>Gender, birth weight, gestational period, mother’s height, social class at birth and at age 16 (indicated by father’s occupation with children with no fathers being excluded from study), birth order, number of siblings.</td>
<td>none</td>
<td>At ages 7, 11 and 16 years, reading scores lower for exposed group; at age 16 mathematics scores also lower. At age 23 years, educational achievement higher amongst the non-exposed.</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Sample Size</td>
<td>Age</td>
<td>Study Design</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>-------------</td>
<td>-----</td>
<td>--------------</td>
</tr>
<tr>
<td>Day, Richardson, Goldschmidt and Cornelius, 2000</td>
<td>U.S.A. (Pittsburgh)</td>
<td>n=672 pairs</td>
<td>3 years</td>
<td>Case control</td>
</tr>
<tr>
<td>Denson, Nanson, and McWatters, 1975</td>
<td>Canada (Sask.)</td>
<td>n=20</td>
<td>5-15</td>
<td>Case control study. Subjects who were diagnosed with hyperkinetic syndrome, plus two groups of matched controls (normal and dyslexic); excluded those with low I.Q. and adopted children. Controlled for pregnancy complications; father's smoking.</td>
</tr>
<tr>
<td>Dunn, McBurney, Ingram and Hunter, 1977, 1976</td>
<td>Canada (Vancouver)</td>
<td>n=318</td>
<td>6.5 years</td>
<td>Prospective study</td>
</tr>
<tr>
<td>Eskenazi and Trupin, 1995; Eskenazi and Bergman, 1995</td>
<td>U.S.A. (California)</td>
<td>n=2000+</td>
<td>5 years</td>
<td>Parental education; family income; mother's age, employment status; father's social class; birth order, sex, gestational age at prenatal class.</td>
</tr>
</tbody>
</table>
Table 2.2 continued

<p>| Study                                      | Data Collection | Variables                                                      | Findings                                                                                                                                  | Notes                                                                 |
|--------------------------------------------|-----------------|                                                               |                                                                                                                                         |                                                                       |
| Fergusson and Lloyd, 1991; Fergusson, Horwood, and Lynskey, 1993 | New Zealand (n=1020) ages: 8, 10, 12. | Child’s race, age, gender, family size; mother’s age, education, socioeconomic status, average standard of living, emotional responsiveness, life events, changes of parents, punishment of child, parental discord; parental history of offending. | Significant increases in rates of childhood problem behaviours amongst those exposed either during and after pregnancy. Smoking during pregnancy associated with small but significant increases in problem behaviours. | After confounding factors included in analyses, no relationship found between exposure and scores on various scales of general intelligence, word recognition, math ability and reading comprehension. |
| Fried, 1989a; Fried and Makin, 1987; Fried and O’Connell, 1987; Kristjansson et al., 1989; Makin et al., 1991; Fried et al., 1992, 1997, 1998, McCartney et al., 1994 | Ottawa, Canada (n=250) ages: 1,2,3,4,5,6, 8, 9, 12 years. | Maternal age, education, socioeconomic status, including father’s and mother’s education, family income, home environment, mother’s age. Also compared post and prenatal exposure to tobacco. Sample was healthy, middle-class, well-educated, white cohort from urban Ottawa, who gave birth in early 1980’s. | Independent variables were prenatal exposure to low levels of alcohol, marijuana and tobacco. Analyses included and compared, exposed to each of these drugs. Impulsivity and attentional problems shown consistently at each of the ages for which the children were tested on tests of vigilance or behavioural ratings were given. Parents behavioural scale at age 6-9 years showed more behavioural problems in both the pre- and postnatally exposed groups, comparing with nonsmoking group. | At all ages, language or reading scores were lower for children prenatally exposed to tobacco, particularly on auditory-related aspects of reading assessments. |
| Gibson and Tibbetts, 1998 | U.S.A. (N=832) ages: 10 - 22 | None mentioned | Combination of two variables, prenatal tobacco use and low Apgar scores, predicted later police or criminal records. | Spelling and reading scores differed between the exposed and non-exposed groups. |
| Hardy and Mellitis, 1972 | U.S.A. ages: 4, 7 years | Socioeconomic factors | Hyperactivity and impulsivity observed in the exposed group. | Spelling and reading scores differed between the exposed and non-exposed groups. |</p>
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Age</th>
<th>Study Type</th>
<th>Controlled for Alcohol Use in Analyses</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landesman-Dwyer, Ragozin and Little, 1981</td>
<td>U.S.A. (Seattle)</td>
<td>4 years</td>
<td>Prospective study.</td>
<td>Healthy, middle-class, married, well-educated, white cohort</td>
<td>Did not find a significant relationship between maternal smoking and attention. Number of heavy smokers was small.</td>
</tr>
<tr>
<td>Leech, Richardson, Goldschmidt, and Day, 1999</td>
<td>U.S.A. (Pittsburgh)</td>
<td>6 years</td>
<td>Longitudinal study of women, all of whom were from lower socioeconomic backgrounds, child’s age and gender, presence of adult male, maternal work, maternal hostility.</td>
<td></td>
<td>Prenatal tobacco exposure is predictive of inattention. 2nd and 3rd trimester tobacco use predicted increased omission errors (measures of inattention).</td>
</tr>
<tr>
<td>Lefkowitz, 1981</td>
<td>U.S.A. (N.Y.)</td>
<td>10 years</td>
<td>Retrospective study; matched exposed and non-exposed cohorts on age, parity, income, education, occupation, father’s occupation, family size.</td>
<td>none</td>
<td>No significant difference on depression, happiness, social behaviour at school, self-esteem, peer-rated popularity.</td>
</tr>
<tr>
<td>McGee and Stanton, 1994</td>
<td>New Zealand</td>
<td>3-9 years</td>
<td>Family background (socioeconomic status, marital status, family adversity), perinatal adversity, health, child rearing (maternal attitude to child, maternal overprotectiveness, attendance at preschool, range of experiences given child, family adversity, child separation from mother).</td>
<td></td>
<td>Relationship between maternal reports of behaviour problems only during the age 5 testing. Behaviour measured: attention deficits-hyperactivity.</td>
</tr>
</tbody>
</table>

99
<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Sample Size</th>
<th>Age</th>
<th>Risk Factors</th>
<th>Evidence/Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milberger, Biederman, Faraone, Chen and Jones, 1993</td>
<td>U.S.A.</td>
<td>(n=140 ADHD, n=120 controls)</td>
<td>6-17 years</td>
<td>Socioeconomic factors, parental I.Q. levels, parental ADHD status</td>
<td>None. Heavy smoking (at least a pack a day for at least 3 months) observed to be a risk factor for ADHD.</td>
</tr>
<tr>
<td>Naeye and Peters, 1984</td>
<td>U.S.A. (Boston)</td>
<td>(n=12,150)</td>
<td>7 years</td>
<td>Demographic and pregravid factors (e.g., age, income, no. of abortions, length of time to become pregnant), numerous pregnancy factors, maternal behaviour (e.g., breast feeding, antenatal clinic visits, stopped work by 3rd trimester), newborn characteristics (e.g., birth order, gestational age at birth, 5-min. Apgar score).</td>
<td>No mention of alcohol reporting, except: &quot;Quantitative data on alcohol intake were not collected ... so alcohol is a variable that is only partially controlled&quot; (p.603). Hyperactivity and short attention span more frequent in children whose mothers smoked throughout pregnancy (measures for attention span and motor activity tests not well described). Lower reading and spelling test scores (using WRAT for reading, spelling and arithmetic).</td>
</tr>
<tr>
<td>Nichols and Chen, 1981</td>
<td>Britain</td>
<td>(n=29,887)</td>
<td>7 years</td>
<td>Poor orientation and poor attention found in exposed group. Prenatal tobacco exposure found to be amongst the 10 highest predictor variables for hyperactivity and impulsivity.</td>
<td>Maternal education and age, duration of breast feeding, marital status, number of siblings, Apgar scores, type of delivery, paternal smoking during pregnancy.</td>
</tr>
<tr>
<td>Niemela and Jarvenpää, 1996</td>
<td>Finland</td>
<td>(n=426)</td>
<td>56 months</td>
<td>None. Poor orientation and poor attention found in exposed group. Prenatal tobacco exposure found to be amongst the 10 highest predictor variables for hyperactivity and impulsivity.</td>
<td>Maternal education and age, duration of breast feeding, marital status, number of siblings, Apgar scores, type of delivery, paternal smoking during pregnancy. None. Poor orientation and poor attention found in exposed group. Prenatal tobacco exposure found to be amongst the 10 highest predictor variables for hyperactivity and impulsivity.</td>
</tr>
<tr>
<td>Study Authors and Details</td>
<td>Measures of Exposure and Covariates</td>
<td>Analyses Adjusted for Alcohol Use, But Measurement or Doses Not Reported</td>
<td>Findings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------------------</td>
<td>-------------------------------------------------</td>
<td>----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olds, Henderson and Tatelaum, 1994</td>
<td>Maternal age, partner support, marital status, diet, alcohol and first trimester drug use, maternal depression, gestational age at initial prenatal care visit, father’s education, duration of breast feeding, number of prenatal visits</td>
<td>Analyses adjusted for alcohol use, but measurement or doses not reported</td>
<td>Children whose mothers smoked ≥10 cigarettes daily had lower I.Q. scores as tested by Stanford-Binet.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orlebeke, Knol, and Verhulst, 1999, 1997</td>
<td>Birth weight; maternal age, socioeconomic factors, type of feeding (bottle or breast)</td>
<td>none</td>
<td>Prenatally exposed children showed more externalizing behavioural problems, but not more internalizing behaviours than controls. Same for boys and girls. Aggression subscale scores increased the overall externalizing score.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rasanen, Hakko, Isohanni, Hodgins, Jarvelin, and Tiidonen, 1999</td>
<td>Socioeconomic factors (father’s socioeconomic, mother’s education, urban/rural residence); pregnancy and birth factors (e.g., complications, mood and attitude to pregnancy); obstetrical complications; family and parenting risk factors (e.g., marital status, age, family size).</td>
<td>none</td>
<td>Maternal smoking associated with violent offenses and persistent offenses, not with nonviolent offenses.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Age</td>
<td>Factors Assessed</td>
<td>Alcohol Use</td>
<td>Outcome</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------</td>
<td>-----</td>
<td>----------------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Sexton, Fox and Hebel, 1990</td>
<td>U.S.A.</td>
<td>3 years</td>
<td>Socioeconomic factors (maternal education, income); maternal age, prenatal visits, race, alcohol and coffee use during pregnancy, number of siblings, mother employed, birth order, number of child illnesses and visits to the doctor and hospitalization days.</td>
<td>Alcohol use controlled, but measurement not reported</td>
<td>Higher I.Q. scores (on McCarthy Scales and Minnesota Child Development Inventory) for those who stopped during pregnancy, comparing to those who smoked throughout pregnancy.</td>
</tr>
<tr>
<td>Streissguth, Martin, Barr and Beth, 1984</td>
<td>U.S.A.</td>
<td>5-15</td>
<td>Child's birth order; race; maternal education; nutrition; prenatal caffeine exposure and prenatal alcohol and other drug exposure.</td>
<td>Specific measures (quantity and frequency) of alcohol at 2 time periods (pre-pregnancy and at 5th month) during an interview.</td>
<td>Poor attention and poor orientation to the task (no significant different in reaction time).</td>
</tr>
<tr>
<td>Trasti, Vik, Jacobsen and Bakketei, 1999</td>
<td>Scandinavia</td>
<td>13 months, 5 years</td>
<td>Maternal age, paternal and maternal income, breastfeeding, maternal education.</td>
<td>none</td>
<td>No difference at age 13 months on Bayley Scales of Infant Development; at age 5 years, no difference on scales of intelligence (WPPSI-R) when adjusted for maternal education. At age 5 years, differences on balance.</td>
</tr>
<tr>
<td>Wakschlag, Lahey, Loeber, Green, Gordon and Leventhal, 1997</td>
<td>U.S.A.</td>
<td>6-12 years</td>
<td>Maternal age, birth complications, prematurity, low birth weight, family factors (e.g., marital status); parental antisocial personality, maladaptive parenting, SES, substance abuse during pregnancy</td>
<td>Controlled; treated as dichotomous variable (yes or no)</td>
<td>age: 12 - 17 years olds referred to clinic (assessed over 5-year period) Results: Maternal smoking is independent risk factor for conduct disorder in males</td>
</tr>
<tr>
<td>Study/Region</td>
<td>Sample Description</td>
<td>Variables andContextual Factors</td>
<td>Findings</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------</td>
<td>----------------------------------</td>
<td>----------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Weissman, Warner, Wickramaratne and Kandel, 1999</td>
<td>U.S.A. (n=50) ages 16-33 years</td>
<td>Demographic factors, parental psychopathological conditions, pregnancy risk factors and family risk factors.</td>
<td>Mentioned that smokers had higher rates of alcohol use than controls, but analytic treatment not discussed.</td>
<td>4-fold increased risk in prepubertal-onset Conduct Disorder in boys, and a 5-fold increased risk of adolescent drug use in girls.</td>
<td></td>
</tr>
<tr>
<td>Weitzman, Gortmaker, and Sobol, 1992</td>
<td>U.S.A.</td>
<td>Child's race, age, gender, birth weight, chronic asthma; family structure, income, divorce or separation of parents, mother's education, intelligence, self-esteem, employment status, chronic disabling health conditions. Compared pre- and/or postnatal tobacco exposure.</td>
<td>Controlled: dichotomous variable of regular use, defined as one or more alcoholic drinks per week during pregnancy</td>
<td>Most behaviour problems amongst those whose mothers smoked both during and after pregnancy, or only after birth of child. Dose-related with strongest link with behavioural problems at exposure of ≥ pack a day.</td>
<td></td>
</tr>
<tr>
<td>Williams, O'Callaghan, Najman, Bor, Andersen, Richards, and Chinlyn, 1998; O'Callaghan, Williams, Anderson, Bor and Najman, 1997</td>
<td>Australia (n=5342) age: 4-6 (mean 5.5 years).</td>
<td>Maternal age, education, social class, marital status, mental health; gestational stage at first clinic visit, complications during pregnancy, child's gender, gestational age at birth; family structure and maternal mental health.</td>
<td>None</td>
<td>Results: dose-response; higher levels of smoking associated with higher rates of externalizing (aggressive) behaviour problems; weaker relationships with internalizing behaviour.</td>
<td></td>
</tr>
</tbody>
</table>
2.4 Socioeconomic background

Socioeconomic status (SES) as a variable is complex in that researchers have often controlled for it, rather than examined its main effect (Gazmararian et al., 1996; Marmot et al., 1995; Adler et al., 1994; Green, 1970a) and conceptualized and defined it differently by various researchers (Williamson, 1999). Its indicators for measurement have not been well established (some of the indicators have been found to be interrelated but overlapping) and some of the behavioural outcomes for which SES has been an independent variable in themselves covary. Marmot, Bobak and Davey Smith (1995) suggested that it may be better to attempt to understand the links between social position and health, rather than treating socioeconomic background “as a nuisance variable that messes up statistical analysis” (p. 172).

Associations between socioeconomic status and health, or the absence of health as measured by mortality and morbidity, have been consistently found over time and across cultures (Susser et al., 1985). In the research literature, this variable has been found to be more often considered a confounder than a risk factor (Liberatos et al., 1988).

At least four theoretical viewpoints have been proposed in attempts to explain the consistency of results in studies of the relationship between social inequality and health, regardless of the outcome variable (e.g., infant mortality, accidents, heart disease) (Cubbin et al., 2000; Reutter et al., 1999; Marmot et al., 1995; Kennedy et al., 1998). The possible explanations are that: (1) the relationship is an artefact or not really present, (2) there is natural selection with those who are more often ill having a tendency to drift down economically and socially (“drift theory”), (3) there are
behavioural or lifestyle differences such that those who choose unhealthful lifestyles are those who come from lower levels of the socioeconomic gradient and (4) there are structural differences between the wealthy and the poor (such as housing, access to health care, employment circumstances) that contribute to poor health. Since socioeconomic inequalities may influence, or covary with, the independent variables that are behavioural in nature (i.e., alcohol and tobacco use during pregnancy) (see, for example, Olkinuora, 1984) and may influence outcome variables (health, academic abilities, behaviour) (see, for example, Kennedy et al., 1998), socioeconomic inequalities are considered an important variable to further explore.

Of concern to this thesis, and indeed to most health studies that include socioeconomic inequalities, is that measurement of socioeconomic status and inequalities has been challenging (Murray et al., 1999; Blane et al, 1998; Wilkinson, 1996; Liberatos et al., 1988; Mackenbach & Kunst, 1997; Russell et al., 1990). Even when individual indicators are used, as opposed to social conditions in the aggregate, there is inconsistency in the use of those indicators (Wilkinson, 1996) with occupation being more often used by British researchers, educational attainment by European researchers and racial background being included with other indicators by researchers from the United States.

Also of concern to the present thesis is that socioeconomic inequalities may influence both independent and dependent variables, possibly in different ways. Canadian data indicated that tobacco use has an inverse relationship with education level so that smoking prevalence decreases with higher educational attainment in both the general population and in the subcategory of
pregnant women (Canada. Health Canada and Statistics Canada, 1999). An extensive examination of this inverse relationship found a threshold effect, with a sharp change between those with less than 9 years of education and those with 10 or more years of education (Zhu et al., 1996). Various categories of smokers (e.g., currently smoking, heavy smoker, those who have not stopped) were associated with numerous indicators of socioeconomic status, including educational status (less than 9 years of education), marital status (divorced or separated), employment status (not being employed) and poverty status (income below poverty level) (Zhu et al., 1996). Likely similar to other western countries, Canadian women with the highest education practice more healthful behaviours, including smoking less (Pomerleau et al., 1997; Hofer & Katz, 1996, Millar and Stephens, 1993). Studies of pregnant Canadian women were consistent in their findings in that women who are younger (less than 24 years), unmarried and with less education have the highest rates of tobacco use both before and during pregnancy (Dodds, 1995; Stewart et al., 1995). Stewart et al. (1995) also found that, at least in the Ottawa area, there was a significant difference in smoking prevalence during pregnancy between those living above and below the poverty level, based on Statistics Canada’s tables of annual income, family size and geographic region of residency. U.S. research is consistent with the Canadian studies, with more tobacco use during pregnancy amongst less educated, low-income women (Leech et al., 1999; MMWR, 1999a; NIDA, 1996; Kleinman & Kopstein, 1987) and unmarried women (Williamson et al., 1989), although the subgroup whose smoking prevalence rates are declining the fastest are black pregnant teenagers who are typically unmarried and have low education (Land & Stockbauer, 1993). A British study found the same association (Haslam et al., 1997), while a French study found no significant associations with education or paid work (Kaminski et al., 1995).
Regarding alcohol use in Canada's general population studies, people in the highest income and highest education categories have been observed to have the lowest number of occasions of heavy drinking (Pomerleau et al., 1997). No population-based studies on use by pregnant Canadian women were found, either with respect to use of alcohol or of other drugs. Population studies of women in the U.S.A. and in France were found. The sociodemographic background of women who continued to drink alcohol during pregnancy (rather than stopping when they became pregnant) has also been studied, with the results being inconsistent. In two U.S. studies, women with the highest incomes were more likely to drink alcohol during pregnancy (Ebrahim et al., 1998; NIDA, 1996), and variables associated with binge drinking during pregnancy were being unmarried, employed and a smoker (Ebrahim et al., 1999). In contrast, another U.S. study (Leech et al., 1999) found that pregnant women who used alcohol heavily did not have any distinguishing sociodemographic characteristics. A 1988 U.S. study using national data found that frequent prenatal drinking was more prevalent amongst older women (>35 years), all racial groups other than Caucasian, those with low incomes and those who are smokers (MMWR, 1995a). A more recent study in Pittsburgh found that the heaviest smokers, at least during the first trimester of pregnancy, were more likely to be Caucasian and less educated (Leech et al., 1999). A study that was conducted over two time periods (before and after medical and media attention regarding FAS) showed that there was a decrease of alcohol use during pregnancy in the 6-year period, but that the decrease was most marked in the highly educated groups (Streissguth et al., 1983). In a study of socially disadvantaged cohort of women in France, alcohol consumption was highest among those with the least education. Abel (1995) has argued that even if some studies have shown prevalence of risky drinking during pregnancy to be at the higher ends of the socioeconomic
gradient, it may not be their offspring who are those most affected by alcohol-related birth
problems since other factors (for example, nutrition) may interact with alcohol exposure.

The only Canadian longitudinal study of pregnant women found that lower socioeconomic status,
as defined by family income and mother's education were associated with both tobacco and
marijuana use during pregnancy but not with alcohol use (Fried & Watkinson, 1990). It should be
noted that the study drew its sample from a homogeneous predominantly middle-class low-risk
Caucasian population.

In summary, there appears to be an association, at least correlational, between the independent
variables, socioeconomic status and alcohol and tobacco use during pregnancy.

In addition, there may be a relationship between socioeconomic status and the outcome variables
of this thesis. The relationship between social conditions and health has been well-documented
Adler et al., 1994, 1993; Evans et al., 1994; Feinstein, 1993; Liberatos et al., 1988; Green, 1970a).
Socioeconomic disadvantages during childhood have been shown to influence health well into
adulthood (Hertzman & Wiens, 1996; Schwartz et al., 1995; Peck, 1994). Academic abilities have
been found to be associated with socioeconomic background. Amongst 4-year old children, those
with multiple social-environmental risk factors were observed to be more than 24 times as likely to
be have low verbal I.Q. scores (Sameroff et al., 1987) and amongst school-aged boys
socioeconomic gradient correlated with both slow physical growth and lower reading achievement
(Weinberg et al., 1974).
Independent associations were found between lower income, minority status and lower parental education and poorer performance on cognitive assessments amongst children aged 6 to 16 years from a large U.S. national cohort (n=2531) (Kramer et al., 1995). The same study found that general health status was a predictor of performance on cognitive assessments (including the WRAT-R) (Kramer et al., 1995).

It has been observed that infants born with low birth weight more often come from disadvantaged backgrounds, even controlling for behavioural factors such as alcohol and tobacco use during pregnancy. This observation has led to suggestions that women in the socially-deprived “group has associated with it a few significant and common unidentified pathological factors or, more likely, that numerous factors in the social environment are acting to reduce birth weight” (Wilcox et al., 1995, p.924). Evidence on this issue has been inconsistent. Brooke et al. (1989) examined several risks (including the use of tobacco, alcohol and caffeine, psychosocial stress and socioeconomic background) and concluded that smoking during pregnancy was the main contributor to low birth weight, while social and psychological factors had little or no direct effect. Orr et al. (1996) found that psychosocial stressors had different effects on those from different racial backgrounds and that for Caucasian women, significant predictors of low birth weight were smoking, drug use and other factors and that psychosocial stressors may be only indirectly associated. These latter studies suggested that smoking may have a more direct association with low birth weight, but that tobacco use during pregnancy and socioeconomic background covary.

Measurement may be complicated by the socioeconomic background of mothers. It has been
found that some groups of women are more likely to assess their children as having poor health; for example, single mothers were observed to be significantly less likely to report their child as having "excellent" health on a 5-point adjectival scale (Angel & Worobey, 1988), mothers under stress reported more illness for themselves and for their children than those not under stress (Mechanic, 1964), and different racial groups assess the state of their children's health differently (Angel & Worobey, 1988). Of particular interest to the present study were the findings that women who used alcohol or drugs during pregnancy were observed to under- or over-rate considerably their infant child's development, with heavy alcohol users being 15-fold more likely to overestimate their infants mental development and illicit drug users being 4-fold more likely to underestimate their infant's physical development, comparing with test results of the Bayley Scales of Infant Development (Seagull et al., 1996).

The results of at least one study suggested that "developmental outcomes are more strongly related to environmental influences than to prenatal insult" (Greene et al., 1991a, p.66). Home environment was more predictive of lower scores on cognitive development than either prenatal exposure to tobacco or to moderate levels of alcohol exposure, even within a predominantly socioeconomicly disadvantaged cohort of mother-child pairs from Cleveland.

2.5 Other potentially confounding factors

There are, of course, several other potentially confounding variables that could mediate or moderate the association between prenatal risk factors and outcomes regarding children's health, behaviour or academic abilities.
Prenatal and postnatal nutritional deficiencies can adversely affect the newborn and child both physically and cognitively. Some researchers have suggested confounding factors that could explain the link between poor nutrition and learning problems as being indirect (Karp, 1993; Karp et al., 1992). The correlational relationships between measures of nutrition and aptitude or school achievement among children from disadvantaged neighbourhoods have not been found among white, upper middle class children (Richards et al., 1984; Karp et al., 1992). Social environments that adversely affect both nutrition and learning abilities appear to exist for children living in poverty (Karp, 1993; Hallberg, 1989).

Poverty and culture have been linked to incidence rates of FAS. The relationships between FAS and poverty or culture are unclear, however, because of the strong relationship between these two factors (some cultural groups and poverty) and between these two factors and other risk factors including nutrition and smoking. Several studies have indicated a positive relationship between specific cultural groups, especially aboriginal groups in Canada and black and aboriginal groups in the United States, so that early researchers hypothesized a genetic link between FAS and those cultural groups. Although epidemiological data have suggested higher incidence rates of FAS among aboriginal than among non-aboriginal populations in Canada (Square, 1997; Robinson et al., 1987), there is no clear evidence of genetic predisposition, rather that poverty may be an intervening factor. Bingol et al. (1987) found a highly statistically significant difference in the prevalence of FAS or FAE between low and high socioeconomic status women. They found FAS to be rare in the high socioeconomic group of chronic alcoholic women, although there were occurrences of lower educational achievement and attention deficit disorder amongst their
children. Even those rates were statistically different, for example 21% of offspring of alcoholic women in the higher socioeconomic group had attention deficit disorder, compared with 71% of the children in the lower socioeconomic group.

2.5.1 Other maternal and child factors

Other factors have been shown to influence the outcomes under study in the present thesis, including maternal age at delivery of the child under study and birth order.

Maternal age and parity have been observed as increased risk for fetal alcohol syndrome both in case reports and epidemiological studies (Abel, 1998b; Jacobson et al., 1996; Sokol et al., 1986). Abel (1998b, 1988, 1984; Abel & Dintcheff, 1985) calculated that there is a 79 fold increased risk of having a second child with FAS if a mother has already had one child with FAS. Whether parity or age increases the risk has not yet been determined in humans, since maternal age, parity, duration of alcoholism and maternal health have been found to covary. Some animal studies suggested that advanced age increases fetal vulnerability more than does parity (Jacobson et al., 1996; Abel & Dintcheff, 1985, 1984). Speculated explanations found in the literature are that there are increasingly greater blood alcohol levels as age advances even when the same amounts of alcohol are consumed, reducing the ability to metabolize alcohol as age increases (Jacobson et al., 1996) and that increased age correlates with an increased stage of alcoholism and the general unhealthiness of pregnant alcoholics (Majewski, 1981). A positive aspect of this relationship is that those generally considered most at risk, that is teenagers or younger mothers, because of the higher rates of alcohol consumed in that age category, may have decreased risk for having
offspring with FAS (Abel, 1998b).

The research on maternal age and parity has been conducted in animal research with high doses of alcohol. In humans, only case reports and other studies involving people with FAS have shown the associations with maternal age and parity, and there have been no studies where more moderate levels of alcohol were consumed.

Only one study was found on the relationship between the effects of prenatal exposure to tobacco and maternal age. Ahluwalia (1997) observed a slightly elevated risk of low birth weight for the offspring of women over age 30 years who smoked during pregnancy.

2.5.2 Other drugs

Outcome variables of this study may be modified by the mother’s use of drugs other than alcohol or tobacco.

Marijuana

More prevalent than other illegal drugs amongst the sample in the Vancouver Island Pregnancy Study was the use of marijuana during pregnancy, with approximately 10 percent (n=40) of the women admitting to using marijuana prior to pregnancy and 5 per cent (n=20) reported using marijuana during at least one of the trimesters of pregnancy, with about half that number using marijuana throughout their pregnancy (Armstrong et al., 2001a). Hashish was also used by 12 (3%) of the women before pregnancy, but half of these women stopped during the first trimester.
and only two women used hashish on an infrequent basis in the third trimester.

The rates of reported marijuana use were lower than those found in other studies; for example the Ottawa Prenatal Prospective Study found in 1978 that 20% of women smoked marijuana at some time during pregnancy (Fried et al., 1995a, 1998b) and in a cohort of women of predominately lower socioeconomic backgrounds in Pittsburgh, U.S.A., the rates for each trimester were about twice that of the Vancouver Island Pregnancy Study (Leech et al., 1999; Day et al., 1992, 1991). Hashish use in the latter study was rare and cocaine use was low (3% during first trimester, 1% in second trimester and 0.3% during third trimester) (Leech et al., 1999).

A limited number of longitudinal studies of the effects of prenatal marijuana exposure on school-aged children were found. Leech et al. (1999) tested the offspring of the cohort of Pittsburgh women for attention and impulsivity problems at age 6 years, finding that second trimester marijuana use was predictive of more errors of commission (reflecting impulsivity) and fewer errors of omission (reflecting inattentiveness). In contrast, Fried, O’Connell and Watkinson (1992a) found that the 6-year old offspring of middle-income mothers who used marijuana during pregnancy had an increased number of errors of omission in a task of vigilance and that there was a dose-response relationship between prenatal marijuana exposure on two indicators of impulsivity/hyperactivity. Prenatal marijuana exposure was not associated with deficits in cognitive and language skills (Fried et al., 1992b). Fried et al. (1998, 1997) found that prenatal marijuana exposure was not significantly related to reading or language skills, nor to global intelligence scores, by ages 9 to 12 years. On the other hand, they found that two of their many
subtests were consistent at testing during the neonatal stage, and at ages 3 and 9-12 years. Their results showed an association between prenatal marijuana use and poorer habituation to visual but not auditory stimuli at neonatal stage and poorer abstract/visual reasoning in 3-year olds. For the 9-12 year olds, overall intelligence was not significantly different between the exposed and non-exposed groups, but the two groups were differentiated on the subtests of Block Design and Picture Completion on the Wechsler Intelligence Scale for Children. The results showed a linear trend. In summary, Fried and his colleagues in Ottawa found that prenatal exposure was negatively associated with integrative abilities based on visual analysis, visual hypothesis testing and impulse control, but not with verbal skills or overall intelligence.

Caffeine

The research on the effects of prenatal exposure to coffee and other caffeine products is inconclusive. Most women have reported use of some source of caffeine during their pregnancy (Watkinson & Fried, 1985) although many decrease their use of caffeinated beverages partly because of nausea, possibly causing bias in the research (Fenster et al., 1991a, 1991b). Animal studies have shown that caffeine does have teratogenic effects but human studies have been sparse, especially those that controlled for the use of other substances, such as tobacco and alcohol (Nehlig and Derby, 1994; Sobotka, 1989). A weak (Armstrong et al., 1992) or no (Fenster et al., 1997, 1991b; Mills et al., 1993) association has been reported between caffeine and spontaneous abortion. In contrast, Fenster et al. (1997, 1991b) observed that consumption during the first trimester of decaffeinated beverages was associated with spontaneous abortion. Only weak associations have been found between caffeine consumption and prematurity or congenital defects
(McDonald et al., 1992a; 1992b). Although birth size may be somewhat lower (Fenster et al., 1991a; Fried & O'Connell, 1987), this effect has not been shown to last, as the children were observed to catch up in size within their first few months (Fried & O’Connell, 1987; Barr et al., 1984). Mills et al. (1993) found that any initial observation of a relationship between low birth weight and caffeine use was no longer statistically significant when other risk factors, especially smoking, were controlled in the analyses. The only well-controlled longitudinal study found no effects of prenatal caffeine exposure on the cognitive and neurobehavioural variables measured during the first two days of life, including reactivity, arousal and suckling and in the longer-term, no effects on motor ability or intelligence at age 4 years, nor on alertness or intelligence at age 7 years (Barr & Streissguth, 1991).

It is possible that caffeine has the potential of mediating the teratogenic effects of other substances, particularly tobacco and alcohol (Nehlig & Derby, 1994).

2.6 Summary

Both prenatal exposure to alcohol and tobacco have been shown in the research literature to be associated with outcomes affecting physical growth, behaviour and academic performance. The research has been inconsistent with respect to physical growth, in association with either tobacco exposure or moderate alcohol exposure and if physical growth deficiencies are influenced by either exposure, this association may have little functional consequence, if the children catch up to the normal in later years, as has been shown in many studies.
As an effect of both prenatal tobacco exposure and prenatal exposure to alcohol, attention deficits dominate the research literature. Independently each has been observed to have a relationship with specific behavioural problems relating to attention deficits or related behaviours including impulsivity and hyperactivity.

Mechanisms have been suggested for the adverse effects of both tobacco and alcohol exposure. Five different mechanisms have been most often suggested, however, fetal hypoxia and malnutrition are commonly linked with both tobacco and alcohol exposure. The evidence is unclear and probably no single mechanism acts alone as a causal factor.

Up until 1941, when rubella was observed to be a teratogen, environmental factors were given little attention as possible risks to the fetus (Naeye, 1992b). In the 1970's, data were collected on large populations in many countries on numerous conditions of newborns, including maternal tobacco use during pregnancy. At the time these studies were being designed, it was still believed that a barrier existed so that ethanol did not reach the fetus. This is most likely the reason for not collecting data on alcohol consumption during pregnancy. Since the late 1960's, thousands of research studies have reported on the effects of prenatal alcohol exposure, many being case reports of people with FAS and only recently have there been studies attempting to study threshold or linear outcomes on specific variables.

Refined methods and measures continue to challenge researchers in this field, since no biological markers have been found to reliably measure amount of alcohol or tobacco used. Self-reporting
has been the measure most often used. Dose and timing of either or both alcohol and tobacco pose measurement problems given that many women use both tobacco and alcohol at varying levels and times during pregnancy. Only one study was found in which tobacco exposure, alcohol exposure and social background were examined for interactive effects. Barrison and Wright (1984) observed that social background and prenatal alcohol and tobacco exposures had an interactive effect on birth weight. In their prospective study of 900 Caucasian women in England, they found that alcohol consumption of more than 100 g of alcohol per week was associated with more than double the risk of low (below the 10th percentile) birth weight and that the risk was significantly increased in offspring of women who smoked cigarettes during pregnancy and who were classified in lower social classes, while controlling for other potential confounding variables such as parity and maternal age. The risk of drinking and smoking was found to be additive (Wright et al., 1984). Moreover, timing of alcohol exposure was included in the analyses, with the observation that preconception and early pregnancy drinking appeared to have the most potential for risk, at least in terms of birth weight outcome (Barrison & Wright, 1984; Wright et al., 1984).

One other study attempted to examine the effects of the combined risks of prenatal alcohol and tobacco exposure to behavioural outcomes such as attention span, activity level, fidgetiness and social compliance during a naturalistic home observation (Landesman-Dwyer et al., 1981). This study was described previously with respect to behavioural outcomes and prenatal tobacco exposure. Caucasian women (n=128) from the Seattle longitudinal study were categorized accordingly: (1) 29 moderate drinkers/smokers, (2) 38 moderate drinkers/non-smokers, (3) 26 occasional or non-drinkers/smokers, (4) 35 occasional or non-drinkers/non-smokers, with the four
groups being similar in terms of other demographic factors such as maternal age, parity and educational levels. Alcoholic women or alcohol abusing women were excluded from the sample. This seemed a useful contribution to the literature in terms of methodology, with the potential of discriminating the results of risks from either tobacco or alcohol, while holding constant the socioeconomic levels, since the women came from relatively similar backgrounds. Unfortunately, tobacco was treated dichotomously, rather than categorically by dose.

The importance of these two studies (Barrison & Wright, 1984 and Landesman-Dwyer et al., 1981) was that interactive effects were considered in their statistics models. Very few studies have replicated this approach because of the complexity of the research and the many factors influencing both the independent and dependent variables. With respect to low birth weight and stillbirth as outcomes, it was noted that “the literature on moderate drinking is contradictory and suffers from poor control of factors known to confound pregnancy outcomes such as social class, parity and smoking habit” (Barrison & Wright, 1984, p.167). From the present review of the literature, the same appears to hold today. As the research accumulates in this relatively new field, patterns are emerging and our understanding of the influence on health of factors such as socioeconomic background are becoming clearer, in an albeit complex topic both to study and to interpret.

Each of the longitudinal studies to date have had considerably different populations, ranging from European populations whose mothers smoked but consumed little or no alcohol to disadvantaged black inner city American populations. Replication of the current studies in more geographic settings may present more data on which to identify patterns.
2.7 Theoretical guides

The literature review above on prenatal alcohol and tobacco exposure summarized the field of human research particularly with respect to academic abilities, health or behavioural problems. To follow is a description of two theoretical perspectives presenting ecological approaches to the relationships between many of the variables under study in the Vancouver Island Pregnancy Follow-up Study. These are not meant to indicate comprehensiveness in all theoretical models on this topic; rather they are two perspectives found useful in formulating the relationships between and realizing the complexity of the interaction of variables.

These two ecological models serve as the organisational frameworks for examining the relationship between the variables and as heuristic devices in designing this research. Both Sewell, Price and Karp (1985) and Abel and Hannigan (1995a) described relationships between various risk factors and conditions, including prenatal alcohol exposure, poverty, poor nutrition and cognitive development. Conceptualizations of each of these models is shown in Figures 2.1 and 2.2 below.
Figure 2.1 Conceptualization of the interacting variables influencing birth outcomes (Sewell, Price and Karp, 1985).

POVERTY

lack of social support

lack of education

ability to be effective parents

in-utero exposure to ETOH

ETOH use in the family

POOR DIET

excess fiber

low vitamin C

little available dietary iron

LOW ABSORPTION OF DIETARY IRON

IRON DEFICIENCY

LEARNING FAILURE

Absorption of lead

EXPOSURE TO LEAD

Other nutritional factors (e.g. hunger, and zinc or protein deficiency)
Figure 2.2 Schematic representation of summary of relationships among permissive and provocative maternal risk factors underlying FAS/ARBDs (alcohol-related birth defects) (Abel and Hannigan, 1995a).

Notes: Sociobehavioural permissive factors are shown inside the circles, key biological provocative factors are shown in the rectangles, dotted-line arrows indicate pathways by which permissive and provocative risk factors act on the fetal unit, and solid-line arrows indicate biological relationships and physiological pathways.
Sewell et al. (1985) argued that assessments of cognitive abilities have been insufficient, resulting in over-emphasis on labelling and classification. Instead, they suggested, environmental factors should be included in any assessment of cognitive abilities and the consequent focus should be on the educational needs of children rather than on apparent intelligence classifications. As a basis for their argument, they noted the concomitant occurrence of poverty, nutritional factors (including hunger, iron and zinc deficiencies, absorption of lead), prenatal exposure to alcohol and alcohol use in the family, all of which have interrelated effects on failure to learn. Their model, illustrated in Figure 2.1, showed an indirect relationship between poverty and learning failure, influenced by synergistic environmental conditions and risk factors. Lack of social support and poor education could result in poverty and poor parenting. When these two conditions co-exist, there could be increased levels of social problems (including alcohol use of the parents) and poor nutrition, with consequences to the child’s ability to learn.

Sewell et al. (1985) focused on the outcome variable of learning abilities. The other two variables of the Vancouver Island Pregnancy Follow-up Study, behaviour and health status, may be influenced by the same interrelationship of risk factors and conditions.

Like Sewell et al. (1985), Abel and Hannigan (1995a) placed importance on socio-behavioural factors. Abel and Hannigan’s model is shown in Figure 2.2. They were more explicit than Sewell regarding the relationships between the variables and explanations of biological mechanisms influenced by social conditions, such as low socioeconomic status and specific risk factors, such as under-nutrition. In addition, their model has been developed with respect to the outcomes of FAS.
or alcohol-related birth defects and therefore seems more specific and relevant to the present study.

Abel and Hannigan (1995a) noted that not all women who drink heavily produce offspring with FAS so that alcohol is a necessary, but not sufficient, factor resulting in the occurrence of FAS. Rather than alcohol being a single causal agent (with expectations of a response), there are factors that increase the susceptibility to alcohol or weaken the defence mechanism. They identified two groups of conditions, permissive and provocative, as possible explanations for the occurrence or nonoccurrence of FAS in spite of the mother drinking alcohol. Permissive conditions are “predisposing behavior, social or environmental factors” (Abel & Hannigan, 1995a, p. 445) that differentiate the fetal response to alcohol. The permissive conditions influence “physiological changes in the internal milieu, called provocative conditions, that increase the vulnerability to alcohol’s toxic effects” (Abel & Hannigan, 1995a, p. 445).

In their model shown in Figure 2.2, “permissive conditions” are shown inside circles and “provocative conditions” are shown in rectangles. The pathways between these variables can be causal or single-directional, indicated by solid line arrows in their schema, or bidirectional that have been shown by dotted line arrows. The “provocative conditions” produce the mechanisms that cause cell damage, the proximal cause of FAS.

Abel and Hannigan (1995a) included in their realm of “permissive conditions” both social conditions, such as lower socioeconomic status and aspects of culture and risk factors, such as
alcohol intake patterns and smoking, although they did not make the categorical distinction of environmental conditions and particular risks. "Provocative conditions" include blood alcohol levels (that are also affected by body weight and other factors), under nutrition and tobacco smoke components.

Their theoretical model offered an opportunity to link animal and behavioural research regarding the teratogenicity of alcohol and provided a more advanced basis for understanding susceptibility to the effects of alcohol, since the specific mechanisms are not yet entirely understood. Rather than focussing on specific dose-responses as the factor determining whether FAS or any alcohol-related birth defect occurs, they proposed these other conditions as determinants.

Abel and Hannigan (1995a) have used various examples to give credence to their theoretical model, one of which is maternal age and parity. The probability of prenatal alcohol-related birth defects increases with parity and maternal age (Abel, 1998b; Jacobson et al., 1996; Sokol et al., 1986; Abel & Dintcheff, 1984, 1985). Abel and Hannigan (1995a) noted the relatively high rates of drinking amongst teenagers, but that if alcohol consumption were the single causal factor for fetal alcohol syndrome, then the number of years of alcohol consumption would be irrelevant. In fact, the opposite has appeared to be the case. Abel and Hannigan (1995a) suggested a number of possible explanations, including increased age allowing for a longer history of alcoholism that possibly comprises maternal health, higher blood alcohol levels associated with consistent levels of consumption, or development of physiological problems such as cirrhosis.
These models (Sewell et al., 1985 and Abel & Hannigan, 1995a) guided the Vancouver Island Pregnancy Follow-up Study in their suggestions that prenatal alcohol exposure is multi-dimensional, and that as a variable it should not be studied independently from other risks to which the child might be subjected. Sewell et al. (1985) suggested the complexity of the relationship between variables and the outcome variable of academic abilities or failure to learn. Abel and Hannigan (1995a; Abel, 1998) focused on alcohol-related birth defects and FAS. Although there is direct concern with alcohol-related effects, there was no attempt to diagnose FAS in the Vancouver Island Pregnancy Follow-up Study. Rather, the study has been guided by their model in the complex risk factors and environmental conditions that they suggested contribute to adverse effects on the child.
Chapter III  Research Questions and Methods

3.1 Research Questions

This research examined prenatal exposure to alcohol and prenatal exposure to tobacco in the attempt to determine the impact of these risk factors to children's health, academic abilities and behaviour. The research also considered the interaction of three variables, prenatal alcohol and prenatal tobacco exposure and socioeconomic status, as potentially posing higher risk than would each of these variables alone.

The general aims of the research were to examine behavioural characteristics, academic abilities and health of elementary school age children who were prenatally exposed to alcohol, or to tobacco, or to both, and to study the effects of the combined risks to the child of prenatal alcohol exposure, prenatal tobacco exposure and lower socioeconomic status. A conceptual model of the relationships among the variables is shown in Figure 3.1, page 129.

The research questions were:

1. Are there interactive effects of (i) prenatal alcohol exposure, (ii) prenatal tobacco exposure, and (iii) socioeconomic status on the health, academic abilities or behaviour of children?
2. Is there a relationship between alcohol exposure during pregnancy and childhood behaviours?
3. Are there more health problems, both in quantity and severity, amongst children who were prenatally exposed to alcohol?
4. Do children prenatally exposed to alcohol have lower scores on the WRAT-3 and lower
ratings regarding school performance compared to those who were not prenatally exposed?

5. Is there a relationship between tobacco exposure during pregnancy and childhood behaviours?

6. Are there more health problems, both in quantity and severity, amongst children who were prenatally exposed to tobacco?

7. Do children prenatally exposed to tobacco have lower scores on the WRAT-3 and lower ratings regarding school performance compared to those who were not prenatally exposed?

8. What are the relationships between socioeconomic background and health, academic abilities and behaviour in this cohort of children?

9. What are the relationships between current weight and prenatal exposure to alcohol or to tobacco or to lower socioeconomic background?
Figure 3.1. Conceptual model of relationships between independent variables (prenatal alcohol exposure, prenatal tobacco exposure and socioeconomic status) and outcome variables (academic abilities, health and behaviour).
3.2 Methods

This was a population-based study in which data were collected at three stages. The first data collection took place during a one-year period, July 1, 1990 to June 30, 1991, when a cohort of pregnant women living on central and northern Vancouver Island visited physicians who had been asked to completed an adapted medical history form which included the T-ACE screening assessment. These women became subjects of the study when they delivered babies in any of pre-specified hospital regions on Vancouver Island. They were identified through medical records at the time of delivery. Physicians had been asked to participate in the study for the one-year period by including questions in the regular medical history, but the subjects did not become known to the researchers until the time of delivery. The women became subjects when they granted permission to participate in the study. Approximately 10% of the women delivering within the region during the week were selected randomly for an indepth interview in the home which took place within eight weeks of giving birth. These interviews lasted approximately 1 ½ hours and were conducted by research nurses. These two stages comprised the Vancouver Island Pregnancy Study. The present study design extended that earlier research into a longitudinal study, known as the Vancouver Island Pregnancy Follow-up Study, by collecting data on the dependent variables from the children, their parents and their teachers. Data were collected through interviews, self-administered questionnaires, rating assessments and standardized test instruments.

3.2.1 Ethics review

Review by The University of British Columbia, Office of Research Services and Administration, Behavioural Research Ethics Board, was completed and approved on February 27, 1998 and re-
3.2.2 Stages of data collection

The three stages of data collection, along with time periods, subject selection and number of subjects and data sources, were as follows:

**Stage 1**
- Time period: July 1, 1990 - June 30, 1991
- Subjects: all birth deliveries in pre-designated hospital districts of central and northern Vancouver Island
- Data source: adapted medical records forms
- \( n = 3,659 \)

**Stage 2**
- Time period: June 1990 - mid-1991
- Subjects: random sample selected from Stage 1 population
- Data source: home interviews conducted within 8 weeks of birth
- \( n = 403 \) (11.0% of population)

**Stage 3**
- Time period: May 1999 - January 2000
- Subjects: children of Stage 2 sample
- Data sources: written questionnaires for mothers and teachers and testing of child
- \( n = 265 \) (65.7% of Stage 2 sample; 7.0% of population)
This Chapter reports the methods of Stage 3. Methods and results of the research of earlier phases have been reported elsewhere (Armstrong et al., 2001a; Armstrong et al., 1994), however, because of the associations between data collected during the first two stages and the final stage, some details of the methods used in previous stages have been repeated here, as required for clarity or for interpretation of results.

3.2.3 Population and sample

3.2.3.i Study population and procedures for locating subjects

The population consisted of all women who delivered babies within five regional hospital districts of central and northern Vancouver Island during the 12-month period, July 1, 1990 to June 30, 1991. The population size was 3,659 women, according to hospital medical records of births in the region during the time period. Women were identified at the time of delivery. The expected number and actual number of deliveries was ascertained by noting all deliveries in the study area, that is, in all hospitals, each week. From the list of actual deliveries, 10% of the subjects were selected randomly for in-depth follow-up interviews. If a subject refused, a replacement random selection was made.

The birth records included demographic, pregnancy, delivery and newborn outcome information, and were adapted for the purposes of this study, to include alcohol risk levels. All physicians providing antenatal and obstetrical care within the catchment area had been asked to participate in the study by administering an alcohol screening tool to all pregnant women under their care and physicians were trained in its use. The screening tool used was the T-ACE questionnaire on risk
levels of alcohol use, designed for use with pregnant populations (Sokol et al., 1989). Physician records were linked with the hospital birth records.

Demographic characteristics

Demographic characteristics of the study population are shown in Table 3.1 below. Women who delivered during the study period ranged in age from 14 years to 47 years of age. Over two-thirds (66.8%) were married, 16.3% lived common-law with a partner and 16.9% were single (including separated, divorced, widowed, or never married). Of those whose employment status was known, most (68.2%) were employed either outside the home or as a homemaker at home, or were students, and the remainder (31.8%) reported being unemployed. Only 40% of the study population’s ethnicity was known, and of these, 76% reported Caucasian, 19.5% aboriginal and 5.5% other ethnic backgrounds.
Table 3.1 Selected maternal demographic variables of study population of women with live births in central and northern Vancouver Island, 1990-91 data collection.

<table>
<thead>
<tr>
<th>Variable</th>
<th>n=3,659</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>26.95 years</td>
</tr>
<tr>
<td>range</td>
<td>14-47 years</td>
</tr>
<tr>
<td>undetermined</td>
<td>4</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
</tr>
<tr>
<td>married</td>
<td>2,436 (66.8%)</td>
</tr>
<tr>
<td>common law</td>
<td>594 (16.3%)</td>
</tr>
<tr>
<td>single</td>
<td>534 (14.6%)</td>
</tr>
<tr>
<td>separated, divorced, widowed</td>
<td>83 (2.3%)</td>
</tr>
<tr>
<td>undetermined</td>
<td>3,647 (100.0%)</td>
</tr>
<tr>
<td>Employment status*</td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>853 (31.6%)</td>
</tr>
<tr>
<td>Employed</td>
<td>1,269 (47.0%)</td>
</tr>
<tr>
<td>Homemaker</td>
<td>482 (17.8%)</td>
</tr>
<tr>
<td>Student</td>
<td>93 (3.4%)</td>
</tr>
<tr>
<td>undetermined</td>
<td>2,697 (100.0%)</td>
</tr>
<tr>
<td>Ethnic background*</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>1,445 (76.0%)</td>
</tr>
<tr>
<td>Aboriginal</td>
<td>351 (18.5%)</td>
</tr>
<tr>
<td>Asian or South Asian</td>
<td>96 (5.0%)</td>
</tr>
<tr>
<td>Other</td>
<td>10 (0.5%)</td>
</tr>
<tr>
<td>undetermined</td>
<td>1,902 (100.0%)</td>
</tr>
</tbody>
</table>

*Data for these variables collected only if indicated on hospital record, or for those women who had a home visit interview, explaining the high number in the “undetermined” category.

Maternal risk behaviours during pregnancy: alcohol and tobacco

Risk levels of alcohol use were measured with the T-ACE screening tool (Sokol et al., 1989).

Sokol (1989) dichotomized risk levels (risk or no risk), with any score above 2 rated as risk. Risk levels for the Vancouver Island cohort had been categorized into three levels, that is, low, medium or high risk (see below, section 3.2.4.i (a)). At the Stage 1 T-ACE assessment, nearly half the
women (49.4%) were considered to be low risk with respect to alcohol, 36.4% had scores considered to be medium risk and 14.7% had scores considered to be high risk, as shown in Table 3.3 below (Armstrong et al., 2001a, 1994). Nearly one-third (32.8%) of these women smoked at some time during their pregnancies.

3.2.3.ii Study sample and procedures for locating subjects

After the birth of their newborns, a sample of 403 women was randomly selected from the original population of 3,659 women (11.0% of the population). All 403 randomly selected women who were interviewed during Stage 2 in 1990-1992 were considered part of the Stage 3 sample and were sought for inclusion in the 1999-2000 data collection.

Extensive efforts were used to locate each of the subjects from the earlier stages of the research since sample loss can be a serious problem in longitudinal studies. As shown in Table 3.2, a total of 299 (74.2%) of the original randomly selected sample was located, of whom 65.7% (n=265) participated in Stage 3 and another 3% (n=12) were found but did not participate for various reasons (refusal, death, difficult to contact). Given the long period with no contact, the low rate of loss to follow-up compared favourably with other Canadian longitudinal studies. For example, an Ontario Child Health Study located and enlisted 75.5% of its sample four years after original follow-up (Boyle, Offord, Racine & Catlin, 1991). The Collaborative Perinatal Study began in 1959 at 12 sites at hospitals throughout the U.S.A. At one of those sites, the Boston Lying-In Hospital, less than 20% of their sample was lost at testing 7 years later mostly because of the researchers' efforts in contacting the subjects annually between initial contact and re-test (Naeye &
Procedures for locating subjects

A multi-step process was used to locate the subjects for Stage 3 data collection. Three directories were used to find current addresses: local telephone books and two electronic databases (CanadaPhone available on CD-ROM and Canada 411 available on the internet). The two electronic databases were searched for subjects and if either the address or the telephone number matched, the subject was sent a letter explaining the study. This yielded nearly 23% of the sample (n=92). These people lived at the same address as they had lived approximately nine years earlier, or at least near enough to have retained the same telephone number. Next, contact was made with people with the same surname from towns in which the subject had been living, and frequently the subject was located through contact information given by relatives. Through this searching, some women were found who had moved out of the province, including to the Yukon, Ontario, Saskatchewan and Alberta. In two cases, ex-husbands would not reveal the whereabouts of their ex-spouses, but in all other cases, family members helped to locate the subjects. Alternatively, if the surname was unusual we searched the electronic directories for any names throughout British Columbia or Canada. The searching through relatives and directories yielded another 48% (n=128) of the subjects who were eventually interviewed. In addition, public health nurses working in the area assisted with locating individuals who were known to them. Public health nurses generally knew subjects if they had new babies or because they lived in the same neighbourhood. The public health nurses asked subjects known to them if they were willing to have us contact them by letter. Four subjects (1.5%) were found through public health nurses.
In summary, 83.5% (253) of the sample was located through publicly available directories, either directly or through someone who knew the whereabouts of the subject. The women were sent two-page letters explaining the study, followed by phone calls asking for their participation.

For the remainder of the sample who had not yet to be traced, information was matched with the British Columbia's Ministry of Health Linked database. Personal Health Numbers or mother's date of birth, either of which were obtained during the 1990-1991 study, were matched with present addresses and telephone numbers. Permission for this matching procedure was granted after application to the provincial Ministry of Health, who restricted the methods of contact. Subjects were sent a letter requesting their participation and asking them to return a card authorizing further contact from the researcher. No further contact could be made with the subject, prior to the card being returned. Of the 150 names sent to the Ministry of Health, 110 addresses were supplied, with 40 names having no match in the database. It appeared from reviewing the original (1990-91) medical data forms that in two cases, the women had no medical numbers nor any relatives in British Columbia and may not have been registered in any way within the medical system. Other women may have moved out-of-province, changed names or were otherwise unknown to the health care system's database. Of the 110 addresses supplied by the Ministry of Health database, 25 (22.7%) were returned by the post office as "address unknown", 39 yielded no response (35.5%) and 41 (37.3%) resulted in the subject being interviewed, three sent refusal responses and one could not be found because she did not supply telephone contact information. A summary of these methods of locating subjects, the contact procedures and the numbers of subjects found and who participated or refused is found in Table 3.2 below.
Table 3.2 Methods of attempting to locate subjects, with refusal and participation rates.

<table>
<thead>
<tr>
<th>Subjects found:</th>
<th>Subjects located through publicly available sources</th>
<th>Names linked with Ministry of Health database</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewed</td>
<td>224</td>
<td>41</td>
<td>265</td>
</tr>
<tr>
<td>Refused</td>
<td>18</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>287</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subjects or their relatives found, but interview not possible:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Moved to address unknown to relatives</td>
<td>3</td>
</tr>
<tr>
<td>ii. Deceased (one child; one mother)</td>
<td>2</td>
</tr>
<tr>
<td>iii. Subjects found but contact to make arrangements for interview not possible (e.g., no phone)</td>
<td>5</td>
</tr>
<tr>
<td>iv. English too limited to interview</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subjects never found:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Not matched with Ministry database</td>
<td>not applicable</td>
</tr>
<tr>
<td>ii. Letters returned “address unknown”</td>
<td>not applicable</td>
</tr>
<tr>
<td>iii. No response to our correspondence</td>
<td>not applicable</td>
</tr>
<tr>
<td></td>
<td>Total</td>
</tr>
</tbody>
</table>

Of the original sample of 403 women, 287 women were found, another 104 were never found and 12 were unavailable because of death (n=2), relocation to unknown locations (n=3), limited English (n=1), or could not be contacted to arrange time and venue of interview (n=5). Of the
287 women who were located, there was a 92.3% participation rate.

3.2.3.ii (a) Refusal rate

The refusal rate was small. Only 22 (7.7%) located women refused to participate, that is 5.4% of the original sample. The most common reasons for refusal were that their husbands did not want them to participate, that they were too busy, or that they did not want to divulge private information or thought anonymity was not assured. Although only 22 women formally refused, another 39 people (noted in the “subjects never found” category in Table 3.2) did not respond to correspondence sent to them regarding the study after their names and addresses were found in the Ministry of Health Linked database. It is not possible to know whether they did not receive the correspondence or whether their non-response was indicative of a passive mode of refusal.

3.2.3.ii (b) Teachers' participation

Parents did not only consent to their own participation, but also that of their child and of their child’s teacher since a further data source was teachers’ responses to a brief written questionnaire. The process for soliciting participation from the teacher was multi-staged, requiring three levels of permission. First, 10 school boards were asked for permission to have teachers in their jurisdiction participate. Nine of the school boards granted permission and one requested additional permission from the local Teachers’ Association, who agreed that their membership could participate. One school board sent our request to their Education Committee who did not approve their teachers’ participation, citing that their teachers had been surveyed too often and were too busy to be surveyed again. Not all teachers’ responses were lost in that district, however, because parents,
teachers and principals agreed that the individual teachers could participate since both the teachers and parents wanted to contribute to the study.

Secondly, each parent who participated was asked to give written consent for the child's teacher to participate, after being shown a copy of the teacher's questionnaire. The teacher was given a copy of the parent's written consent form and asked for written consent for his or her own participation. Finally, written permission was required from each teacher. The interviewer took the questionnaire and consent forms to the school and either waited while the teacher completed them, asked to have them mailed back, or picked them up on another occasion.

The teachers' participation rate was high. Completed questionnaires were received from 242 teachers (91.3%). Four teachers (1.5%) refused to participate and 10 parents (3.8%) denied permission for their child's teacher to participate. The most common reason for the parent refusing the teacher's participation was that they thought that teachers were busy and should not be given further work.

There were nine other children for whom there were no teachers' questionnaires. Seven (2.6%) children were home-schooled and two (0.8%) moved within days of the interview (one was not found again and for the other it was not possible to find a teacher who knew her well enough to complete the questionnaire).
3.2.4 Variables and measures

The dependent variables of interest were health, behaviour and academic abilities. Data were collected for each of these variables from three sources, parent, teacher and child. They were collected when the children were on average 8 years old. All data were collected during a 9-month period, May 1999 to February 2000.

Data for the independent variables were collected in the earlier stages of the study, that is, during a one-year period, 1990 to 1991, when the mothers were pregnant and during the first weeks of life of their children. Data for potentially confounding variables were collected during all stages of data collection.

The variables under study:

Independent variables:
- prenatal alcohol exposure, treated both as a dichotomous and a continuous variable
- prenatal tobacco exposure, treated both as a dichotomous and a continuous variable
- socioeconomic status, defined by parental education, parental occupations and income

Dependent variables:
- health of child at approximately age 8
- behavioural problems of child at approximately age 8
- academic abilities of child at approximately age 8

Each of these independent and dependent variables, their definitions, measurements, methods of data collection and data sources are described below. Table 3.6, found at the end of this chapter on pages 171-2, lists the variables, according to category, and the stage at which the data were collected.
3.2.4.i Independent Variables

The independent variables are prenatal alcohol exposure, prenatal tobacco exposure and socioeconomic background. Data were collected for these variables during the 1990/91 data collection stages through self-reports by the mother.

3.2.4.i (a) Prenatal alcohol exposure

There were four measures related to maternal alcohol use, two assessments of risk and a self-reporting of actual alcohol intake at two time periods, before pregnancy and during pregnancy. The T-ACE test measures risk (Sokol et al, 1989) and it was administered twice, once during pregnancy in the physician's office (by the woman's physician or office staff), and for a second time during an in-depth home interview that took place within 8 weeks of delivery. All data regarding the measurement of prenatal alcohol exposure were collected through maternal self-reports. During the home interview, the interviewer administered the T-ACE test, that referred to tolerance level before pregnancy, and asked specific questions about alcohol consumption frequency and quantity prior to and during each trimester of pregnancy. Therefore, any recall data were reported within 10 months or less of the actual behaviour.

Measurement of alcohol risk level

The T-ACE questionnaire (Sokol et al., 1989), administered during a office visit to the physician and repeated during the home interview, is a four-question screening tool with a summative score ranging from 0 to 5.
All physicians in the geographic area were asked to participate in the 1990-1991 Vancouver Island research project. They were provided with training at local hospital sites in the use of the study instrument. Each physician was encouraged to participate by completing a T-ACE questionnaire as part of the routine pre-natal visit for each patient who was likely to give birth during the study period. The standard Provincial Prenatal Record was amended to include 10 questions about alcohol use, beginning with a question about whether the patient had ever had a drink of alcohol. If the response was positive, the patient was asked age of first drink, age she first got drunk, her preference for type of drink (beer, wine, liquor) and the four questions comprising the T-ACE questionnaire (Sokol et al., 1989) with reference to drinking prior to pregnancy. Those questions are shown in Appendix A.

The T-ACE does not ask about quantity and frequency of drinking and therefore does not measure consumption. Rather, it measures risk level, with a score of 0 indicating no risk and at the upper extreme a score of 5 indicating high risk level. The T-ACE screening tool was adapted from the CAGE (Ewing, 1984) screening tool that has four questions about attempts to cut down on alcohol use (C), being annoyed by others suggesting the need to cut down (A), feeling guilty about one's consumption (G) and using alcohol in the morning as an eye-opener (E). Sokol et al. (1989) found that the CAGE did have good predictive properties except for the item about feeling guilty. This question was replaced with a question about tolerance (T) with scores for that question ranging from 0 to 2 (0 if she does not get high, 1 if she needs only one drink to get high and 2 if she needs two or more drinks to get high). The other three questions score one point each, that is, the questions about being annoyed (A), cutting down (C) and using alcohol as an eye-opener (E).
An external reviewer found a sensitivity of 76 percent, 79 percent for specificity, 14 percent for positive predictive value and 79 percent for efficiency (Russell, 1994), using the original scoring criteria of Sokol, Martier and Ager (1989) that classifies women with a score of two or great as being “at risk”.

T-ACE scores range from 0 to 5 were dichotomized for level or risk (risk or no risk), according to Sokol, Martier and Ager (1989). For the purposes of the Vancouver Island Pregnancy Study, the scores were categorized into three levels, low risk (scores of 0 - 1), medium risk (score of 2) and high risk level (scores of 3, 4 or 5). This categorization was found to be more appropriate, based on an examination of the Vancouver Island cohort data and an examination of associated risk variables (Armstrong, 2001; Armstrong et al., 2001b).

Numbers of women scoring in each of these categories have been reported previously (Armstrong et al., 2001a, 2001b), and are shown in Table 3.3 below, for both the total population with T-ACE scores and repeated T-ACE for the 403 randomly selected original sample, and for the sample included in the Stage 3 data collection. The correlation between the two sets of scores from the different administrations of the T-ACE (that is, at Stage 1 and Stage 2 with n=403) was .53 (p=.001).
Table 3.3 Distribution of T-ACE risk levels for population (Stage 1), random sample (Stage 2) and sample found at Stage 3.

<table>
<thead>
<tr>
<th>Risk level (and scores)</th>
<th>total population frequency (%)</th>
<th>random sample frequency (%)</th>
<th>random sample frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stage 1</td>
<td>Stage 2</td>
<td>Stage 3***</td>
</tr>
<tr>
<td>Low risk level (scores 0 or 1)</td>
<td>1,511 (49.4%)</td>
<td>237 60.0</td>
<td>164 (61.9%)</td>
</tr>
<tr>
<td>Medium risk (score of 2)</td>
<td>1,114 (36.4%)</td>
<td>128 32.4</td>
<td>85 (32.1%)</td>
</tr>
<tr>
<td>High risk level (scores of 3, 4, or 5)</td>
<td>434 (14.2%)</td>
<td>30 7.6</td>
<td>16 (6.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>3,059* (100.0%)</td>
<td>395 100.0</td>
<td>265 (100.0%)</td>
</tr>
</tbody>
</table>

*Data missing from 600 (16.4%) women from total population (n=3,655).
**Data missing from 8 (2.0%) of the sample (n=403).
***Sample (n=265) refers to those participating at Stage 3, but data were collected for T-ACE assessments at Stage 2.

Alcohol consumption

The postnatal data collection involved interviews at the women’s homes with 403 women randomly selected from the total population of women who delivered during the study period. Home interviews were one to two hours in duration and conducted by trained community health nurses. During the home interview, respondents were asked about their alcohol consumption. They were asked 15 questions about alcohol consumption, beginning with whether they had ever had a drink. The T-ACE questions were repeated, again referring to pre-pregnancy behaviour. In addition, during the home interview, they were asked about their preference for alcohol beverages during pregnancy and the amount and frequency of drinking each type of alcohol (beer, wine or liquor). They were questioned on drinking five or more drinks on any one occasion. Although respondents were not questioned on the period of time they took to drink those five or more drinks, that quantity of alcohol consumed over a 2-hour period has been considered to be bingeing.
Respondents were asked about quantity, frequency and type of alcohol beverage for each of four time periods, pre-pregnancy and each of the three trimesters of pregnancy.

These data regarding frequency and amount of alcohol consumed and period in which the alcohol was consumed were treated both as dichotomous data and as continuous data. As a dichotomous variable, analyses were completed for whether the women drank at all during pregnancy. As a continuous variable, total amounts of alcohol consumed for each trimester and over the length of the pregnancy were calculated. Data collected regarding alcohol use during pregnancy are summarized in Table 3.4 below.

<table>
<thead>
<tr>
<th>Table 3.4 Data collected during home interview regarding alcohol consumption.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Type of alcohol used: beer, wine, liquor</td>
</tr>
<tr>
<td>2. Quantity</td>
</tr>
<tr>
<td>(a) On a day when you drank beer (or wine, or liquor), how many cans/bottles would you usually have?</td>
</tr>
<tr>
<td>(b) What was the greatest number of drinks you had in a single day in these periods (that is, before pregnancy, first, second and third trimester)?</td>
</tr>
<tr>
<td>(c) Did you ever drink more than that described on a usual occasion, such as on weekends or at parties?</td>
</tr>
<tr>
<td>(d) What was the greatest number of drinks you had in a single day?</td>
</tr>
<tr>
<td>3. Frequency</td>
</tr>
<tr>
<td>How often did you drink (categorized by each period relating to pregnancy (before pregnancy, first trimester, second trimester and third trimester): 1-2 times a week; 2-3 times a month; about once a month, or less than once a month?</td>
</tr>
<tr>
<td>4. Binging</td>
</tr>
<tr>
<td>How often did you drink at least 5 drinks per day (categorized by each period relating to pregnancy): 2-3 times a month, about once a month, or less than once a month?</td>
</tr>
</tbody>
</table>
3.2.4.i (b) Prenatal and postnatal tobacco exposure

Women were questioned about their tobacco use during Stage 2, that is, at the postnatal home interview. All data on prenatal tobacco exposure were collected through self-report of the mother about her own use or use by others in the household. As part of the structured interview, women were asked five questions about tobacco use:

(1) whether anyone in the household smoked during the pregnancy,
(2) whether the respondent smoked during her pregnancy,
(3) how many cigarettes she smoked daily and what brands,
(4) during which trimesters, if any, she had an aversion to tobacco, and
(5) during which trimesters, if any, she had a craving for tobacco during her pregnancy.

For the purposes of statistical analyses, this exposure was treated both as a dichotomous variable (whether the women smoked and whether the fetus was exposed through others in the household smoking), as a continuous variable (calculated by multiplying the frequency and amount of use for the duration of the pregnancy) and as a categorical variable according to the number of cigarettes smoked by the mother daily (<10 per day, 10-20 per day or >20 per day).

Postnatal tobacco exposure data were collected during Stage 3. Respondents were asked about the status of their smoking, that is, whether they were currently smoking, had stopped or had never smoked. If they had stopped, they were questioned about the amount and frequency of their past smoking and for how long they had stopped. If they continued to be smokers, they were questioned about the amount and frequency of their current smoking behaviour and if they smoked
in the house. Two additional questions asked about smoke exposure from anyone else in the household and the number of times per day the child was exposed to second-hand smoke.

3.2.4.i (c) Socioeconomic background

From the literature review reported in the previous chapter, it was noted that the indicators generally used to place people along a socioeconomic gradient are income, parental education and occupation with other factors such as ethnicity sometimes being included (Murray et al., 1999; Green, 1970a). These three indicators were used for the current study:

**Income.** Respondents were asked to report their income level, from a list of 10 levels ranging from less than $10,000 to over $80,000. They were also asked about all sources of household income, from a list of 17 items, as well as their main source of income, under the assumption that some sources of income (such as welfare payments) were further indicative of income levels.

**Education.** Respondents were asked to report the highest level of schooling completed for each of four possible parents, birth mother and birth father, adoptive mother and adoptive father. In all but five cases, the mother was the respondent so she self-reported as well as reported for the child's father or step-father. In the five cases when the father responded, he self-reported and reported for the mother and step-mother. There were no adoptive mothers in this cohort. The question about parental education was asked at two times, Stage 2 (home interview after birth of child) and Stage 3 (during the 1999-2000 interview). For the purposes of internal checking, respondents were asked at Stage 3 if they had returned to school since the earlier interview. The
categories for levels of education were adapted from the (National Longitudinal Study on Children and Youth (NLSCY) (Canada. Statistics Canada, 1997), with 14 levels of education ranging from grade 9 or less to graduate degree.

**Occupation.** Data on parental occupation were collected at Stage 3. Using the NLSCY (Canada. Statistics Canada, 1997) survey, the occupational categories had 21 groups according to the 1980 Standard Occupational Classification (Canada. Statistics Canada, 1981). These categories proved to be too specific for the needs of this study and for the sample size, so these categories were collapsed into five groups, according to the 1991 Standard Occupational Classification (Canada. Statistics Canada, 1993), ranging from professional or administrative occupations to unskilled occupations.

To summarize, there are six indicators of socioeconomic background: amount of income, source of income, mother’s education, father’s education (or education of step-father), mother’s occupation and father’s occupation.

Each of these indicators was entered separately into the statistical analysis to examine their influence on the outcomes. Although there was an attempt to calculate one composite score for socioeconomic background by giving weights to income, education and occupation, according to the model suggested by Green (1970a), this became impractical, mostly because of the extensive list of occupations that would require more precise ranking. There was also an assumption that each of these indicators could have different effects on outcome variables because they operate
through different causal pathways.

3.2.4.ii Dependent Variables

The dependent variables are health, academic abilities and behaviour. Data were collected from three sources for these variables: parent, child and teacher. Data on the health and behaviour variables were gathered through second-hand reporting from a parent and from the child’s teacher. Data on the academic abilities were collected by testing the child and by second-hand reporting from the child’s teacher. The specific instruments developed for the data collection were discussed in more detail below, and sources of data collection for measurement of these dependent variables are shown in Table 3.5. The table shows that each dependent variable had more than one data source; for example, indicators of academic abilities were measured both by testing the child and by asking the teacher to rate the child’s performance compared to others in the class. Each of these variables, shown in Table 3.5, are described in detail below.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mother's report of child</td>
</tr>
<tr>
<td>Health</td>
<td>yes</td>
</tr>
<tr>
<td>Behaviour</td>
<td>yes</td>
</tr>
<tr>
<td>Academic abilities</td>
<td>yes</td>
</tr>
</tbody>
</table>

3.2.4.ii (a) Health

Health was measured by three indicators: general health rating, a composite of various measures of
activity and morbidity, and absenteeism from school. In addition, health was measured in both
general terms (that is, general state of health) and according to illness in specific terms (for
example, number of illnesses or hospitalizations).

Rating of health, compared to others the same age, was measured through second-hand reporting
from the mother (except in the five cases where the father was the respondent), who was asked the
question: “In general, how would you rate your child’s health compared to others of the same
age?” Although there have been various attempts to measure health using questionnaires or
instruments (for example, Donovan et al., 1993; Chambers et al., 1987), one of the most widely
used measures is the single-question self-reported health status question asking respondents to rate
health status as excellent, very good, good, fair or poor (Ratner et al., 1998). Ratner et al. (1998)
refuted earlier studies in their reporting that this question is useful only in relation to physical
health status, with respondents interpreting the word “health” to mean physical health. The
number of items on the scale varies (usually three or four), but to be consistent with the Canadian
NLSCY (Canada. Statistics Canada, 1997), five options were used in this research.

This measure allowed comparison of general health with that of others within the same age group.
In addition, the mother was asked to rate her own health compared to others of similar age and to
rate the health of other children in the family compared to others the same age. This allowed for
comparisons between the general health rating of the subject and others in the family. For each of
these health rating questions, an open-ended question followed, asking the reasons for giving such
a response.
In addition, data were collected on indicators of illness or health through a set of questions specific to activity level and generally regarding health. Most of these questions were adapted from the NLSCY (Canada. Statistics Canada, 1997). These indicators and their types are listed below:

Health problems:
- description of health problems, both current and past history (qualitative data collection, categorized),
- description of major illnesses during lifetime (categorized from qualitative data),
- number of hospitalizations both during past 12 months and since birth, length of time in hospital and reasons (ratio data),
- frequency during past year of contact with various health care professionals, including physicians, pediatricians or other doctors, psychologists or psychiatrists, public health nurses or nurse practitioners, social workers, child welfare or children’s aid workers and others (ordinal data).

Activity levels questions:
- level of physical activity compared to other children of the same age, measured on a 5-point scale (interval data),
- sleep requirements compared to other children, measured on a 5-point adjectival scale (interval data).

Illness or disability-related questions:
- use of specific medications (ventolin or inhalers for asthma, Ritalin, tranquillizers, anticonvulsants or anti-epileptic pills or other medications) (nominal data),
- causes for worry or unhappiness (qualitative data),
- abilities (in sight, hearing, speech, mobility, dexterity), feelings, memory, thinking and problem-solving (nominal data),
- pain and discomfort (nominal data),
- serious injuries: frequency, type and cause (various types of data, including nominal),
- asthma and other long-term conditions (nominal data).

Parents were asked to report the height and weight of the child and that of the parents. Data were treated as dichotomous, categorical, or continuous, as appropriate according to the variable. For example, whether the child had problems with vision or hearing was treated as a dichotomous variable, while those data for which scales were used (such as the extent to which the child is
The third measurement used to indicate health status was the frequency of absenteeism from school, data that were collected from the teachers. This may not be a valid measure of state of health if used as the only measure to indicate health status, since there are various reasons other than the student’s health that could cause absenteeism, however, it was used as an indicator contributing to the other measures, rather than as a stand-alone measure. This question also offered the possibility of another data source, namely the child’s teacher, to contribute to data regarding health. Having an additional data source was deemed important because mothers’ evaluations of their children’s health can be influenced by many factors beyond their actual health status, including culture, socioeconomic status and marital position (Angel & Worobey, 1988; Zola, 1966).

These data regarding absenteeism were categorical: 0 to 3 days absent, 4-6 days absent, 7-10 days and 11 or more. The number of days absent per month was calculated according to the teachers’ response and when the questionnaire was completed. All questionnaires were completed after at least 3 months of the school being in session (that is, none were completed before the end of November).

3.2.4.ii (b) Academic abilities

Academic abilities were defined as the abilities of the child compared to normative age-specific standards in reading, spelling and arithmetic. Three measures were used: assessment of children
using the revised Wide-Range Achievement Test (WRAT-3) (Wilkinson, 1993; Jastak and Wilkinson, 1984; Jastak and Jastak, 1978), the teacher’s rating of the child compared with others in his or her classroom, and the parent’s assessment of the child’s difficulty with core subjects.

The WRAT (Wilkinson, 1993; Jastak and Wilkinson, 1984, 1979) is a test of academic abilities for children from pre-school ages to grade 12. It can be used for either individual testing or for groups of children. The third revision (WRAT-3) was used in this study and each child was tested individually. Its purpose was to test abilities in three standard subjects, spelling, reading and arithmetic, comparing individualized performances with others of the same age of a normative, albeit non-Canadian, standard.

The WRAT-3 has three subtests: (a) decoding skills of reading (that is, pronouncing printed letters and words), (b) spelling (measuring the ability to write one’s own name and write words from dictation) and (c) arithmetic (counting, reading number symbols, solving problems given orally and computing written problems). The three subtests are intercorrelated, indicating these measures may have a developmental component (Wilkinson, 1993).

The WRAT-3 has acceptable reliability and content and construct validity (Wilkinson, 1993). Test-retest reliability correlations range from .91 to .98 on tests of the WRAT-3 given to a sample of 142 subjects, ages 6 to 16 years (Wilkinson, 1993), indicating good stability, although these reliability tests are not well-described by the test’s authors. Reliability testing (test-retest) has shown to be high (r=.94) for the 7-10 year age group (Sattler, 1992) on the WRAT-R, the
previous edition on which the WRAT-3 was based. In addition, the test appears to be reasonably consistent with other tests, although it does appear to yield lower scores than some tests with similar purposes, such as the widely-used Kaufman Test of Educational Achievement (Prewett et al., 1991a, 1991b; Kaufman & Kaufman, 1985).

For the purposes of this study, the advantages of using the WRAT-3 were that it could be administered by interviewers who were not specially trained in psychology or education and it could be administered individually in a reasonably short time period (less than 1/2 hour). It also had reasonable reliability for the age cohort under study as well as for older children so research could use the same assessment tool if follow-up of these children were to be done. Furthermore, WRAT-3 and its predecessors have been widely used and scores are standardized on U.S. national samples according to age, gender and urban/non-urban stratifications.

A disadvantage of this test is its limitation in two areas of measurement; neither reading comprehension nor complex arithmetic computations are tested. A further limitation is that no standard scores are provided for varying socioeconomic stratifications nor according to cultural backgrounds, such as Canadian children or children of aboriginal heritage.

A further data source for the child's academic abilities was the teacher who had known the child for a minimum of two months. Data were collected from the teacher through the use of a short questionnaire designed specifically for this study (shown in Appendix B). Some of the questions were adapted for use from the work of Conry (1999). The teacher rated the child, compared to
other children of the same age, on overall abilities, pre-reading or reading or language skills, numbers or arithmetic skills, movement, physical education or sports abilities, citizenship or social interaction, and school or academic motivation. Teachers reported on their direct knowledge or opinions of the children. The data from all of these questions were interval.

A history of repeating or skipping grades was collected. Although this may have been a useful indicator of academic history, current trends suggest that few children repeat or skip grades in elementary school in British Columbia. These two questions were adapted from the NLSCY (Canada. Statistics Canada, 1997) and the data source was the mother's questionnaire. It was expected that the mother or father would be able to answer questions about skipping or repeating grades more readily than the teacher who may be inconvenienced in seeking that data from school records.

3.2.4.ii (c) Behaviour

Behaviour was defined in terms of the prevalence of both social competencies and antisocial problems. An assessment tool with 8 subscales was used to measure Hyperactivity, Inattention, Anxiety, Emotional Disorder, Conduct Disorder, Physical Aggression, Indirect Aggression and Prosocial Behaviour. It is referred to as the Behaviour Rating Scale in this thesis. It is shown in the parents' questionnaire and the teachers' questionnaire in Appendix B.

The assessment instrument had been adapted previously from the Child Behavior Checklist (CBCL) (Achenbach et al., 1987; Achenbach and Edelbrock, 1981, 1978; Achenbach, 1978) for
use by Canadians for the NLSCY (Canada. Statistics Canada 1997) and other research (Offord & Lipman, 1996; Boyle et al., 1987; Offord et al., 1987). Originally, the CBCL was devised to assess and categorize clinical behavioural problems of children (Achenbach et al., 1987; Achenbach & Edelbrock, 1981, 1978; Achenbach, 1978). It was used with normal children to test validity, allowing standardization of normal populations of English speaking 4-16 year-old American children (Achenbach and Edelbrock, 1981) and since then has been widely used for clinical purposes and for research. The Canadian adaptation (Offord and Lipman, 1996; Boyle et al., 1987; Offord et al., 1987) has contributed a more positive slant through the inclusion of a 12-item subscale on Prosocial Behaviour and has changed some of the vocabulary. This adapted version has parents' and teachers' versions and both were used in the NLSCY (Canada. Statistics Canada, 1997).

Both versions of the behaviour scale were used for the current study. Teachers and parents are asked to report on the behaviour of a child in self-administered questionnaires. The parents' version of the instrument consists of 47 items describing the child's behaviour, emotions or attitudes and social relations. For example, respondents were asked whether the child “tells lies or cheats”, “seems to be unhappy, sad or depressed”, or “shows sympathy to someone who has made a mistake.” Respondents rated each child on a three-point scale, “not true”, “sometimes or somewhat true”, or “often or very true.” The teachers' version is the same in all questions except that it drops one item (“steals at home”) about which the teacher would have little or no information.
There were three advantages to using this instrument. First, it had been tested and used on a large national Canadian cohort for the NLSCY (Canada. Statistics Canada, 1997). Second, its subscales measure attributes (such as inattentivity) that are important to this study at least on a theoretical basis. Third, it was practical to use in that it is self-administered, could be easily explained by interviewers who were not psychologists, and it has both parents' and teachers' versions. The use of both parents' and teachers' rating scales was deemed important because assessments have differed according to rater and according to the contexts in which the rater has known the child (Kohen et al., 1997; Verhulst & Ende, 1991; Verhulst & Akkerhuis, 1989; Achenbach et al., 1987).

Scores for the behavioral scale were calculated in two ways, first with a total summative score and second calculating scores for each of the subscales, with all scores being treated as interval-level data. Correlational analyses were conducted to compare scores from both the parent and the teacher.

3.2.4.iii Other variables

Several other variables were measured as potential confounders. Data for each of these were collected as part of the self-administered parents' questionnaire. They include:

a. physical height and weight of both parents;

b. mother's access of educational, social or health services when the child was an infant;

c. mother's well-being within year of giving birth (e.g., duration of breast-feeding, post-partum depression);
d. CAGE questionnaire (Ewing, 1984) regarding current alcohol risk level of mother;

e. changes in home, school or parenting (that is, adoption) of child;

f. family factors (age of mother, birth order of child, number of siblings, marital status of mother;

g. child’s activities and hours spent at each (e.g., television and video games, reading, sports);

h. social support (of mother and of other adults in child’s life);

i. socialization of child (time spent playing with other children, ability to get along with other
   children and ability to get along with siblings);

j. nutrition (mother listed the child’s food intake from the day previous to the interview, with the
   food intake later being categorized according to type, such as bread or dairy products).

Data on each of these variables were collected by self-reporting of parents or by second-hand
reporting by the parents about the child. In most cases, variables were dichotomous except in a
few cases when variable responses were rated on a scale.

3.2.5 Study instruments and means of administration

Study instruments were designed to collect data from three sources; mother (or other parent or
guardian), teacher and child. Instruments used to collect data from parents and from teachers are
described below and these instruments are included in Appendix B.

3.2.5.i Parents’ questionnaire

Data were collected from the mother using a self-administrated written questionnaire devised for
the project. As noted above, there were five exceptions to the mother self-reporting or reporting
on her child, these cases being when the father was the primary caregiver and he completed the questionnaire.

Although it was self-administered, an interviewer was present during the time of administration to answer questions readily. The interviewer was trained to encourage questions from the mother for clarification of questions. In many cases, the mother had no difficulty completing the questionnaire, in other cases individual questions were clarified and in a few cases, the interviewer read through the total questionnaire for the respondent.

There were 18 exceptions to the interviewer being present, all because the questionnaire was sent by mail. In these cases, the child had moved to distant locations (13 in British Columbia, 2 in Alberta, 1 in Saskatchewan, 1 in Ontario and 1 in the Northwest Territories) where interviewers were not sent for practical reasons. Although it is not ideal that some of the respondents did not have a interviewer present as planned in designing the study and the questionnaire, it appeared more important to include these subjects in spite of this deviation from the original research design. For those completing the questionnaire without the presence of an interviewer, follow-up telephone calls were made before and after completion to clarify the meaning of any questions and to encourage completion of the total questionnaire.

**Development and pre-testing**

Many of the items for the questionnaire were used in the NLSCY (Canada. Statistics Canada, 1997) and were selected so that comparisons could be made with national data. Other questions
were devised specifically for this research. The final product is a 97-item questionnaire divided in
the following sections: child's background (26 questions), child’s health and family health (27
questions), environment (22 questions), child’s education (13 questions), child’s activities (8
questions) and a 46-item Behaviour Rating Scale. Most mothers took 3/4 to 1 hour to complete
the questionnaire, and the range was ½ to 2 hours.

The NLSCY survey questions were designed to be asked verbally, either in person or by telephone.
The current design required two data sources (mother and child), thus to conserve scarce time and
financial resources, it was decided to adapt the NLSCY questions into written questions. The
mother responded to the written questionnaire while the child was being tested, thereby limiting
the amount of time the interviewers were with the family.

The questionnaire was pre-tested with 13 women (7 at first pretest and 6 at subsequent pretest), all
with early elementary school age children, to estimate the time required for completion of the
questionnaire, to test for discriminating responses and to get feedback on the comprehensibility of
the questions and the instructions. The questionnaire was revised after the pretests according to
the input to clarify instructions or wording of some questions, not including those from the
NLSCY or from established instruments.

3.2.5.ii Teachers’ questionnaire

The teachers’ questionnaire was a short, three-page, eight-question, self-administered, written
questionnaire. The usual length of time for completion was eight minutes.
There was a temporal process for administering the questionnaire. First, the interviewer interviewed the mother, obtained signed written consent forms including permission to approach the teacher, and to ascertain the child's grade and name of the teacher and the school. This was followed by the interviewer delivering a package to the school that included a teachers' questionnaire, written consents from the mother and the relevant school board and a letter describing the study. The interviewer either waited for it to be completed, picked it up on another day, or left a self-addressed stamped envelope for it to be returned to the interviewer. The interviewer was not always present during the completion of the questionnaire because of the varying time pressures on teachers.

The questionnaire included two questions establishing the relationship with the child (amount of time teacher saw the child each week, length of time teacher knew the child), one question about absenteeism, and four questions asking the teacher to rate the child on abilities and activities compared to other children of the same age and gender (Conry, 1999). The final question was the 46-item Behaviour Rating Scale described above. A copy of this instrument is in Appendix B.

Development and pre-testing

Fifteen questionnaires were completed by six different teachers to pre-test the instrument. The pre-testing assessed: (a) testing procedures such as amount of time required to complete the questionnaire and its instructions; (b) intra-rater reliability; and (c) inter-rater reliability. Since the majority of the instrument comprised the Behaviour Rating Scale, a standard tool, limited pretesting was required. Because of the input from these teachers, a small number of changes
were made to the wording of new questions and to clarify the instructions, but the Behavior Rating Scale was not altered.

3.2.5.iii Child's WRAT-3 test

The child was given one test, the Wide Range Achievement Test 3 (WRAT-3), described above. Length of the assessment and completion time of this test depends on the level of achievement with those at higher levels being given more questions. This group took an average of approximately 20 minutes and none took more than 30 minutes for completion.

The assessment was administered at the same time the mother was completing her questionnaire. Prior to testing, mothers gave written consent for their child to participate. The interviewer explained the test procedures and administered the test. Interviewers reported that the children were generally pleased to do the test, willing to participate and felt important by being included in the study. There were five exceptions to this procedure, all because the families lived in places other than Vancouver Island so no interviewer was present. For these cases (four individuals plus one set of twins), three school teachers, one school psychologist and one school principal administered the assessment and all were experienced in the administration of the WRAT-3.

3.2.6 Analytic procedures

All data were examined for their distributions. Chi-square analyses were completed to compare the samples from the randomly selected sample of Stage 2 (n=403) and follow-up sample of Stage 3 (n=265) of the study, examining differences with respect to maternal age, socioeconomic factors,
drinking patterns, birth weight or other factors that could influence further analyses. Chi-square analyses had been completed previously to compare the population (Stage 1) and the randomly selected sample of Stage 2 (Armstrong et al., 2001a). From the sample at Stage 2, the subjects were classified according to participation, that is, participated at Stage 3, lost for the follow-up study, or refused. These three groups were compared according to the same demographic, maternal behavioural and social factors, and infant variables.

Correlations were interpreted as weak if they were below .3, even if statistically significant, since there is very low predictive value below that level. They were interpreted as moderate if they fell between .4 and .6, and as high if above .7. Analyses were considered statistically significant at p=.05, and were reported as .05, .01 or .001.

Bivariate analyses were completed to determine the independent relationships between each of the risk conditions and each of the dependent variables. Cross-tabulations, univariate and multivariate analysis and logistic regression analysis were conducted to estimate the relationships between the independent and dependent variables, controlling for the covariates.

Finally, a series of tests were conducted in which both the main effects and interaction effects of variables were compared with the scores of children who were exposed to none of the measured risks. These were one sample t-tests with the null hypothesis that there was no difference between the scores of those exposed to no risks (of the various variables) and either the medium risk levels or high risk levels. The variables included in these statistical models were smoking during 3rd
trimester (dichotomized variable according to whether exposed or not to smoking during 3rd trimester that is essentially throughout pregnancy), current smoking status of the primary caregiver (dichotomized variable as to current smoker or not), T-ACE risk (Stage 2 administration), alcohol consumption patterns (three levels, abstainer, social drinker and heavy drinker), each of the five indicators of socioeconomic status (each of which had three levels of risk), and marital status (dichotomized according to married or not currently married). Separate analyses were required when adding each of the five indicators of socioeconomic status to the models, since the analyses became too restrictive in cell size if all were added into one model. Scores were compared between those with the lowest risk level and other levels of risk. The Beta, or mean difference in scores, of lowest risk level for these variables (for example, no smoking or alcohol use during pregnancy) were set as the baseline for comparison. Regressions were calculated for the main effects of each of the variables and for the effects of the combination of variables on the three academic scores, with the health ratings and with the behavioural outcomes.

A series of Independent sample t-tests for equality of means were calculated to compare scores in reading, spelling and arithmetic of those in the high-risk categories and low-risk categories. This final step in the analysis was to include all three independent variables, alcohol exposure, tobacco exposure and socioeconomic background into the model. Extreme levels of the combined variables (for example, lowest alcohol risk level and lowest tobacco exposure and lowest socioeconomic indicator are combined and compared with highest levels these variables. At one extreme corner is a cell that combines the highest risk of these three dimensions and at the other extreme corner is a cell that combines that constitutes the least risk. A comparison was made
between the combined high risks and the combination of no or lesser risks, and subsequently it was planned to move in a level on each variable to compare lesser extremes.

The high risk group consisted of women who had a high T-ACE risk level, drank alcohol during their pregnancy and smoked cigarettes throughout pregnancy and had the lowest indicators of socioeconomic status. Initially, tobacco exposure during pregnancy was included in the model but when no effect was observed on any of the academic abilities, consistent with all previous analyses, it was excluded from the model that included multiple independent variables. This permitted less restriction in the analyses when including multiple variables. Socioeconomic indicator variables needed to be added to the model separately since including all at once was restrictive on the analyses, resulting in the degrees of freedom being exhausted. By deleting tobacco exposure from the model, it was possible to keep three categories for each variable, that is three levels of socioeconomic status and three risk levels of T-ACE and alcohol consumption (abstainers, social drinkers and heavy drinkers) and to conduct a series of contrasts between the various levels for each of the academic subjects. The remaining variables combined to determine risk level were each of the socioeconomic indicators and T-ACE risk and alcohol consumption patterns.

In each case, the results of Levene's test for equality of variances guided whether the t-test for equality of means assumed equal variances or equal variances not assumed.

Three aspects of the analyses require further detail, that is, how twins, missing data and non-normally distributed data were treated.
Twins

There were two sets of twins. The results might have been skewed by including two children's outcomes but only one mother's behaviour, therefore only one child from each pair was included in the analyses. For each analysis, the most extreme scores of the pairs, that is, in one set the highest scoring twin's results were used and in the other set the lower scoring twin's results were used. For any analyses in which the results might have been altered because of this consistently used combination, all other combinations of pairs were used as a check to ensure this was not altering the results of the study. Checking using the other alternative pairing combinations never changed the results.

Missing data

Missing data were treated as missing and not accounted for in any of the analyses, with one exception, described below. For example, there were 265 parents who completed questionnaires about their family characteristics and about the child who was the subject of the study. Only 252 children completed tests of their academic abilities, since one child was unavailable at the time the interviewer travelled to Victoria and the others lived in remote areas of the province or country and were sent the questionnaire by mail, with no trained person available to test the child. Two of these 252 children were twins, so all analyses regarding academic abilities using the WRAT-3 were completed on a total of 251 children.

The exception to removing missing data from the analyses was made with the Behaviour Rating Scale. Since it consisted of eight subscales, each of the subscales and the total score would have
been lost if the missing data were removed from the analyses. Instead, the modal score was used as replacement for the missing items. Because the scores for each of the subscales on both the Teachers’ and the Parents’ Behaviour Rating Scales were skewed, use of the modal score meant that the missing items were replaced with the most conservative (least problem-based) scores. Analyses were re-done to ensure that the results were not altered because of this procedure. One subscale (Indirect Aggression) had considerably more missing items than any other, but the missing items appeared to be randomly omitted. Indirect Aggression items include questions such as “when mad at someone, tells the other one’s secrets to a third person” and “when mad at someone, tries to get others to dislike that person.” It was presumed that responses to these items were missing merely because the respondent was unable to observe such behaviour because of the particular behaviour described.

Non-normal distributions

The distribution of the data for alcohol use and for tobacco use during pregnancy were skewed since the greatest number of women drank little or no alcohol and did not smoke. Most analyses were repeated to include and exclude the non-smokers and non-drinkers. There were normal distributions for both socioeconomic background indicators and for academic abilities scores. When the data were not normally distributed, either non-parametric analyses were completed or logarithms were used in the analyses.

Path analyses was examined as a possibility for describing the direct and indirect effects of the independent variables on each of the dependent variables. This analysis calls for both theoretical
design of the relationships between the variables and statistical assumptions. It was not found to
be suitable for the analyses in this project.

Statistical assumptions could not be met in order to use path analysis for two of the dependent
variables, health and academic abilities. The statistical assumptions for path analysis are that
variables are continuous and normally distributed, both of which precluded such analysis for the
health outcome. While these assumptions were not violated for the academic abilities outcome, the
effect size of each of the three results, reading, spelling and arithmetic, were small. Because of
these small effect sizes, it was difficult to show differences with any regression model, and
therefore power required for path analysis for which there was more than one regression analysis
yielded no results.

These statistical assumptions and a further assumption regarding linear relationships were not
violated in the case of the behavioural outcomes. Theoretical assumptions required for this study
are threefold: that there are measurable, observed relationships between the independent and
dependent variables, that the independent variables precede the outcomes temporally and that the
the independent and dependent variables do not have a spurious relationship. The first two of
these assumptions are not violated for the variables in that the independent variables and dependent
variables are correlated and the independent variables (that occurred during pregnancy) precede
the outcomes for these children at approximately 9 years old. There is no indication that the
variables have a spurious relationship, especially when including socioeconomic status as one of
the independent variables.
Although such analysis was attempted, any conclusions were limited. There was a reasonable sample size but when the sample was divided into the necessary cells with respect to risk levels of alcohol and tobacco use and socioeconomic status many of the cells were small. Another limitation of any conclusions was that this study in some respects was as much a cross-sectional study at two points in time rather than a gathering of data at many points until the children achieved the age of 8 or 9 years old. While there were two data collection points, that is Stage 1 during pregnancy and Stage 2 shortly after birth, most of the data collected during these two stages were about lifestyle during pregnancy.

Although path analysis was attempted, given the sample size and design, any results would have been considered too tentative to report with confidence. As an alternative, models were constructed with simple correlations reported instead of the compound or additive calculations required for path analysis.
Table 3.6 Variables, variable type and source of data collection.

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Source: Stage 1 Medical records during pregnancy (n=3,659)</th>
<th>Source: Stage 2 (1990-1991) Interview after birth (n=403)</th>
<th>Source: Stage 3 (1999-2000) Interview and testing at ~age 8 (n=265)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol risk, using T-ACE</td>
<td>(1) Mother’s alcohol risk level prior to pregnancy, using the T-ACE; (2) quantity/frequency at pre-pregnancy, 1st, 2nd, and 3rd trimester</td>
<td>Alcohol use: current use of father and mother</td>
<td></td>
</tr>
<tr>
<td>Mother’s tobacco use during pregnancy</td>
<td></td>
<td>Current tobacco use, second-hand smoke exposure to child</td>
<td></td>
</tr>
<tr>
<td>Socioeconomic background, measured by occupation and education for both father and mother and source of income</td>
<td></td>
<td>Socioeconomic status, indicated by parental occupation, parental education and income amount and source</td>
<td></td>
</tr>
<tr>
<td>Other: Maternal age</td>
<td></td>
<td></td>
<td>Other: Parents’ height and weight Marital status</td>
</tr>
<tr>
<td>Marital status of mother; Measurement of neonate: weight, length, Head circumference; Nutrition during pregnancy; Medication use during pregnancy.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socio-emotional stress factors: i. social supports ii. stress relieving activities iii. postnatal depression iv. history of mental illness v. history of abuse vi. history of substance abuse</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

171
<table>
<thead>
<tr>
<th>Dependent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic: WRAT-3 assessment (spelling, reading, arithmetic); history of skipping or repeating grades, and of learning assistance and teachers’ ratings of progress.</td>
</tr>
<tr>
<td>Health: general rating scale, specific illnesses or diseases, number of visits to medical practitioners and hospitalization history, other indicators of health and well-being, school absenteeism</td>
</tr>
<tr>
<td>Behaviour: teachers’ and parents’ behaviour rating scale (with 8 subscales: Conduct Disorder, Hyperactivity, Emotional Disorder, Anxiety, Indirect Aggression, Physical Aggression, Inattention and Prosocial Behaviour).</td>
</tr>
</tbody>
</table>
Chapter IV  Results

In this chapter, the results are reported, first describing the characteristics of, and any biases of, the sample, followed by frequencies for each of the independent and dependent variables and finally observations of the main and interactive effects of the independent variables on each of the outcome variables.

4.1 Sample

The population comprised women (n=3,659) who lived within a geographic catchment area of 12 hospital districts on Vancouver Island and who gave birth between July 1, 1990 and June 30, 1991. From that population, a sample of 403 women were randomly selected for home interviews that occurred approximately eight weeks after the birth of the child. The results reported here are those from a follow-up of the children of 265 of those 403 women.

4.1.1 Participation in the follow-up study

Of the original random sample of 403 women sought for follow-up, 265 (65.7%) were interviewed, as shown on Table 3.2 above. Only 22 women (5.5%) refused participation, another 104 (25.8%) were never found, and 12 (3.0%) were not interviewed for other reasons. The 12 people who fell into this latter category included one mother who had died, one child who had died for reasons unrelated to the variables of this study, one who did not speak English well enough to be interviewed, three who had moved to addresses (two to Ontario and one to Holland) unknown to their relatives or neighbours, and five who were found but could not be interviewed because further contact was impossible as they did not have telephones.
A series of nonparametric chi-square analyses was conducted to examine differences between the random sample selected at Stage 2 (n=403) and the sample of women who participated at follow-up (n=265), those who refused to participate and those who were never found. Characteristics of the sample analyzed were maternal demographic characteristics (geographic area where the women lived during the initial interview when their children were born, maternal age, education, marital status, occupation and ethnicity), maternal lifestyle characteristics (smoking and alcohol risk levels) and child characteristics (gender and birth weight).

No sampling biases were observed according to the geographic area where the women originally lived either for the number of women who were interviewed at follow-up or for women who refused, nor for those who could not be located for follow-up. Vancouver Island had been divided into four areas in the original 1990-1991 sampling: south and west (including Port Alberni, Duncan, Tofino, Bamfield, Ladysmith), mid-east island (including Nanaimo, Parksville, Qualicum Beach), mid-north island (including Comox, Courtenay, Campbell River, Gold River, Tahsis) and north (including Port Hardy and Port McNeill). Since there were differences in various demographic and lifestyle characteristics according to the geographic area found in Stage 2 of this study (Armstrong, 2001a), it was important to observe no differences according to geography between the two stages of the study.

There was no significant difference between the two samples according to maternal education, for either those women who were interviewed or those who refused participation. No differences
were found with respect to maternal age at the time of the birth of the child, for either those who participated in the follow-up, or for those who could not be located, although young mothers (less than age 20 years) were over-represented amongst those who refused (n=22, $\chi^2=16.03$, df=2, $p<.001$) (one expected, five observed).

There were biases in the follow-up sample with respect to marital status, employment status, and maternal racial background. Married women were slightly over-represented in the follow-up sample ($\chi^2=8.55$, df=3, $p<.05$; 191 expected versus 211 observed) and women in common-law partnerships were slightly over-represented in the group who were not found for follow-up ($\chi^2=7.66$, df=3, $p<.05$). Caucasian women were somewhat over-represented in the follow-up sample ($\chi^2=8.7$, df=3, $p<.05$; 241 expected versus 255 observed) and aboriginal women were over-represented in the group who could not be located for follow-up ($\chi^2=11.30$, df=3, $p<.01$; 7 expected versus 14 observed). There were also differences between the two samples with respect to occupational status, with more unemployed women not being located for follow-up ($\chi^2=14.7$, df=3, $p<.01$; 21 expected versus 33 observed) and more employed women who completed the interview at follow-up ($\chi^2=8.14$, df=3, $p<.05$) (121 expected versus 106 observed).

Analyses were conducted to compare sample representativeness on two lifestyle variables, alcohol risk level and maternal smoking. No statistical differences were found with respect to maternal smoking behaviour for those who participated (for example, 3rd trimester smoking, $\chi^2=.49$, df=3, $p=.92$) or for those who refused participation. No statistically significant differences were found between T-ACE scores (Stage 2) for those who were interviewed at follow-up ($\chi^2=1.2$, df=2, $p=.55$).
who refused to participate ($\chi^2=97, df=2, p=.65$) and for those not located for follow-up ($\chi^2=3.0, df=2, p=.19$).

Child characteristics were also examined for differences between the samples according to gender and birth weight. No differences were observed between the original random sample and participating follow-up sample for either variable (for gender, $\chi^2=.44, df=1, p=.51$; for birth weight, $\chi^2=4.0, df=7, p=.78$).

To summarize, it appeared that there were differences between the original random sample and the follow-up sample with respect to mother's demographic variables of marital status, employment status and racial background, but no differences with respect to geographic location or maternal education. There were no differences between the two samples with respect to lifestyle characteristics according to the mother's alcohol risk level or whether she smoked tobacco during pregnancy. There were also no differences between the samples at the two stages of the study according to gender or birth weight of the child.

4.1.2 Demographic characteristics of sample participating at Stage 3

There were 265 families who participated in the data collection at Stage 3. There were two sets of twins, and the remaining 263 children were singleton births. Table 4.1 shows demographic descriptive statistics of the sample, including frequencies of socioeconomic indicators (income, parental education and parental occupations), age of mother at the time she gave birth to this child, T-ACE risk level and history of smoking during pregnancy. It also gives frequencies of child's

176
gender, age and single parenthood.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current marital status of mother</td>
<td>Married</td>
<td>197</td>
<td>(74.3%)</td>
</tr>
<tr>
<td></td>
<td>Common-law</td>
<td>27</td>
<td>(10.2%)</td>
</tr>
<tr>
<td></td>
<td>Single</td>
<td>12</td>
<td>(4.5%)</td>
</tr>
<tr>
<td></td>
<td>Divorced, separated, widowed</td>
<td>29</td>
<td>(11.0%)</td>
</tr>
<tr>
<td>Occupation: birth mothers (current)</td>
<td>Administrative or executive</td>
<td>104</td>
<td>(39.3%)</td>
</tr>
<tr>
<td></td>
<td>Other white collar (e.g., teacher, clerical, social services)</td>
<td>124</td>
<td>(46.7%)</td>
</tr>
<tr>
<td></td>
<td>Primary industries, including skilled and unskilled trades</td>
<td>20</td>
<td>(7.6%)</td>
</tr>
<tr>
<td></td>
<td>unknown or not employed</td>
<td>17</td>
<td>(6.4%)</td>
</tr>
<tr>
<td>Occupation: birth fathers (current)</td>
<td>Administrative or executive</td>
<td>53</td>
<td>(20.1%)</td>
</tr>
<tr>
<td></td>
<td>Other white collar (e.g., teacher, clerical, social services)</td>
<td>29</td>
<td>(10.9%)</td>
</tr>
<tr>
<td></td>
<td>Primary industries, including skilled and unskilled trades</td>
<td>157</td>
<td>(59.2%)</td>
</tr>
<tr>
<td></td>
<td>unknown or not employed</td>
<td>17</td>
<td>(6.9%)</td>
</tr>
<tr>
<td>Education (current): birth mothers</td>
<td>Less than high school graduation</td>
<td>31</td>
<td>(11.7%)</td>
</tr>
<tr>
<td></td>
<td>High school graduation</td>
<td>46</td>
<td>(17.4%)</td>
</tr>
<tr>
<td></td>
<td>Some college, university or technical school</td>
<td>70</td>
<td>(26.4%)</td>
</tr>
<tr>
<td></td>
<td>Completed college or technical school</td>
<td>76</td>
<td>(28.7%)</td>
</tr>
<tr>
<td></td>
<td>Completed university</td>
<td>32</td>
<td>(12.1%)</td>
</tr>
<tr>
<td></td>
<td>Post-graduate university education</td>
<td>7</td>
<td>(2.6%)</td>
</tr>
<tr>
<td></td>
<td>unknown</td>
<td>3</td>
<td>(1.1%)</td>
</tr>
<tr>
<td>Education: birth fathers (current)</td>
<td>Less than high school graduation</td>
<td>42</td>
<td>(15.8%)</td>
</tr>
<tr>
<td></td>
<td>High school graduation</td>
<td>48</td>
<td>(18.1%)</td>
</tr>
<tr>
<td></td>
<td>Some college, university or technical school</td>
<td>51</td>
<td>(19.3%)</td>
</tr>
<tr>
<td></td>
<td>Completed college or technical school</td>
<td>67</td>
<td>(25.3%)</td>
</tr>
<tr>
<td></td>
<td>Completed university</td>
<td>30</td>
<td>(11.3%)</td>
</tr>
<tr>
<td></td>
<td>Post-graduate university education</td>
<td>10</td>
<td>(3.8%)</td>
</tr>
<tr>
<td></td>
<td>unknown</td>
<td>17</td>
<td>(6.4%)</td>
</tr>
<tr>
<td>Income: total household (1999-2000)</td>
<td>&lt;$10,000</td>
<td>3</td>
<td>(1.2%)</td>
</tr>
<tr>
<td></td>
<td>$10,000-$19,999</td>
<td>23</td>
<td>(8.7%)</td>
</tr>
<tr>
<td></td>
<td>$20,000-$39,999</td>
<td>52</td>
<td>(19.6%)</td>
</tr>
<tr>
<td></td>
<td>$40,000-$59,999</td>
<td>75</td>
<td>(28.3%)</td>
</tr>
<tr>
<td></td>
<td>$60,000-$79,000</td>
<td>50</td>
<td>(18.9%)</td>
</tr>
<tr>
<td></td>
<td>&gt;$80,000</td>
<td>46</td>
<td>(17.3%)</td>
</tr>
<tr>
<td></td>
<td>unknown</td>
<td>16</td>
<td>(6.0%)</td>
</tr>
</tbody>
</table>
Table 4.1 (continued)

<table>
<thead>
<tr>
<th>Main source of income</th>
<th>Wages or salaries</th>
<th>204 (77.0%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self-employed</td>
<td>33 (12.5%)</td>
</tr>
<tr>
<td></td>
<td>Welfare</td>
<td>10 (3.8%)</td>
</tr>
<tr>
<td></td>
<td>Workers' Compensation, Aboriginal benefits, child tax benefit, disability or seniors pension</td>
<td>10 (3.8%)</td>
</tr>
<tr>
<td></td>
<td>Other income, or not stated</td>
<td>8 (3.0%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maternal age at birth of child</th>
<th>&lt; 20 years</th>
<th>8 (3.0%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 to 30 years</td>
<td>181 (68.3%)</td>
</tr>
<tr>
<td></td>
<td>&gt; 30 years</td>
<td>76 (28.7%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>T-ACE Risk (Stage 2)</th>
<th>Low risk (score 0 or 1)</th>
<th>164 (61.9%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medium risk (score 2)</td>
<td>85 (32.1%)</td>
</tr>
<tr>
<td></td>
<td>High risk (score 3, 4 or 5)</td>
<td>16 (6.0%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Smoking</th>
<th>Ever smoked during pregnancy</th>
<th>87 (32.8%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never smoked during pregnancy</td>
<td>178 (67.2%)</td>
</tr>
</tbody>
</table>

Characteristics of children (n=267, including two sets of twins):

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male</th>
<th>133 (50.0%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>134 (50.0%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ages</th>
<th>7 years</th>
<th>3 (1.1%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8 years</td>
<td>227 (85.0%)</td>
</tr>
<tr>
<td></td>
<td>9 years</td>
<td>37 (13.9%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parenting</th>
<th>Lives only with mother</th>
<th>57 (21.3%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lives only with father</td>
<td>5 (1.9%)</td>
</tr>
</tbody>
</table>

4.2 Independent and dependent variables

Frequencies of both the independent and dependent variables are described below.

4.2.1 Independent variables

Data collected for prenatal alcohol exposure, alcohol risk level, and prenatal tobacco exposure and socioeconomic indicators are described.
4.1.2.1 Alcohol use during pregnancy

There were two assessments of alcohol consumption during pregnancy and two assessments of risk drinking, as described in Chapter III. Alcohol consumption was measured by self-reports of alcohol drinks consumed per day with reference to different time periods, that is, before pregnancy and during pregnancy. The risk assessments were measured by the T-ACE test (Sokol et al., 1989) administered at two different times, with both referencing alcohol experiences just before pregnancy. The two times of administration of the T-ACE tests were during the Stage 1 data collection (the patient's visit to her physician) and during the Stage 2 data collection (home visit interview after the child was born). Correlations between these four measures were calculated and correlation coefficients and alpha levels are shown in Table 4.2 below.

<table>
<thead>
<tr>
<th></th>
<th>T-ACE risk Stage 1</th>
<th>T-ACE risk Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-ACE risk, administered at Stage 1</td>
<td></td>
<td>.53 (p&lt;.001)</td>
</tr>
<tr>
<td>T-ACE risk, administered at Stage 2</td>
<td>.53 (p&lt;.001)</td>
<td></td>
</tr>
<tr>
<td>Absolute alcohol consumption during pregnancy</td>
<td>n.s.</td>
<td>.29 (p&lt;.001)</td>
</tr>
<tr>
<td>Absolute alcohol consumption before pregnancy</td>
<td>.22 (p&lt;.05)</td>
<td>.38 (p&lt;.001)</td>
</tr>
</tbody>
</table>

There was a statistically significant positive correlation between the two T-ACE risk assessments (r=.53, p<.001) administered at two different times. There were statistically significant positive correlations between the scores the two T-ACE risk scores and alcohol consumed before pregnancy. T-ACE risk always (Stage 1 and Stage 2) refers to alcohol risk prior to pregnancy. Alcohol use during pregnancy was found to be statistically significantly correlated only with the
second administration of T-ACE risk assessment. These data indicated that some women reduced their drinking during pregnancy in comparison with their use before pregnancy, and this reduction would lower the correlation between the two time periods and between T-ACE levels and use during pregnancy. One example illustrates this. The woman who reported drinking to the most extreme levels before pregnancy ("2-3 litres" of a type of berry wine) said that she stopped drinking during her pregnancy and that her husband had also stopped to support her. This woman scored in the high risk group according to the T-ACE risk levels at both Stage 1 or Stage 2, since the T-ACE refers to the period before pregnancy, but she was in the abstainer category for use during pregnancy.

Amount of alcohol use during pregnancy was fairly low, according to the self-reports of quantity consumed. Nearly one-half (48.3%) of the women reported that they did not drink alcohol during any of the trimesters. Of those who did report drinking, most said they usually consumed only one drink per occasion, and only three women usually drank more than one drink per occasion throughout pregnancy. There were 21 (7.9%) women who were categorized as heavy drinkers by either drinking 2 or more drinks per day (2 women) or by reportedly binge drinking (20 women) during pregnancy, that is, consuming five or more drinks per occasion, or doing both (1 woman). These results are summarized in Table 4.3 below.
### Table 4.3 Number and percentage of women who reported levels of drinking.

<table>
<thead>
<tr>
<th>Frequency (percentage)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>non-drinker or abstained during pregnancy 128</td>
<td>(48.3%)</td>
</tr>
<tr>
<td>1 or fewer drinks per day 116</td>
<td>(43.8%)</td>
</tr>
<tr>
<td>2 or more drinks daily and/or some occasions of binge drinking* 21</td>
<td>(7.9%)</td>
</tr>
<tr>
<td>Total 265</td>
<td>(100.0%)</td>
</tr>
</tbody>
</table>

*Note: only 1 woman drank more than 2 drinks per day plus some binge drinking.

### 4.1.2.ii Tobacco use during pregnancy

There were 85 women who smoked during their pregnancies. The number of exposures to tobacco smoke for each child for the total pregnancy period was calculated by multiplying frequency and quantity of smoking. The result was a total number of exposures to which the fetus was exposed throughout the pregnancy, based on 288 days of pregnancy. Disregarding the non-smokers, the minimum exposure throughout pregnancy was 80 cigarettes (about two per week), the maximum was 7,980.3 (approximately 28 cigarettes daily) and the mean was 2,600 (approximately 9 cigarettes daily) with a standard deviation of 1585.

Smoking behaviour was categorized into four levels according to quantity smoked daily: none, <10 cigarettes daily, 10-20 cigarettes daily, and >20 cigarettes daily. Use during each of the trimesters was also analysed. Total numbers of women who smoked at each of these levels, during each of the trimesters is shown in Table 4.4.
Nearly one-third (32.8%) of the sample reported that they had smoked at least on some occasions during their pregnancy, with many of the women stopping sometime during the first trimester.

Women did cut down on their smoking so that there were fewer smokers after the 1st trimester. The number of smokers was similar during the 2nd and 3rd trimesters, as was the amount smoked per day.

Tobacco use during pregnancy was statistically significantly positively correlated with alcohol risk level measured by the T-ACE risk level ($\rho=0.30, p<0.001$) and with absolute alcohol consumed during pregnancy ($\rho=0.13, p<0.05$). Smoking during pregnancy was statistically significantly correlated with current second-hand smoke exposure for the children, indicating that those who smoked during pregnancy continued to smoke ($\rho=0.50, p<0.01$), and that it would have been difficult to partial out children exposed only to smoking during pregnancy, or only after pregnancy.

4.1.2.iii Socioeconomic status

During the latest (Stage 3) data collection, three indicators of socioeconomic status were
measured, parents’ education level, occupations and income. These indicators were inter-correlated; for example, mothers’ occupation was correlated with her highest level of education \((\rho=0.33, p<0.01)\) and with household income \((\rho=0.30, p<0.01)\) and with fathers’ occupation level \((\rho=0.19, p<0.05)\).

Indicators of socioeconomic status measured at Stages 1 or 2 were parental education and occupation and fathers’ income. These were all positively correlated with current indicators of socioeconomic background; for example, maternal education at both time periods (during pregnancy and currently) were correlated \((\rho=0.72, p<0.01)\) as was income at the two times of data collection \((\rho=0.32, p<0.01)\).

Women who smoked at any time during their pregnancy were less educated than the non-smokers \((\rho=0.18, p<0.01)\), had lower occupational levels \((\rho=0.22, p<0.01)\) and lower household incomes \((\rho=0.16, p<0.05)\).

4.2.2 Outcome variables: academic abilities, health and behaviour

4.2.2.i Academic ability scores of study sample

Data were collected on academic abilities from three sources: testing of the children using the WRAT-3, by asking the child’s teacher to rate the child, and by questioning the parents on which subjects their child was having any difficulties. The WRAT-3 tested the child on reading, spelling and arithmetic. WRAT-3 scores and the national (U.S.) standards are shown in Table 4.5 below.
Table 4.5 Results of WRAT-3 scores (n=252), including mean, minimum and maximum scores, standard deviation, correlations between reading, spelling and arithmetic, and compared with U.S. national standardized scores.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Minimum and maximum scores</th>
<th>Standard deviation</th>
<th>Correlation with spelling score</th>
<th>Correlation with arithmetic scores</th>
<th>WRAT-3 national (U.S.) standard scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>106</td>
<td>66-148</td>
<td>15.8</td>
<td>.72*</td>
<td>.46*</td>
<td>99.2</td>
</tr>
<tr>
<td>Spelling</td>
<td>99.3</td>
<td>70-155</td>
<td>12.8</td>
<td>-</td>
<td>.49*</td>
<td>99.5</td>
</tr>
<tr>
<td>Arithmetic</td>
<td>97.3</td>
<td>61-127</td>
<td>12.2</td>
<td>-</td>
<td>-</td>
<td>99.8</td>
</tr>
</tbody>
</table>

*Correlation is significant at p<.001 level (2-tailed).

The scores for each of the three academic subjects for this cohort were normally distributed.

Reading scores were slightly higher than the national (U.S.) standardized scores (Wilkinson, 1993), as shown in Table 4.5. Wilkinson (1993) used discriminate analysis in an attempt to ascertain if the WRAT-3 could correctly separate children in special groups of gifted children, mentally handicapped children and learning disabled children (n=111 with mean age 10.6 years). It may be questionable to compare this British Columbia sample with U.S. children, however, such results would indicate that at least some of the present sample fall within all the groups categorized by Wilkinson. WRAT-3 scores have been classified from “deficient” (score of 69 or below), borderline, low average, average, high average, superior and very superior (score of 130 and above) (Wilkinson, 1993).

To describe the children in this study group with very low scores, there were three children whose scores were below 69 in reading (two scoring 66 and one scoring 69), four who scored below 69
in arithmetic (one scoring 61, and three scoring 63), and no one scoring in the “deficient” category for spelling. Those three who scored below 69 on reading also scored in the “below average” category or lower on the other two tests. The only child who scored below 69 in both reading and arithmetic has been given learning assistance in school, is a very small child, has a brother diagnosed with attention deficit disorder, has a mother who engaged in binge alcohol drinking during pregnancy, and has two parents who have not gone beyond high school in their own education. Another child who scored 66 in reading has been diagnosed with asthma, is home-schooled but when previously in school had been given learning assistance, has a mother whose drinking before pregnancy put her at medium risk level on the T-ACE test, and has a father whose education was on the lowest category level (grade 9 or less). The third child who scored in the “deficient” category for reading has a mother who began drinking at a young age (age 10) and who ranked in the highest T-ACE risk level (“high risk”) for her drinking prior to pregnancy and has two parents who are educated at the college level. All these children with very low reading scores have mothers who are current or former smokers. To describe those in the “deficient” category for arithmetic, one (described above) also was in the same category for reading, another scored below “low average” on all test scores, and the other two scored in the “average” category for spelling and reading. Three of the four children who had these very low arithmetic scores have mothers who scored within the low risk level on the T-ACE, and the fourth one is described above as having a mother who binge drank, scored within the high risk level on the T-ACE test and two parents with only high school education.
Teachers' ratings of the children's abilities, parents' ratings of their children's areas of academic difficulties and WRAT-3 were positively correlated. The correlation coefficients and alpha values are shown in Table 4.6 below.

Table 4.6 Correlational relationships (Spearman's rho) between WRAT-3 scores on reading, spelling and arithmetic tests, comparisons with teachers’ ratings of reading and arithmetic and with parents’ assessments of their child's difficulties with these subjects.

<table>
<thead>
<tr>
<th></th>
<th>Teachers' ratings - reading</th>
<th>Teachers' ratings - arithmetic</th>
<th>Parents' rating - reading</th>
<th>Parents' rating - spelling</th>
<th>Parents' rating - arithmetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>WRAT-3 reading</td>
<td>.58**</td>
<td></td>
<td>.63**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WRAT-3 spelling</td>
<td></td>
<td></td>
<td></td>
<td>.28**</td>
<td></td>
</tr>
<tr>
<td>WRAT-3 arithmetic</td>
<td></td>
<td>.43**</td>
<td></td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>Teachers' rating - reading</td>
<td></td>
<td></td>
<td>.57**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teachers' rating - arithmetic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.22*</td>
</tr>
</tbody>
</table>

*Correlation is significant at the .05 level (2-tailed).
**Correlation is significant at the .01 level (2-tailed).
n.s. - correlation not significant.
Note: teachers were not asked to rate children’s ability in spelling.

Table 4.6 shows that most correlations between the WRAT-3 test scores and teachers' and parents' assessments of these children's abilities were statistically significantly correlated. There was one exception, that being the parents' ratings of arithmetic abilities, that were not observed to be correlated with the child's test scores. These correlations provide concurrent validation of the WRAT-3 testing on the subjects of reading, spelling and arithmetic.

4.2.2.ii Health

Parents were asked to rate their child's health, compared to other children of the same age, on a
scale rating health as “excellent”, “very good”, “good”, “fair” or “poor”.

Parents also were asked to rate the health of others in the same family, that is, to rate their own health compared to others of the same age, to rate their oldest child and youngest children compared to others of the same ages, with the same five-point adjectival scale used for each rating. These questions about other family members gave a broader context to the responses in that the health of most of the family was measured. The maternal responses for the four family members were all skewed and were statistically significantly inter-correlated, as shown in Table 4.7.

| Table 4.7 Parents’ ratings of their child’s health, their own health and their youngest and oldest children’s health, on a 5-point scale, and correlations among these ratings. |
|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Parents’ rating of child’s health | Parents’ rating of own health | Parents’ rating of youngest sibling’s health | Parents’ rating of oldest sibling’s health |
| Excellent | 131 (49.4%) | 54 (20.4%) | 60 (39.0%) | 76 (40.6%) |
| Very good | 95 (35.8%) | 119 (44.9%) | 70 (45.5%) | 81 (43.4%) |
| Good | 32 (12.1%) | 72 (27.2%) | 17 (11.0%) | 24 (12.8%) |
| Fair | 7 (2.7%) | 17 (6.5%) | 7 (4.5%) | 6 (3.2%) |
| Total | 265 (100.0%) | 265 (100.0%) | 154** (100.0%) | 187 (100.0%) |
| Correlation with rating of index child | .24* | .39* | .35* |

*Correlation coefficient (Spearman’s rho) is significant at .001 level (2-tailed).
**These totals less than n=265 since many families did not have a child younger or older than the subject.

Parents’ ratings of their child’s health were skewed to the left, that is, negative skew, with nearly one-half of the parents rating their child as being in “excellent” health, only 2.7% rating their child as being in “fair” health and none rating their child as having “poor” health. Their ratings of this
child's health were statistically correlated with their rating of their own health (\(\rho = .24, p < .05\)), their youngest child’s health (\(\rho = .39, p < .05\)) and their oldest child’s health (\(\rho = .35, p < .05\)). Because of skewed distributions, non-parametric calculations were conducted for these correlations (i.e., Spearman’s rho) and for other analyses examining relationships with independent variables, the results of which are reported below.

Another set of questions posed to gather information about the child’s health were specific to conditions or diseases, such as chronic illness (e.g., allergies, asthma, bronchitis, epilepsy or heart conditions), hearing or vision or speech problems, difficulties with mobility and emotional problems. These questions, for the most part, were drawn directly from the NLSCY and the results were similar to that study in that the number of children with any of these illnesses or conditions was very small. Table 4.8 below gives frequencies of these conditions or illnesses.
Finally, parents were asked about the frequency of use of services of health professionals for their child during the past year. The list of health professionals included medical professionals (general practitioners, pediatricians, and other medical doctors), public health nurses or nurse practitioners, psychiatrists or psychologists, social workers, child care or children's aid workers, and dentists or orthodontists. The results are shown in Table 4.9 below.

Table 4.8 Number of children with specific chronic illnesses or conditions.

<table>
<thead>
<tr>
<th>Illness or condition</th>
<th>Number with condition (%)</th>
<th>n=265</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asthma</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Ever diagnosed by professional</td>
<td>17 (6.4%)</td>
<td></td>
</tr>
<tr>
<td>- Attack during past 12 months</td>
<td>7 (2.6%)</td>
<td></td>
</tr>
<tr>
<td>- Wheezing or whistling in past year</td>
<td>16 (6.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>Allergies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>46 (23.1%)</td>
<td></td>
</tr>
<tr>
<td><strong>Epilepsy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 (0.1%)</td>
<td></td>
</tr>
<tr>
<td><strong>Bronchitis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 (&lt;0.1%)</td>
<td></td>
</tr>
<tr>
<td><strong>Heart condition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 (&lt;0.1%)</td>
<td></td>
</tr>
<tr>
<td><strong>Other long-term conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 (1.9%)</td>
<td></td>
</tr>
<tr>
<td><strong>Cerebral palsy, mental handicap, or kidney condition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Emotional, psychological or nervous difficulties</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 (3.7%)</td>
<td></td>
</tr>
<tr>
<td><strong>Learning disability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9 (3.5%)</td>
<td></td>
</tr>
<tr>
<td><strong>Medication prescriptions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ritalin</td>
<td>5 (1.9%)</td>
<td></td>
</tr>
<tr>
<td>Ventolin</td>
<td>11 (4.2%)</td>
<td></td>
</tr>
<tr>
<td>Anti-convulsants</td>
<td>2 (0.1%)</td>
<td></td>
</tr>
</tbody>
</table>
Table 4.9 Frequency of child’s visits with various health professionals in the past year, including mean number of visits.

<table>
<thead>
<tr>
<th>Professional</th>
<th>none</th>
<th>1-3 times</th>
<th>4-6 times</th>
<th>7-9 times</th>
<th>≥10 times</th>
<th>mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Practitioner</td>
<td>106</td>
<td>122</td>
<td>26</td>
<td>1</td>
<td>4</td>
<td>1.51</td>
</tr>
<tr>
<td>Pediatrician</td>
<td>238</td>
<td>16</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0.19</td>
</tr>
<tr>
<td>Other medical doctor</td>
<td>228</td>
<td>28</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.28</td>
</tr>
<tr>
<td>Public Health Nurse or Nurse Practitioner</td>
<td>247</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dentist or Orthodontist</td>
<td>70</td>
<td>171</td>
<td>14</td>
<td>2</td>
<td>5</td>
<td>1.59</td>
</tr>
<tr>
<td>Psychologist or Psychiatrist</td>
<td>243</td>
<td>13</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0.14</td>
</tr>
<tr>
<td>Social worker</td>
<td>249</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Child welfare worker or children’s aid worker</td>
<td>248</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other therapist or counsellor (e.g., Speech Therapist)</td>
<td>226</td>
<td>21</td>
<td>7</td>
<td>1</td>
<td>3</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Note: n=259 for all practitioners except Pediatricians (n=258).

Finally, teachers were questioned regarding the number of days the child was absent from school.

The number of days per month children were absent from school ranged from 0 (17 children) to 8 days (1 child). Most children (64.1%) were absent less than ½ day per month, 79.1% were absent up to one day per month and 99.1% were absent up to 2 ½ days per month.

Bivariate correlations were calculated between variables in each pairing of four measures of health: parents’ rating of child’s health, parents’ rating of amount of time the child was in relatively good health, a composite measure of number of visits to key health professionals (general practitioners, pediatricians, other medical specialists and public health nurses or nurse practitioners), and number
of day absent from school. The results are shown in Table 4.10 below.

| Table 4.10 Correlational relationships, including p values, among four measures of health: rating by parents, visits with various medical and nurse professionals, amount of time child has been in good health in recent months, and school absenteeism. |
|-------------------------------------------------|------------------|-----------------|-----------------|
| Rating of child’s health by parents              | Number of visits to medical and nurse practitioners and public health nurses | Rating of amount of time child has been in good health in recent months |
| Rating of child’s health by parents               | 1.00              | .22**           | n/a             |
| Number of visits to medical and nurse practitioners and public health nurses | -                 | 1               | -.17*           |
| Rating of amount of time child has been in good health in recent months | .37**             | -               | 1               |
| Absenteeism from school                          | n.s.              | n.s.            | n.s.            |

*Correlation coefficient (Spearman’s rho) is significant at .01 level (2-tailed).
**Correlation coefficient (Spearman’s rho) is significant at .001 level (2-tailed).

Parents’ rating of the child’s health was confirmed by the number of visits to medical practitioners or social workers, since the children who were rated as the healthiest had the fewest visits to these professionals. Rating of child’s health was found to be statistically significantly positively correlated with total number of visits to health professionals (rho=.22, p<.001), and to visits to specific professionals, including general and pediatric practitioners (r=.33, p<.001), social workers (rho=.17, p<.01), public health nurses or nurse practitioners (rho=.18, p<.01), child care or aid workers (rho=.17, p<.01) and psychiatrists (rho=.18, p<.001). The positive correlation indicated that more visits to health professionals were made by those with the poorest health rating.

There were statistically significant correlations among three indicators of child’s health, that is,
parents' ratings, recent health history and number of visits to a composite of health practitioners, meaning that the poorer the parents rated their children's health the more often those children visit health practitioners. Because of these correlations, there is confidence that these are reasonably accurate measurements of health. In contrast, the number of days absent from school was not significantly correlated with any other indicator.

4.2.2.iii Behaviour

Behaviour was measured by the use of a Behavioural Scale, as described in the Methods chapter. The two versions of the Behaviour Rating Scale (Parents' and Teachers') were almost identical, except for one question being omitted from the teachers' version. In addition to these Behaviour Rating Scales, another general question was asked of teachers and parents, about general behavioural or emotional problems of the children. This question was not the same for the teachers and parents. The correlations between the two versions of the scales, and the two additional questions are shown in Table 4.11 to follow.
<table>
<thead>
<tr>
<th>Parents’ Behavioural Rating Scale</th>
<th>Correlation with Teachers’ Behavioural Scale ratings</th>
<th>Parents’ response to additional question on emotional/nervous problems***</th>
<th>Teachers’ response to additional question on behavioural problems***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total score Behavioural scale</td>
<td>.47**</td>
<td>.52**</td>
<td>.41**</td>
</tr>
<tr>
<td>Subscale: Hyperactivity</td>
<td>.53**</td>
<td>.39**</td>
<td>.44**</td>
</tr>
<tr>
<td>Subscale: Inattentiveness</td>
<td>.32**</td>
<td>.39**</td>
<td>.26**</td>
</tr>
<tr>
<td>Subscale: Conduct Disorder</td>
<td>.43**</td>
<td>n.s.</td>
<td>.36**</td>
</tr>
<tr>
<td>Subscale: Emotional Disorder</td>
<td>.26**</td>
<td>.35**</td>
<td>n.s.</td>
</tr>
<tr>
<td>Subscale: Anxiety</td>
<td>.23**</td>
<td>.33**</td>
<td>n.s.</td>
</tr>
<tr>
<td>Subscale: Indirect Aggression</td>
<td>.16*</td>
<td>.21**</td>
<td>.19**</td>
</tr>
<tr>
<td>Subscale: Physical Aggression</td>
<td>.41**</td>
<td>.49**</td>
<td>.37**</td>
</tr>
<tr>
<td>Subscale: Prosocial</td>
<td>.27**</td>
<td>-.25**</td>
<td>-.26**</td>
</tr>
</tbody>
</table>

n.s. - Correlation is not significant.
*Correlation significant at p<.05 level (2-tailed).
**Correlation significant at p<.01 level (2-tailed).
***Parents were asked a question (besides those on the Behavioural Scale) about their children’s emotional/nervous problems, and teachers were asked (besides questions on the Behavioural Scale) to rate behavioural problems comparing to other children.

Each of the subscales for teachers’ ratings was statistically significantly correlated with those of the parents’ ratings, as shown in Table 4.11. The lowest correlation observed was between the parents’ and teachers’ ratings of the Indirect Aggression subscale, that also being the subscale for which there were the most missing responses, on both teachers’ and parents’ scales. This subscale had only five questions. One of those questions had 24% missing responses from parents and 13% responses missing from teachers. Other questions from that subscale had lower rates of missing
responses. Rather than delete the whole subscale, missing values were replaced with the modal number (that is, 1 on a 3-point scale), as noted in the Methods chapter above. Analyses were completed for the subscale and independent variables, but caution was used in further analysis.

Inter-rater correlation for the subscale Hyperactivity was higher than any other subscale (\(\rho = .53\) \((p < .01)\). There were five children whose parents reported that they were presently taking Ritalin, prescribed for hyperactivity. The parents of these children rated these children somewhat higher on the hyperactivity scale than did the teachers.

Some of the items on the scale are used for more than one sub-scale, increasing the potential for correlation between these subscales. In the case of both the parents' and the teachers' scoring, the inter-correlation between the Emotional Disorder and Anxiety subscales was higher than any other pairs of subscales \(\text{parents } \rho = .89, p < .01; \text{teachers } \rho = .92, p < .01\). For the teachers' ratings, there was intercorrelation between all the subscales to a significant level. For the parents' ratings, most subscales were intercorrelated, with two exceptions: Inattentiveness was not correlated with Indirect Aggression and Prosocial Behaviour was not correlated with Anxiety.

4.3 Relationship between independent and dependent variables

Correlations between each of the variables were calculated, followed by a series of univariate or multivariate analyses of variance testing models that included the effects of all three independent variables on academic abilities, health and behaviour. Finally, the results of analyses are reported in which the independent variables are treated as a composite risk to the dependent variables.
4.3.1 Academic Abilities

The relationships between reading, spelling and arithmetic scores and each of the independent variables, as well as the correlation coefficients and alpha levels, are shown in Figure 4.1 below.

Each of the coefficients represent independent correlations between the variables indicated.

Figure 4.1 Relationships and correlation coefficients between independent variables (socioeconomic background, tobacco use and alcohol use during pregnancy) and academic abilities as measured by WRAT-3, including p values.

- **Correlation is significant at .05 level (2-tailed).**
- **Correlation is significant at .01 level (2-tailed).**
- n.s. - correlation not significant

NOTE: double-headed arrows indicate statistic shown is bivariate.
4.3.1.i Prenatal alcohol exposure and WRAT-3 scores

Mean WRAT-3 scores, according to T-ACE risk levels, are shown in Chart 4.1 below. Although the means show differences according to low, medium and high risks, these differences were not statistically significant for any of the academic scores. Correlational analyses were completed for each of the academic scores and measures of alcohol consumption and measures of T-ACE risk levels. A statistically significant correlation was observed between reading scores and absolute alcohol consumption per day before pregnancy ($\rho=.13, p<.05$), but no other correlation was found to be statistically significant. This association between reading scores and absolute alcohol consumption before pregnancy was confirmed in the multivariate ANOVA test ($F=1.4$, $df=(80, 169)$, $p<.05$).

Chart 4.1. Reading, spelling and arithmetic WRAT-3 scores, according to T-ACE risk levels (measured at Stage 1).

Note: differences in scores are not statistically significant.
Later in the analyses (see below, page 202), a series of t-tests was calculated to examine combined effects. In those analyses, alcohol consumption was the only variable found to have a statistically significant negative main effect on reading scores ($\beta = -29.97$, $S.E. = 12.34$, $t = -1.438$, $p < .05$) in the one-sample t-test analyses that compared various risks.

4.3.1.ii Prenatal tobacco exposure and WRAT-3 scores

When the association was tested between each academic ability score and tobacco exposure using number of tobacco exposures as a continuous variable, no statistically significant correlations were observed.

The correlational relationships between smoking by trimester and each of the academic scores was less clear, since positive correlations were observed indicating that increased smoking was related to increased academic scores. There were positive correlation coefficients between reading scores and smoking during 2nd trimester ($\rho = .16$, $p < .01$) and 3rd trimester ($\rho = .18$, $p < .01$). Similarly, there were positive correlation coefficients between spelling scores and smoking during both 2nd trimester ($\rho = .14$, $p < .05$) and 3rd trimester ($\rho = .14$, $p < .05$). The correlations were not statistically significant between arithmetic scores and smoking during any trimester.

No statistically significant relationships were observed between any academic score and 1st trimester smoking. Frequencies of 2nd and 3rd trimester smoking were similar, as shown on Table 4.4 above, with nearly all the same women continuing to smoke through both trimesters, with the result that the test statistics give similar results.
Multivariate analyses confirmed statistically significant associations among WRAT-3 scores and smoking during these trimesters. Spelling scores and either 2nd trimester or 3rd trimester smoking were statistically significant (2nd trimester $F=2.97$, df=(3,246), $p<.05$; 3rd trimester $F=3.12$, df=(3,246), $p<.05$). Reading scores only just reached statistical significance level ($p=.05$) although this was observed only for the 3rd trimester smoking ($F=2.64$, df=(3,246), $p=.05$). The adjusted R Square for each of these academic scores, indicating the amount of variation explained by smoking at the 2nd or 3rd trimester was small (reading $r^2=.019$, spelling $r^2=.025$, arithmetic $r^2=.02$). Bonferroni's adjustment for multiple calculations suggests that it would be more conservative to adjust the $\alpha$ level to .017 ($\alpha=.05/3$ calculations), in which case none of the academic subjects would be considered statistically significant.

A series of contrasts was conducted to examine differences between the levels of smoking, that is, comparing each of the smoking levels (0 cigarettes, less than 10 cigarettes daily, 10-20 cigarettes daily, and more than 20 cigarettes daily) and WRAT-3 scores. Spelling scores and smoking during the 2nd or 3rd trimesters showed statistically significant positive differences between those not exposed prenatally to cigarettes and those whose mothers smoked to the more extreme levels (10-20 cigarettes daily, $p<.01$; and >20 cigarettes daily, $p<.01$).

4.3.1.iii Socioeconomic background and WRAT-3 scores

All indicators of socioeconomic status (household income, parental education, parental occupation) were compared with each of the WRAT-3 scores. Parents' education was statistically significantly positively correlated with reading scores of their children (mothers' education $\rho=.15$, fathers' education $\rho=.13$).
Only fathers' education was positively correlated with spelling scores (\(\rho = .13, p < .05\)). Mothers' occupational level was statistically significantly correlated only with spelling scores (\(\rho = 1.4, p < .05\)). Neither fathers' occupation level nor household income were observed to be correlated with any WRAT-3 scores.

Multivariate analysis confirmed the association between fathers' education level and spelling scores (\(F = 3.2, df = 5, p < .01\)). Other significant correlations were not confirmed by multivariate ANOVA tests, with the main effects of mothers' education or parents' occupation levels or household income not revealing statistically significant differences on any of the WRAT-3 scores. The combination of fathers' and mothers' low education had a statistically significant effect on spelling scores (\(F = 2.01, df = 21, p < .01\)), with Wilks Lambda (.65) suggesting that nearly 35% of the variance for spelling scores can be attributable to the additive effect of both parents' level of education. This effect of parents' education level did not show statistically significant results for the other academic subjects.

Power for some of these calculations was very low; for example, mothers' education and each of the academic scores was less than 20%, for fathers' education and arithmetic power was observed to be only 15%, and for household income and academic scores the power ranged from 23% for spelling to 33% for reading. The effect of both parents' education had higher power (69% for arithmetic, 68% for reading and 99% for spelling).

The main effects of each of the independent variables on academic test scores have been reported
above. Next, the effects of a combination of risks (alcohol exposure, alcohol risk level, tobacco exposure, and socioeconomic indicators) are reported. These were analysed in two ways, first using t-tests comparing low risk and high risk for each of the independent variables and then by comparing the effects of multiple risks.

4.3.1.iv Comparing risk levels of a combination of independent variables on WRAT-3 scores

A series of statistical tests were completed to examine the main effects only, or the combination of two variables on the dependent variable, as reported above. Here, two series of analyses compare a combination of risks. The cumulative effect of more than one risk under study was considered using two methods: (a) a series of analyses of variance were calculated to examine the interaction of the independent variables, and (b) combining the three independent variables and comparing the effects of the maximum risks with those of the minimum risks.

4.3.1.iv (a) Comparisons of academic scores according to level of risk

For the first analyses, analyses of variance tests were calculated, using multiple fixed factors to analyse the effects on the dependent variables. Frequencies for numbers of people in each of the categories in the independent variables used in the model are shown in the following Table 4.12.
Table 4.12 Frequency of categorical variables used in ANOVA.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marital status</td>
<td>not married</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>married or living common law</td>
<td>224</td>
</tr>
<tr>
<td>Current smoking status</td>
<td>yes</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>199</td>
</tr>
<tr>
<td>T-ACE risk</td>
<td>low risk</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td>medium risk</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>high risk</td>
<td>11</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td>Abstainer</td>
<td>89</td>
</tr>
<tr>
<td>during pregnancy</td>
<td>Social drinker (1 or fewer drinks per day)</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>Heavy (2 or more drinks per day or ever binging)</td>
<td>12</td>
</tr>
<tr>
<td>Total household income</td>
<td>&lt;$20,000 annually</td>
<td>13</td>
</tr>
<tr>
<td>income level</td>
<td>$20,000 - $40,000 annually</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>&gt;$40,000 annually</td>
<td>133</td>
</tr>
<tr>
<td>Mothers’ highest education</td>
<td>University educated</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Trade, college, technical school</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>High school graduation or less</td>
<td>50</td>
</tr>
<tr>
<td>Fathers’ highest education</td>
<td>University educated</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Trade, college, technical school</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>High school graduation or less</td>
<td>68</td>
</tr>
<tr>
<td>Mothers’ occupation</td>
<td>Executive or administrative</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Social services, teaching, etc.</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Trade or primary industry</td>
<td>13</td>
</tr>
<tr>
<td>Fathers’ occupation</td>
<td>Executive or administrative</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Social services, teaching, etc.</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Trade or primary industry</td>
<td>125</td>
</tr>
</tbody>
</table>

As described in the Methods chapter, scores were compared between those with the lowest risk level and other levels of risk. The Beta, or mean difference in scores, of lowest risk level for these variables (for example, no smoking or alcohol use during pregnancy) was set as the baseline for comparison. Regressions were calculated for the main effects of each of the variables and for the
effects of the combination of variables on the three academic scores.

None of the tests that combined variables reached statistical significance in the series of t-tests. For reading scores, alcohol consumption during pregnancy was the only variable found to have a statistically significant negative main effect on reading scores ($\beta=-29.97$, S.E.$=12.34$, $t=-1.438$, $p<0.05$) when comparing heavy alcohol use with abstainers in a one sample t-test (with null hypothesis that $\beta=0$). For the spelling scores, no main effects nor any interaction effects were observed to be statistically significant. Similarly, with arithmetic, no main effects nor any interaction effects were observed to be statistically significant.

For some of this analysis, small effect size resulted in small observed power. For example, observed power for arithmetic and alcohol use patterns was .31 with $n=12$. Calculations showed that sample size required for such a difference in scores would need to be 38 ($\alpha=.05$, power=.75).

When two or more variables were included in the model, the sample size of each cell became even smaller and in some cases it was not possible to have confidence in the results. An example of this was the case of spelling scores, where there was only one person in the high risk group of maximum T-ACE risk and low income, whereas a minimum sample of 13 would be required (at $\alpha=.05$, power=.75).

4.3.1.iv (b) Comparisons between the most at-risk groups and least at-risk groups

In the second series of analyses, in which the dependent variables were combined, the most at risk groups were compared with the least at-risk groups, a procedure also described in Methods.
None of the analyses for any of the risk levels and each of the academic subjects was found to be statistically significant, with the exception of fathers' education.

The risks levels of T-ACE, categorized alcohol consumption level and fathers' level of education were examined in a three-way cross-tabulation, so that those who fell into highest risk for all three variables were considered to be in the "high risk" category, all who fell into the middle category for all risks were considered "medium risk" category and those falling into low risk for all three combined were considered in the "low risk" category. Using these categories, ANOVA results showed significant results for spelling scores ($F=5.03$, $df=2, 38$, $p<.05$), but not for reading ($p=.08$) nor arithmetic ($p=.37$). Next, a series of t-tests contrasting the three levels of risk in which T-ACE levels, alcohol consumption and fathers' education level were included in the model are shown in Table 4.13 below.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Mean scores of each risk level</th>
<th>Contrast</th>
<th>Contrast value</th>
<th>S.E.</th>
<th>t (df=28)</th>
<th>p value (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>high =96.0</td>
<td>high vs low risk</td>
<td>-18.00</td>
<td>8.12</td>
<td>-2.22</td>
<td>.035</td>
</tr>
<tr>
<td></td>
<td>medium=106.9</td>
<td>high vs medium risk</td>
<td>-10.94</td>
<td>7.92</td>
<td>-1.38</td>
<td>.178</td>
</tr>
<tr>
<td></td>
<td>low risk=114.0</td>
<td>medium vs low risk</td>
<td>-7.06</td>
<td>4.81</td>
<td>-1.47</td>
<td>.153</td>
</tr>
<tr>
<td>Spelling</td>
<td>high=86.7</td>
<td>high vs low risk</td>
<td>-16.67</td>
<td>5.80</td>
<td>-2.88</td>
<td>.008</td>
</tr>
<tr>
<td></td>
<td>medium=95.7</td>
<td>high vs medium risk</td>
<td>-9.02</td>
<td>5.65</td>
<td>-1.60</td>
<td>.121</td>
</tr>
<tr>
<td></td>
<td>low=103.3</td>
<td>medium vs low risk</td>
<td>-7.65</td>
<td>3.43</td>
<td>-2.23</td>
<td>.034</td>
</tr>
<tr>
<td>Arithmetic</td>
<td>high=89.7</td>
<td>high vs low risk</td>
<td>-6.92</td>
<td>5.93</td>
<td>-1.17</td>
<td>.253</td>
</tr>
<tr>
<td></td>
<td>medium=98.0</td>
<td>high vs medium risk</td>
<td>-8.83</td>
<td>5.78</td>
<td>-1.44</td>
<td>.160</td>
</tr>
<tr>
<td></td>
<td>low=96.6</td>
<td>medium vs low risk</td>
<td>1.42</td>
<td>3.51</td>
<td>.40</td>
<td>.689</td>
</tr>
</tbody>
</table>

Note: Levene's test for Equality of Variances showed no differences in variance, therefore equal variances was assumed for each of the contrast analyses.
The results of the t-tests contrasting the various risk levels are shown in Table 4.13. For the reading scores, a significant difference was observed between the high and low risk groups ($t=-2.22$, $p<.05$). For the spelling scores, statistically significant differences were observed between the high and low risk groups ($t=-2.88$, $p<.01$) and the medium and low risk groups ($t=-2.23$, $p<.05$). No differences between the groups were observed for their arithmetic scores. A Bonferroni adjustment for multiple tests to avoid a Type I error suggests that $p=.018$ should be used ($\alpha$ at $.05/3$), leading to the conclusion that only the contrast for spelling between high and low risk groups would be considered statistically significant.

As previously reported, fathers' education was statistically significantly correlated with reading ($\rho=.22$, $p<.01$) and spelling scores ($\rho=.15$, $p<.05$). Multivariate analyses showed fathers' education to have main effects on spelling scores only ($F=3.12$, $df=5$, $p<.01$).

Sample size calculations were completed for all contrasts and it was found that in most cases, it would be necessary to nearly double the size of the sample (for example, for both low and high risk groups) for the tests to reach significance at the same differences in scores ($\alpha=.017$, for a Bonferroni adjustment of $.05/3$).

4.3.2 Health

The relationships and independent correlations examined for the health outcomes of children are shown in Figure 4.2 below. The model includes all three independent variables, that is, prenatal alcohol exposure and risk level and tobacco exposure and socioeconomic background. An early
outcome variable, birth weight, has been added to the model. This was measured at Stage 2 of the study and available from medical charts. Further analyses explored the relationship between current exposure to second-hand smoke, as shown in Figure 4.3.

**Figure 4.2** Correlation coefficients (bivariate analysis) between independent variables (alcohol and tobacco exposure during pregnancy and socioeconomic background) and health, as measured by parents' rating of child's health and number of visits to medical professionals, including p values.

- **Socioeconomic background indicators:**
  - Parents' education
  - Parents' occupations
  - Household income

- **Health indicators:**
  - Parents' ratings and number of visits to medical professionals

- **Variables and Correlations:**
  - Mothers' occupation (rho=-.19**)
  - Fathers' occupation (rho=.16*)
  - Mothers' education (rho=-.13*)
  - Fathers' education (rho=-.24**)
  - Maternal age at pregnancy (rho=-.29**)
  - Tobacco exposure during pregnancy (rho=.26*)
  - Each trimester (rho=-.20*)
  - 3rd trimester smoking and child health rating (rho=.26*)
  - T-ACE risk and total tobacco use (rho=.30**)
  - T-ACE risk and both mothers' (rho=.26**) and fathers' education (rho=.29**); and maternal age at pregnancy (rho=.28**)
  - Alcohol use or risk level
  - Amount of alcohol exposure (rho=.15*)
  - T-ACE risk (rho=.21*); Amount of alcohol exposure (rho=.13*)

* Correlation is significant at .05 level (2-tailed).
** Correlation is significant at .01 level (2-tailed).
n.s. - correlation not significant.

**NOTE:** double-headed arrows indicate statistic shown is bivariate.
4.3.2.i Birth weight

Appropriate birth weight is important to the health of babies and children. For this reason, birth weight was added to the model in examining current health of this sample of children. As neonates, birth weights of this group ranged from 1035 grams to 5100 grams, with 4 (1.5%) considered low birth weight (that is, below 2500 grams) and 1 (0.4%) considered very low birth weight (that is, below 1500 grams). Each of the sets of twins had one neonate in the low birth weight category. The proportion of low birth weight and very low birth weight (1.9%) newborns in this group was below that of the general British Columbia population rate of 5.2% (Statistics Canada, 1998), however, the numbers are too small to make accurate comparisons.

Four of the five low birth weight neonates had at least one person in the household who smoked during the time of pregnancy. Of these four low birth weight infants, two were exposed only to their mothers' smoking and two others were exposed to the smoking of both their mothers and others in the household. Only one low birth weight child was not exposed either directly or indirectly to tobacco during pregnancy, according to our data collection of smokers living in the household. The combined effect of two smokers in the household during the pregnancy had a statistically significant effect on birth weight ($t=33.87, p<0.001$).

Examining the birth weight of the total sample (rather than extreme cases of low or very low birth weight), birth weight was correlated with maternal smoking during all trimesters ($\text{rho}=0.21, p<0.01$) and with amount smoked ($\text{rho}=0.21, p<0.001$). The relationship between birth weight and various measures of maternal smoking was confirmed by univariate ANOVA analyses, including comparing exposed
with non-exposed subjects ($F=9.12$, df=1, $p<.01$), number of exposures to tobacco throughout pregnancy ($F=4.50$, df=3, $p<.01$) and smoking throughout pregnancy to 2nd and 3rd trimester ($F=3.88$, df=3, $p<.01$)

Prenatal tobacco exposure was not found to be statistically significantly correlated with current weight or height, indicating that although it may have contributed to lower birth weight, there was catch-up over the years.

Birth weight and prenatal alcohol exposure were correlated ($\rho=-.15$, $p<.02$). Univariate analyses did not reveal a significant difference between the three groups of users (abstainers, social drinkers and heavy drinkers) with respect to birth weight ($p=.07$), but since power for such an analysis was only .53, a larger sample size would be required to draw any conclusions.

Birth weight was observed to be positively correlated with current weight ($\rho=.21$, $p<.001$), and also with maternal weight ($\rho=.20$, $p<.01$). Current weight and height of the child were related to parents' height and weight, since each was correlated positively with each of the heights and weights of both parents ($\rho$ coefficients ranging from .23 to .31, all $p<.01$).

4.3.2.ii Prenatal alcohol exposure and health

Child health was statistically significantly negatively correlated with both T-ACE risk level ($\rho=-.21$, $p<.05$) and absolute alcohol exposure throughout pregnancy ($\rho=-.13$, $p<.05$), both indicating that higher alcohol risk or use corresponds with lower health ratings. Other measures of health, for
example, total visits to medical professionals, were not statistically significantly correlated with health rating.

Univariate analyses indicated that there was a statistically significant difference in health ratings between those exposed and those not exposed to alcohol ($F=6.1$, $df=1$, $p<.02$, observed power=.69). Similar analysis indicated a relationship between T-ACE risk level (measured as Stage 1) and health rating ($F=3.2$, $df=2$, $p<.05$). When comparing health rating according to patterns of drinking, that is, abstainers compared with social drinkers and with heavy or binge drinkers, a statistically significant difference was not observed ($F=2.8$, $df=2$, $p=.06$, power=.56) although $p$ value approached significance and may have reached significance with higher power for the analyses.

Somers’ d test, a directional measure of association between ordinal variables, was calculated. T-ACE risk and alcohol consumption were treated as categorical variables so that these analyses were calculated ordinal to ordinal. A statistically significant association between T-ACE risk level (Stage 1 data collection) and child health rating was observed ($T=-2.47$, $p<.05$) and between alcohol consumption patterns and child health rating ($T=-2.21$, $p<.05$), indicating that as T-ACE risk or alcohol consumption increases, child health rating decreases.

4.3.2.iii Prenatal and postnatal tobacco exposure and health

As shown in the model illustrated in Figure 4.2 above, prenatal tobacco exposure was statistically significantly negatively correlated with low birth weight ($\rho=-.20$, $p<.01$). Lower birth weight was not found to be associated with lower health ratings or with number of visits to medical
professionals. Parents' rating of their child's health was correlated with prenatal tobacco use. The number of times in hospital was the only other indicator of poor health that was statistically significantly correlated with prenatal tobacco exposure.

Postnatal tobacco exposure was added to the model to examine the relationship of this risk to health and its effects combined with prenatal tobacco exposure. Figure 4.3 below shows the conceptual and correlational relationships between maternal education, prenatal smoking and postnatal smoking and child health, as measured by both the parents' ratings and total number of visits to medical professionals during the past year.
Figure 4.3 Correlation coefficients (bivariate analyses) between maternal education, prenatal and postnatal exposure to smoking and child's health.

**Correlation is significant at .01 level (2-tailed).**
* Correlation is significant at .05 level (2-tailed)
n.s. - correlation not significant.

NOTE: double-headed arrows indicate that statistic is bivariate.
As shown in the Figure 4.3, smoking during pregnancy and current smoking were found to be significantly correlated (rho=.55, p<.01). Maternal education and smoking behaviour were significantly correlated (rho=-.34, p<.01), that is comparing maternal education at the time of pregnancy with level of smoking during pregnancy. The relationship remained stable over time, since current maternal education was observed to be significantly correlated with the number of cigarettes smoked daily at present (rho=-.25, p<.05). These relationships indicated that women with lower education levels were more likely to be smokers during pregnancy and currently.

Prenatal tobacco exposure was not found to be correlated with the number of visits to medical professionals. A statistically significant positive correlation was observed between amount smoked during 3rd trimester and child health rating, when non-smokers were omitted from the model, so that increased amount of smoking indicated poorer health rating by the parent (rho=.26, p<.05).

Current maternal smoking appeared to have different effects according to measurements used to indicate health. Current maternal smoking was observed to be statistically significantly negatively correlated with number of visits to health professionals (rho=-.37, p<.01), but not with poorer health rating by the parents. In univariate analysis, when measuring health by the total number of visits to medical professionals, a statistically significant difference was observed between those exposed to high and low levels of tobacco, as calculated by a cumulative effect of frequency and quantity of mothers’ tobacco use (F=7.80, df=3, 16, p<.001).

Only 6 children had spent at least one night in the hospital in the past year, and the mothers of five
those children smoked during pregnancy. Beyond the past 12 months, 40% of the children prenatally exposed had been overnight patients in hospitals, and the difference between those exposed and not exposure prenatally was significantly different ($t=34.3$, $df=133$, $p<.001$).

When measuring health according to specific conditions or diseases, no correlations reached statistically significant levels. This includes the number of children with asthma whose health was not observed to be associated with the number of tobacco exposures during pregnancy.

Although prenatal tobacco exposure alone was not observed to be associated with health rating (except for 3rd trimester smoking), an additive effect of current level of smoking and amount of prenatal exposure to tobacco was found to be statistically significantly associated with health rating ($F=3.33$, $df=4$, $p<.02$). The same analyses using total medical visits as an indicator of health did not reach statistical significance, although power for that calculation was low (observed power=.27). Somers’ d analyses did not show significance between child health rating and tobacco exposure during pregnancy.

4.3.2.iv Socioeconomic background and health

Indicators of socioeconomic background observed to be significantly correlated with health rating were mothers’ education ($\rho=-.13$, $p<.05$) and both parents’ occupations (mothers $\rho=-.19$, $p<.01$; fathers $\rho=-.16$, $p<.05$). Household income and only one indicator of health (amount of time children have been healthy in the past year) showed a statistically significant negative correlation ($\rho=-.13$, $p<.05$).
Another possible indicator of health, number of injuries, was negatively correlated with fathers' education \((\rho=-.22, p<.05)\) so that there were more injuries amongst those whose fathers had achieved lower education levels.

Somers' d test, a directional measure of association between ordinal variables, is appropriate for scales or ordinal data, as in the case of data for child health, gathered through a rating scale. Variables that were tested against child health were categorized so that the analyses were calculated ordinal to ordinal. Statistically significant relationships were found between child health rating and mothers' education \((T=-2.08, p<.05)\), mothers' occupation level \((T=-2.03, p<.05)\), fathers' occupation level \((T=-2.48, p<.05)\) and household income \((T=-2.40, p<.05)\). The only socioeconomic indicator not showing a statistically significant relationship with child's health rating was fathers' education level.

Univariate ANOVA tests were used to test the association of independent variables on health rating. Results of these analyses found a statistically significant relationship between health rating and a combination both parents' education level \((F=4.03, df=4, p<.01, power=.91)\). Similarly a statistically significant relationship was found between health rating and a combination of both parents' occupation levels \((F=4.39, df=2, p<.05, power=.75)\).

4.3.2. v Combined effects of independent variables on health
Similar to the analysis with the WRAT-3 scores, analyses were conducted comparing those in the high risk categories to those in the low risk categories for the three dimensions of independent
variables, that is, prenatal exposure to alcohol and to tobacco and socioeconomic background. Included in the model were the following independent variables: tobacco exposure throughout 2nd and 3rd trimester, T-ACE risk, alcohol consumption during pregnancy, marital status and each of the five socioeconomic indicators. For all groupings, no significant differences were observed between the groups when contrasting those in the low, medium and high risk categories and their health ratings outcome.

Socioeconomic indicators (mothers' education, both parents' occupations) were statistically significantly correlated with tobacco exposure during pregnancy. Univariate analyses that included both tobacco use and socioeconomic factors showed that the health of offspring of women in lower occupational categories who also smoked during pregnancy during 3rd trimester was rated lower than others (F=2.65, df=10, p<.01, power=.95). Analyses that included both amount of alcohol exposure during pregnancy and mothers' level of education was observed to be statistically significantly related to health rating (F=3.07, df=3, p<.05).

The additive effect of tobacco exposure and all other indicators of socioeconomic background did not show significant results, however, each calculation had very low power levels. In many cases, power to conduct analyses posed a problem when combining two or more variables. Combining the effect of mothers' education and tobacco exposure, for example, had a power level of .27 for analyses with respect to health rating. Analyses of health rating to include smoking and alcohol use did not have adequate power (power=.20) for the calculation, even though main effects were observed to be significant for both alcohol use and smoking in ANOVA tests (alcohol use during
pregnancy $F=3.81, \text{df}=2, p<.05$; maternal smoking $F=3.70, \text{df}=1, p=.05$). Similarly, mothers' level of education was observed to be statistically significant in ANOVA tests when using health rating as the outcome measure. When tobacco exposure was added to the model, power was too low for the calculation ($\text{power}=.13$).

4.3.3 Behaviour

Behavioural outcomes were measured mainly by two scales, the Parents' Behavioural Scale and the Teachers' Behavioural Scale. These were inter-rater measures of the total Behaviour Rating Scale and 8 subscales, Hyperactivity, Inattentiveness, Physical Aggression, Indirect Aggression, Prosocial Behaviour, Conduct Disorder, Emotional Disorder. All except one subscale denotes negative behaviour so that the higher the rating, the more negative the behaviour should be rated. The exception is the Prosocial Behaviour subscale that measures positive social behaviour and this will be reflected in the results as reported.

A series of Spearman's rho correlations was conducted between each of the subscales and the independent variables. Spearman's rho was used because of the total scores and each of the subscales were positively skewed, with more children being rated as having good behaviour. These relationships and correlation coefficients resulting from the analyses of these relationships are shown in Figure 4.4 below.
Figure 4.4 Correlation coefficients (bivariate analyses) between independent variables (socioeconomic background, tobacco use and alcohol use during pregnancy) and behaviour, as measured by the Teachers’ Behaviour Rating Scale, including p values.

Current household income and total Teachers Behavioural Scales (rho=-.19**) and with 5 subscales Hyperactivity (rho=-.21**), Inattention (rho=-.18**), Indirect Aggression (rho=-.19**) Conduct Disorder (rho=.24**), Physical Aggression (rho=-.14*) and Prosocial Behaviour (rho=.16*).

Two other subscales correlated with fathers’ education on Parents Scale - Emotional Disorder (rho=-.13*) and Anxiety (rho=-.14*).

* Correlation is significant at .05 level (2-tailed).
** Correlation is significant at .01 level (2-tailed).
N.S. - correlation not significant.

NOTE: double-headed arrows indicate statistic shown is bivariate.
4.3.3.i Prenatal alcohol exposure and risk and behaviour

Each of the subscales and the total scores from the teachers’ ratings are shown in relationship to the T-ACE risk levels (according to Stage 2 administration) in Table 4.14 below, and in relationship to alcohol use levels in Table 4.15. Results of these scores are similar in that for each subscale and the total scores, the scores increase as risk or alcohol exposure increases.

Table 4.14 Teachers’ Behaviour Rating Scale ratings, according to T-ACE risk scores (Stage 2 administration), including mean, standard deviation (S.D.) and range of scores according to each T-ACE risk level.

<table>
<thead>
<tr>
<th>T-ACE risk</th>
<th>Total score</th>
<th>Hyperactivity</th>
<th>Inattention</th>
<th>Conduct Disorder</th>
<th>Emotional Disorder</th>
<th>Anxiety</th>
<th>Indirect Aggression</th>
<th>Physical Aggression</th>
<th>Prosocial Behavior*</th>
</tr>
</thead>
<tbody>
<tr>
<td>low n=147</td>
<td>Mean 63.7</td>
<td>8.6</td>
<td>5.5</td>
<td>11.4</td>
<td>9.3</td>
<td>8.2</td>
<td>6.1</td>
<td>4.8</td>
<td>17.3</td>
</tr>
<tr>
<td></td>
<td>S.D. 12.0</td>
<td>3.1</td>
<td>1.7</td>
<td>12.5</td>
<td>2.6</td>
<td>2.3</td>
<td>2.0</td>
<td>1.4</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>minimum 46</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>maximum 108</td>
<td>18</td>
<td>11</td>
<td>26</td>
<td>17</td>
<td>16</td>
<td>15</td>
<td>11</td>
<td>29</td>
</tr>
<tr>
<td>medium n=82</td>
<td>Mean 65.9</td>
<td>8.9</td>
<td>5.8</td>
<td>11.4</td>
<td>9.6</td>
<td>8.5</td>
<td>6.0</td>
<td>4.7</td>
<td>18.5</td>
</tr>
<tr>
<td></td>
<td>S.D. 13.6</td>
<td>3.0</td>
<td>2.0</td>
<td>2.7</td>
<td>2.9</td>
<td>2.5</td>
<td>1.7</td>
<td>1.4</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>minimum 46</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>maximum 109</td>
<td>18</td>
<td>12</td>
<td>21</td>
<td>21</td>
<td>18</td>
<td>12</td>
<td>10</td>
<td>29</td>
</tr>
<tr>
<td>high n=15</td>
<td>Mean 66.6</td>
<td>8.9</td>
<td>5.5</td>
<td>11.4</td>
<td>9.2</td>
<td>8.2</td>
<td>6.8</td>
<td>4.9</td>
<td>18.9</td>
</tr>
<tr>
<td></td>
<td>S.D. 14.5</td>
<td>3.3</td>
<td>1.7</td>
<td>1.8</td>
<td>3.2</td>
<td>2.5</td>
<td>2.3</td>
<td>1.4</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td>minimum 49</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>maximum 93</td>
<td>16</td>
<td>9</td>
<td>15</td>
<td>17</td>
<td>13</td>
<td>13</td>
<td>8</td>
<td>26</td>
</tr>
<tr>
<td>Total n=244</td>
<td>Mean 64.6</td>
<td>8.7</td>
<td>5.6</td>
<td>11.4</td>
<td>9.4</td>
<td>8.3</td>
<td>6.1</td>
<td>4.8</td>
<td>17.8</td>
</tr>
<tr>
<td></td>
<td>S.D. 12.7</td>
<td>3.1</td>
<td>1.8</td>
<td>2.5</td>
<td>2.7</td>
<td>2.4</td>
<td>1.9</td>
<td>1.4</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>minimum 46</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>maximum 109</td>
<td>18</td>
<td>12</td>
<td>26</td>
<td>21</td>
<td>18</td>
<td>15</td>
<td>11</td>
<td>29</td>
</tr>
</tbody>
</table>

Note: scores for Prosocial behaviour subscale are reversed to fit with other subscales, so that higher scores mean less prosocial behaviour.
Table 4.15 Teachers' Behaviour Rating Scale ratings, according alcohol use levels, including mean, standard deviation (S.D.) and range of scores according to each alcohol level.

<table>
<thead>
<tr>
<th></th>
<th>Total score</th>
<th>Hyper-activity</th>
<th>Inattention</th>
<th>Conduct Disorder</th>
<th>Emotional Disorder</th>
<th>Anxiety</th>
<th>Indirect Aggression</th>
<th>Physical Aggression</th>
<th>Prosocial Behavior*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstainer</strong></td>
<td>Mean</td>
<td>63.0</td>
<td>8.5</td>
<td>5.3</td>
<td>11.4</td>
<td>9.2</td>
<td>8.1</td>
<td>6.0</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>10.8</td>
<td>3.1</td>
<td>1.4</td>
<td>2.2</td>
<td>2.6</td>
<td>2.3</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>n=112</td>
<td>minimum</td>
<td>46</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>maximum</td>
<td>96</td>
<td>18</td>
<td>11</td>
<td>26</td>
<td>16</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td><strong>Social drinker</strong></td>
<td>Mean</td>
<td>64.8</td>
<td>8.7</td>
<td>5.7</td>
<td>11.5</td>
<td>9.3</td>
<td>8.4</td>
<td>6.1</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>13.1</td>
<td>3.0</td>
<td>1.8</td>
<td>2.7</td>
<td>2.6</td>
<td>2.4</td>
<td>1.9</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>n=112</td>
<td>minimum</td>
<td>46</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>maximum</td>
<td>108</td>
<td>17</td>
<td>12</td>
<td>21</td>
<td>17</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td><strong>Heavy drinker</strong></td>
<td>Mean</td>
<td>72.8</td>
<td>8.9</td>
<td>6.7</td>
<td>12.7</td>
<td>11.2</td>
<td>9.6</td>
<td>6.6</td>
<td>5.6</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>17.1</td>
<td>3.3</td>
<td>2.5</td>
<td>3.1</td>
<td>3.8</td>
<td>2.9</td>
<td>2.6</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>n=20</td>
<td>minimum</td>
<td>49</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>maximum</td>
<td>109</td>
<td>18</td>
<td>12</td>
<td>20</td>
<td>21</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Mean</td>
<td>64.6</td>
<td>8.7</td>
<td>5.6</td>
<td>11.4</td>
<td>9.4</td>
<td>8.3</td>
<td>6.1</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td>S.D.</td>
<td>12.7</td>
<td>3.1</td>
<td>1.8</td>
<td>2.5</td>
<td>2.7</td>
<td>2.4</td>
<td>1.9</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>n=244</td>
<td>minimum</td>
<td>46</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>maximum</td>
<td>109</td>
<td>18</td>
<td>12</td>
<td>26</td>
<td>21</td>
<td>18</td>
<td>15</td>
</tr>
</tbody>
</table>

Note: scores for Prosocial behaviour subscale are reversed to fit with other subscales, so that higher scores mean less prosocial behaviour.

For the alcohol consumption levels, as can be seen from Table 4.15, there is consistency in that the total score and every sub-scale score increases as the rate of drinking increases. Scores are lowest for the children whose mothers abstained from drinking for every subscale, higher for the children of social drinkers, and highest for the children of heavy drinkers.

Prenatal alcohol exposure was observed to be statistically significant correlated with the total Behaviour Rating Scale scores and to most of the subscales, although the results differed according to the ratings of teachers or parents. A summary of these correlations is shown in the following Table 4.16. T-ACE from Stage 1 administration was used in the calculations of these correlations.
Both alcohol use or risk levels were statistically significantly correlated with the total Behaviour Rating Scale scores, as rated by both teachers (rho=.25, p<.01) and parents (rho=.21, p<.05). This indicated that the higher use or risk level, the more negative the behaviour. Only one of these
relationships could be confirmed by the ANOVA test, that is, according to the Teachers' 
Behaviour Rating Scale, total scores statistically significantly differed based on alcohol use during 
pregnancy (F=5.31, df=2, p<.01).

Teachers and parents rated the children differently. In addition, the associations between alcohol 
and behaviour differed according to the measurement for alcohol, that is, T-ACE risk levels 
(measuring before pregnancy risk) or alcohol consumption during pregnancy. Alcohol use was 
more often statistically significantly correlated with more subscales, but not for all subscales.

Some of the differences between analyses may be explained by the power for the analyses, 
dependent on sample and effect sizes. For those subscales for which statistically significant 
differences were not observed, the power was low and with the sample size differences were 
unlikely to be found. Observed power ranged from .055 to .53 and even with the latter power (.53 
for Total score, T-ACE risk on parents' rating), the level of p value neared significance at .07.

Distribution of subscale scores according to gender was explored. The following table shows the 
main effects of the ANOVA analyses for the teachers' ratings by gender for both T-ACE risk and 
alcohol consumption during pregnancy.
Table 4.17 ANOVA results for Teachers’ rating scale using both T-ACE risk (Stage 1) and alcohol consumption during pregnancy, by gender.

<table>
<thead>
<tr>
<th></th>
<th>T-ACE risk F test</th>
<th>Alcohol consumption F test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>boys df=(2,58)</td>
<td>girls df=(2,119)</td>
</tr>
<tr>
<td>Total score</td>
<td>n.s.</td>
<td>10.16**</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>n.s.</td>
<td>6.36**</td>
</tr>
<tr>
<td>Conduct Disorder</td>
<td>n.s.</td>
<td>5.21**</td>
</tr>
<tr>
<td>Inattentiveness</td>
<td>n.s.</td>
<td>3.33*</td>
</tr>
<tr>
<td>Emotional Disorder</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Anxiety</td>
<td>n.s.</td>
<td>3.09*</td>
</tr>
<tr>
<td>Indirect Aggression</td>
<td>n.s.</td>
<td>6.44**</td>
</tr>
<tr>
<td>Physical Aggression</td>
<td>n.s.</td>
<td>3.16*</td>
</tr>
<tr>
<td>Prosocial Behaviour</td>
<td>n.s.</td>
<td>6.34**</td>
</tr>
</tbody>
</table>

Significant differences were observed for T-ACE risk levels and girls' scores on the 6 subscales:

Hyperactivity (F=6.36, df=(2, 58), p<.01), Conduct Disorder (F=5.21, df=(2, 58), p<.01), Inattentiveness (F=3.33, df=(2, 58), p<.05), Indirect Aggression (F=6.44, df=(2, 58), p<.01), Physical Aggression (F=3.16, df=(2, 58), p<.05), and Prosocial Behaviour (F=6.34, df=(2, 58), p<.01). Significant differences were observed for prenatal alcohol consumption and boys' scores on three subscales: Inattentiveness (F=3.09, df=(2, 119), p<.05), Emotional Disorder (F=3.54, df=(2, 119), p<.05), and Anxiety (F=3.50, df=(2, 119), p<.05). There was a significant difference observed for prenatal alcohol consumption on only one subscale for girls, that is, Conduct Disorder (F=3.18, df=(2, 117), p<.05).
There was inconsistency between the two measures of alcohol use, however, alcohol use was associated with all behaviour scores, both total and gender-specific. Because of the low power level to complete many of these analyses, it may not be possible to understand fully the relationships between alcohol use during pregnancy and some of the subscales from these data.

To explore the risk of alcohol exposure on behavioural characteristics further, a series of analyses were conducted in which the non-risk exposure levels was compared with each of the levels of risk exposure. In the case of alcohol, the behavioural scores of children with no exposure to alcohol (children of abstainers) were compared with the scores of children exposed to social drinking (1 or fewer drinks daily) or heavy drinking (2 or more drinks daily and/or binge drinking). The results of these comparisons are shown in the following Table 4.18.
Table 4.18 Comparisons of Teachers’ Behaviour Rating Scale scores between children of abstainers and those prenatally exposed to heavy drinking and to social drinking levels.*

<table>
<thead>
<tr>
<th>Behaviour</th>
<th>Exposure level</th>
<th>Beta**</th>
<th>S.D.</th>
<th>S.E.</th>
<th>t (df=2)</th>
<th>p</th>
<th>95% Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviour total score</td>
<td>Heavy drinking</td>
<td>37.05</td>
<td>12.75</td>
<td>12.38</td>
<td>2.99</td>
<td>.003</td>
<td>12.60 to 2.99</td>
</tr>
<tr>
<td></td>
<td>Social drinking</td>
<td>1.93</td>
<td>12.75</td>
<td>2.32</td>
<td>.83</td>
<td>.407</td>
<td>-2.65 to 6.50</td>
</tr>
<tr>
<td>Subscales:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>Heavy drinking</td>
<td>6.24</td>
<td>3.08</td>
<td>2.95</td>
<td>2.11</td>
<td>.036</td>
<td>.40 to 2.07</td>
</tr>
<tr>
<td></td>
<td>Social drinking</td>
<td>.50</td>
<td>3.08</td>
<td>.55</td>
<td>.90</td>
<td>.371</td>
<td>-.60 to 1.59</td>
</tr>
<tr>
<td>Inattention</td>
<td>Heavy drinking</td>
<td>5.02</td>
<td>1.77</td>
<td>1.78</td>
<td>2.83</td>
<td>.005</td>
<td>1.52 to 8.83</td>
</tr>
<tr>
<td></td>
<td>Social drinking</td>
<td>.62</td>
<td>1.77</td>
<td>.33</td>
<td>1.86</td>
<td>.065</td>
<td>-.04 to 1.27</td>
</tr>
<tr>
<td>Emotional Disorder</td>
<td>Heavy drinking</td>
<td>6.46</td>
<td>2.74</td>
<td>2.93</td>
<td>2.20</td>
<td>.029</td>
<td>.67 to 12.25</td>
</tr>
<tr>
<td></td>
<td>Social drinking</td>
<td>.12</td>
<td>2.74</td>
<td>.55</td>
<td>.21</td>
<td>.458</td>
<td>-.97 to 1.20</td>
</tr>
<tr>
<td>Physical Aggression</td>
<td>Heavy drinking</td>
<td>3.53</td>
<td>1.39</td>
<td>1.45</td>
<td>2.43</td>
<td>.016</td>
<td>.66 to 6.39</td>
</tr>
<tr>
<td></td>
<td>Social drinking</td>
<td>.20</td>
<td>1.39</td>
<td>.27</td>
<td>.72</td>
<td>.472</td>
<td>.72 to .11</td>
</tr>
<tr>
<td>Indirect Aggression</td>
<td>Heavy drinking</td>
<td>4.23</td>
<td>1.93</td>
<td>1.95</td>
<td>2.16</td>
<td>.032</td>
<td>.37 to 8.1</td>
</tr>
<tr>
<td></td>
<td>Social drinking</td>
<td>-.005</td>
<td>1.93</td>
<td>.37</td>
<td>-.12</td>
<td>.88</td>
<td>-.78 to .66</td>
</tr>
<tr>
<td>Prosocial Behaviour</td>
<td>Heavy drinking</td>
<td>8.80</td>
<td>4.54</td>
<td>4.47</td>
<td>1.97</td>
<td>.051</td>
<td>-.003 to 17.63</td>
</tr>
<tr>
<td></td>
<td>Social drinking</td>
<td>.17</td>
<td>4.54</td>
<td>.84</td>
<td>.21</td>
<td>.838</td>
<td>-1.48 to 1.82</td>
</tr>
</tbody>
</table>

*Heavy drinking is defined as 2 or more drinks per day and/or some occasions of binge drinking, social drinking is defined as 1 or fewer drinks per day but not including abstainers.

**Beta is the difference in mean scores between the abstainers and the scores of those exposed to the heavy drinking or social drinking groups. Beta for abstainers is set at 0 in order to compare with heavy or social drinking groups.

Note: The two remaining subscales (Conduct Disorder and Anxiety) had power too small for calculations because of limited sample sizes.

Note: Sample size: abstainers n=~89, social drinkers n=~85 and heavy drinkers n=~12 (approximate since it changes slightly according to behaviour subscale).

There were no statistically significant differences between the mean scores of the abstainers and those of the social drinkers on any subscale nor on the total Behaviour Rating Scale scores. The results shown in Table 4.18 indicate that the differences between those who were exposed to no alcohol during pregnancy and those who were exposed to either social drinking (1 or fewer drinks
daily) or heavy drinking (2 or more drinks per day or binge drinking). For four subscales (Hyperactivity, Inattention, Physical Aggression and Indirect Aggression) the mean scores of the heavy drinkers and the mean scores of the abstainers were statistically significant. For the total Behaviour Rating Scale, a statistically significant difference was observed between the mean scores of the heavy drinkers and the abstainers ($t=2.99, p<.01$).

The differences between the same scores for Prosocial Behaviour approached significance ($p=.051$). Observed power for this calculation was .50 ($n=12$) and sample size calculation showed that a sample size of 21 (at $\alpha=.05$, power=.75) would be required to reach significance for the same effect size. Similarly, sample size calculations were completed for the two subscales that did not show consistent results with the other subscales. For the Conduct Disorder subscale ($n=12, \beta=3.21, \text{S.D.}=2.5$), the observed power was .21 and a sample size of 60 (at $\alpha=.05$, power =.75) would be required to show a statistically significant difference between the mean scores of the heavy drinking group and those of the abstainers. For the Anxiety subscale ($n=12, \beta=4.92, \text{S.D.}=2.4$), the observed power was .45 and a sample size of 24 (at $\alpha=.05$, power =.75) would be required to show difference between the children of abstainers and of heavy drinkers.

The subscales that were observed consistently to have statistical significance associations in all analyses (correlation, F test, t-test to compare risks) with respect to alcohol use pattern during pregnancy were Inattention, Hyperactivity, and Physical Aggression, as well as the total Teachers' Behaviour Rating Scale. Other subscales (that is, Indirect Aggression, Anxiety, Prosocial Behaviour, and Emotional Disorder) have observed an association on some statistical tests but not
others, most often with power being low so that results are not so much disconfirmed, rather sample size was too low to provide clear direction of effect.

Teachers were asked a general question in addition to the Behaviour Rating Scale questionnaire. That question was: “In your opinion, how often does this child have behavioural problems compared to other children the same age and sex?” and the responses were recorded on a 5-point adjectival scale. There was a statistically significant negative correlation between alcohol consumption patterns and degree to which the children more often had behavioural problems (\(\rho = -0.13, p < 0.05\)), however, Pearson Chi-Square test did not reach statistical significance when comparing the groups falling into each category, that is, abstainer, social drinker or heavy drinker during pregnancy.

4.3.3.ii Prenatal and postnatal tobacco exposure and behaviour

There were few correlations that reached statistical significance between subscales on the Behavioural Rating Scales and prenatal tobacco exposure. With the parents' ratings, no correlations were observed between any of the prenatal tobacco exposure measures and total Behaviour Rating Scale or any of the subscales.

With the teachers' ratings, only two subscales showed statistically significant correlations with tobacco exposure. Prosocial behaviour was correlated negatively with smoking during each of the trimesters (\(\rho \) ranging from 0.13 to 0.17, \(p < 0.05\)), and with number of tobacco exposures during pregnancy (\(\rho = 0.15, p < 0.05\)). Bivariate analysis confirmed the relationship between teachers' rating of Prosocial
Behaviour and prenatal tobacco exposure throughout pregnancy (F=3.5, df=3, p=.05, observed power=.50) and similar results for each trimester of smoking (e.g., 3rd trimester smoking (F=3.4, df=3, p=<.05, observed power=.76).

Although a statistically significant correlation was observed between teachers' rating of Conduct Disorder and prenatal tobacco exposure (rho=.13, p<.05), this relationship could not be confirmed by a univariate test. Prenatal tobacco exposure alone during any trimester did not appear to have an association with Conduct Disorder scores, however, the statistics for 1st trimester smoking for the total sample neared significance (p=.059) and for the remainder of the results power for each gender subsample and each trimester was low (ranging from .08 to .38). No other subscale showed significant correlations or test statistics indicating differences between the exposed and non-exposed groups.

Scores for the Hyperactivity subscale were disproportionate according to gender, with males scoring considerably higher. From the research literature, it appeared that boys' scores could have been associated with prenatal tobacco exposure, therefore, a series of statistical tests were conducted to ascertain the relationship between gender, tobacco exposure and each of the subscales. Analyses were conducted initially controlling for gender and subsequent analyses examined the associations between smoking and each subscale for each gender separately. For two subscales (Prosocial and Indirect Aggression), scores by gender are reversed with females scoring higher, so analyses for these were exclusive of males.
None of these tests showed statistically significant differences between the groups, whether smoking was treated as a dichotomous variable (exposed versus non-exposed) or according to levels of smoking or trimester. Observed power for these calculations was low, ranging from .06 (for smoking and Indirect Aggression) to .49 (for smoking and Prosocial Behaviour).

Current exposure to second-hand smoking was statistically significantly correlated with the total Behaviour Rating Scale scores (\( \rho = .15, p < .05 \)) and with two subscales, Conduct Disorder (\( \rho = .15, p < .05 \)) and Prosocial Behaviour (\( \rho = .16, p < .05 \)), for the teachers' ratings only. The relationships with second-hand smoke exposure and teachers' ratings were confirmed by statistical tests for both the total Behaviour Rating Scale scores (\( F = 2.17, df = 10, p < .05 \)), and for Conduct Disorder. Differences for Prosocial Behaviour were not observed to be statistically significantly either when the total sample was included, or when the genders were included separately, although the results neared statistical significance for total sample Prosocial Behaviour scores (\( p = .06, \) observed power = .82). No statistically significant correlations were observed with parents' ratings of behaviour.

Further bivariate analyses were conducted to examine the effect on behaviour scale scores of the combination of exposure to prenatal and current second-hand smoke. Statistically significant differences between scores were not observed for the total Behaviour Rating Scale, either for the total sample or either gender. Analyses were calculated for each gender and for the total sample, with the results still showing no significant differences in total Behaviour Rating Scale scores.

For the subscale Conduct Disorder, analyses showed statistical significance when combining the
risk of exposure to prenatal tobacco use and current maternal smoking. These results showed statistically significant differences in scores for total sample and for boys only, but no results reached significance for girls. Statistically significant results were observed for second-hand smoking and each of the trimesters. A summary of these results are shown in Table 4.19, in which consistency has been shown between parents' ratings and teachers' ratings for Conduct Disorder scores and tobacco exposure by trimester.

<table>
<thead>
<tr>
<th></th>
<th>1st trimester</th>
<th>2nd trimester</th>
<th>3rd trimester</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total sample</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parents' Scale</td>
<td>F=2.0, df=11, p&lt;.05</td>
<td>F=1.8, df=12, p=.056</td>
<td>F=1.8, df=11, p=.052</td>
</tr>
<tr>
<td>Teachers' Scale</td>
<td>F=3.5, df=11, p&lt;.001</td>
<td>F=3.0, df=12, p&lt;.001</td>
<td>F=2.7, df=11, p&lt;.01</td>
</tr>
<tr>
<td><strong>Boys only</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parents' Scale</td>
<td>F=3.3, df=5, p&lt;.01</td>
<td>F=3.0, df=5, p&lt;.05</td>
<td>F=3.0, df=5, p&lt;.05</td>
</tr>
<tr>
<td>Teachers' Scale</td>
<td>F=3.7, df=5, p&lt;.01</td>
<td>F=3.8, df=5, p&lt;.01</td>
<td>F=3.8, df=5, p&lt;.01</td>
</tr>
<tr>
<td><strong>Girls only</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parents' Scale</td>
<td>n.s. (power=.21)</td>
<td>n.s. (power=.20)</td>
<td>n.s. (power=.13)</td>
</tr>
<tr>
<td>Teachers' Scale</td>
<td>n.s. (power=.24)</td>
<td>n.s. (power=.21)</td>
<td>n.s. (power=.28)</td>
</tr>
</tbody>
</table>

For girls, power to conduct these analyses was low, since the effect size was smaller. The sample had an equal number of boys and girls, but boys had much higher scores for Conduct Disorder than girls. It is not known from these data whether there was a relationship between Conduct Disorder and tobacco exposure for boys only or whether a larger sample size of girls could detect differences for girls as well.
As discussed above, prenatal tobacco exposure alone during any trimester (without the added risk of current second-hand smoke exposure) did not appear to have an influence on Conduct Disorder scores. Only when the added risk of current maternal smoking exposure was included in the model did the results consistently show differences for boys only, and for the total sample.

Finally, a series of t-test analyses was completed in which the Beta coefficients for the behaviour scores were compared between those most at risk and least at risk. This was similar to the analysis completed for alcohol exposure comparisons described above. In the case of tobacco, the scores of those whose mothers continued to smoke during their 2nd or 3rd trimester were compared with the scores of those who did not smoke during those trimesters. The t-tests did not show significant differences for the total Behaviour Rating Scales (either teachers' or parents' ratings) nor with any of the teachers' rating of the subscales.

4.3.3.iii Socioeconomic background and behaviour

Statistically significant differences in total Behaviour Rating Scale scores and various subscales scores were observed in indicators of socioeconomic background. The following Table 4.20 shows correlations (Spearman's rho) between total scores for both teachers' and parents' ratings for all indicators of socioeconomic background.
Table 4.20 Correlation coefficients (Spearman's rho) and F tests for total scores on Teachers' Behaviour Rating Scale and total scores on Parents' Behaviour Rating Scale and each of five socioeconomic indicators.

<table>
<thead>
<tr>
<th></th>
<th>Teachers' Behaviour Scale</th>
<th>Parents' Behaviour Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>rho</td>
<td>F test</td>
</tr>
<tr>
<td>Household income</td>
<td>-.19**</td>
<td>2.59** (df=9)</td>
</tr>
<tr>
<td>Fathers' occupation</td>
<td>.16*</td>
<td>2.10** (df=20)</td>
</tr>
<tr>
<td>Mothers' occupation</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Mothers' education</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Fathers' education</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

*Correlation is significant at the .05 level (2-tailed).
**Correlation is significant at the .01 level (2-tailed).
n.s. - Correlation is not significant.

Household income was found to be negatively correlated with Behaviour Rating Scale scores as rated by both teachers (rho=-.19, p<.01) and parents (rho=-.18, p<.01), although only the Teachers' Behaviour Rating Scale was confirmed by ANOVA tests (F=2.59, df=9, p<.01). Father's occupation and Teachers' Behaviour Rating Scale scores were correlated showing more behavioural problems as the occupational prestige level decreased and this was confirmed by the ANOVA test (F=2.10, df=20, p<.01). The Behaviour Rating Scale scores did not differ according to either parents' education level or to maternal occupation.

Analyses for each of the 8 subscales were conducted in order to identify the types of behavioural problems related to socioeconomic indicators. In addition, since there were large discrepancies between the genders for these subscales, analyses were completed for both genders and for each gender separately. Results of these ANOVA tests have been summarized in the following table.
giving the main effects of the socioeconomic indicators on behavioural subscales. Only household income and parental occupation levels have been included in Table 4.21 because no statistically significant test statistics were observed for the other two indicators, that is, mothers' and fathers' education level.

Table 4.21 ANOVA F test coefficients and p values for associations with teachers' rating for total Behaviour score and subscales and three socioeconomic indicators, household income, and mothers' and fathers' occupation levels.

<table>
<thead>
<tr>
<th>Behaviour Subscales</th>
<th>Household Income*** (n=236)</th>
<th>Mothers' Occupation*** (n=228)</th>
<th>Fathers' Occupation*** (n=220)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total sample (df=9)</td>
<td>Boys only (df=9)</td>
<td>Girls only</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Inattention</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Indirect Aggression</td>
<td>1.99*</td>
<td>1.98*</td>
<td>n.s.</td>
</tr>
<tr>
<td>Physical Aggression</td>
<td>1.92*</td>
<td>2.02*</td>
<td>n.s.</td>
</tr>
<tr>
<td>Conduct Disorder</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Prosocial behaviour</td>
<td>2.16*</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

*F test significant at alpha=.05.
**F test significant at alpha=.01.
***No relationship was observed with two subscales, Emotional Disorder and Anxiety.

No relationships were observed between two subscales, Emotional Disorder and Anxiety, and any socioeconomic indicator. The subscale Indirect Aggression was found to be associated with more socioeconomic background indicators than other subscales, including income (F=1.99, df=9, p<0.05),
mothers’ occupation (F=3.22, df=17, p<.01) and fathers’ occupation (F=2.13, df=20, p<.01). In separating the analyses by gender, statistically significant associations were found with fathers’ occupation for both boys’ scores (F=2.36, df=20, p<.01) and girls’ scores (F=2.00, df=20, p<.05), with mothers’ occupation only for girls’ scores (F=3.93, df=17, p<.01) and with household income only for boys’ scores (F=1.98, df=9, p<.05). Physical Aggression was observed to be associated with income (F=1.92, df=9, p<.05) and with fathers’ occupation (F=1.49, df=20, p<.01) for the total sample, with each gender for fathers’ occupation (boys F=1.80, df=19, p<.05; girls F=1.78, df=18, p<.05), but only for boys scores with income (F=2.02, df=9, p<.05). Fathers’ occupation was observed to have an association with the total sample for three other subscales, Hyperactivity (F=1.77, df=20, p<.01), Inattention (F=1.84, df=20, p<.05) and Conduct Disorder (F=2.31, df=20, p<.01). Conduct Disorder scores also had a statistically significant association with mothers’ occupation (F=1.89, df=17, p<.05). Finally, Prosocial Behaviour was found to have a statistically significant association with two variables, household income (total sample F=2.16, df=9, p<.05) and for boys only with fathers’ occupation (F=1.82, df=19, p<.05).

Boys and girls were found to be affected differently by these socioeconomic indicators, with income having no relationship with any of the girls’ subscales and maternal occupation having no effect on any of the boys’ subscales.

To summarize with respect to socioeconomic indicators, fathers’ occupation appeared to have influenced more subscale scores that other socioeconomic indicators. It was observed to be associated with most subscales, including Hyperactivity, Inattention, Indirect Aggression, Physical Aggression and Conduct Disorder, when the analyses were conducted for both genders combined.
Fathers' occupation was related to the scores for boys on three subscales, Indirect Aggression, Physical Aggression and Conduct Disorder, and the scores for girls on two subscales, Indirect Aggression and Physical Aggression. Mothers' occupation was found to be associated with two subscales for the total sample, Conduct Disorder and Indirect Aggression, and only one behavioural subscale for girls, Indirect Aggression, with no effect on any boys' behaviour subscales. Household income had an effect on three subscales, Indirect Aggression, Physical Aggression and Prosocial Behaviour with respect to ANOVA for combined genders, both Indirect Aggression and Physical Aggression for boys only and no significant relationship with any subscales for girls.

The Parents' Behaviour Rating Scale scores differed from that of the teachers' ratings. Only three subscales (Hyperactivity, Indirect Aggression and Physical Aggression) were observed to have associations with any socioeconomic indicator. A statistically significant association was observed between Hyperactivity and both household income (both genders, \( F=2.00, df=9, p<0.05 \)) and mothers' education (both genders \( F=2.96, df=5, p<0.05 \); boys \( F=2.73, df=5, p<0.05 \)). Similar to the Teachers' Behaviour Rating Scale, Indirect Aggression was observed to have a statistically significant association with fathers' occupation on the Parents' Behaviour Rating Scale (both genders \( F=1.64, df=20, p<0.05 \); boys \( F=1.68, df=20, p<0.05 \); girls \( F=1.79, df=18, p<0.05 \)). Physical Aggression for boys was observed to have a statistically significant association with only mothers' occupation on the Parents' Behaviour Rating Scale \( (F=1.87, df=14, p<0.05) \).

To summarize with respect to specific subscales, five subscales for both genders were observed to
have associations with socioeconomic indicators. Hyperactivity was related to income on both scales and mothers’ education on Parents’ Behaviour Rating Scale. Indirect Aggression was related to fathers’ occupation on both scales and by income on Teachers’ Behaviour Rating Scale. Physical Aggression was related to fathers’ occupation and to income on the Teachers’ Behaviour Rating Scale and to mothers’ occupation on the Parents’ Behaviour Rating Scale. Conduct Disorder was related to both parents’ occupation levels on the Teachers’ Behaviour Rating Scale. Prosocial Behaviour was found to have an association with income on the Teachers’ Behaviour Rating Scale.

Separate analyses by each gender shows somewhat different results for socioeconomic indicators. For boys, Indirect Aggression was associated with three indicators (income and father’s occupation on Teachers’ Behaviour Rating Scale and fathers’s occupation on Parents’ Behaviour Rating Scale). Similarly, there was a statistically significant association between girls’ scores on the Indirect Aggression subscale and three indicators (fathers’ occupation on both Teachers’ and Parents’ Behaviour Rating Scale ratings and mothers’ occupation on Teachers’ Behaviour Rating Scale). For boys, Physical Aggression scores were associated with both income and fathers’ occupation on the Teachers’ Behaviour Rating Scale. Inconsistent with any other socioeconomic indicators were two gender-specific scores, that is, boys’ scores on Hyperactivity being associated with mothers’ education and boys’ scores associated with fathers’ occupation on the Prosocial Behaviour subscale.

As noted previously, an additional general question about each child’s emotional or behavioural
problems was posed to teachers. The responses were not correlated to a significant level with any of the socioeconomic indicators.

Parents were questioned about major worries their child has endured in his or her lifetime. These are categorized by income in Table 4.22.

<table>
<thead>
<tr>
<th>Experienced great amount of worry</th>
<th>Income category</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;$19,999</td>
<td>$20,000-39,999</td>
<td>&gt;$40,000</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>19 (73.1%)</td>
<td>23 (45.1%)</td>
<td>70 (41.9%)</td>
<td>112 (45.9%)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>7 26.9%</td>
<td>28 (54.9%)</td>
<td>97 (58.1%)</td>
<td>132 (54.1%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>26 (100.0%)</td>
<td>51 (100.0%)</td>
<td>167 (100.0%)</td>
<td>244 (100.0%)</td>
<td></td>
</tr>
</tbody>
</table>

Chi-Square analyses indicated significant differences between those who had or had not experienced “a great amount of worry” ($\chi^2=8.81, df=2, p<.05$) according to income categories. It can be noted from Table 4.22 that the middle and upper income groups were proportionate to the totals, while the lower income group had considerably more people who had experienced a great amount of worry. The same results were found when the income categories were less broadly grouped, that is, calculating differences across all 10 income categories (ranging from below $10,000 to above $80,000). Chi-Square analysis showed statistically significant differences in the groups ($\chi^2=18.11, df=8, p<.05$). The cause of the children’s major worries are reported in Table 4.23.
Table 4.23 Number of children who experienced major worries, according to cause of the worry and income category of parents.

<table>
<thead>
<tr>
<th>Cause of child's major worry</th>
<th>&lt;$19,999</th>
<th>$20,000-$39,999</th>
<th>&gt;$40,000</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>5</td>
<td>8</td>
<td>23</td>
<td>36</td>
</tr>
<tr>
<td>Divorce</td>
<td>8</td>
<td>9</td>
<td>11</td>
<td>28</td>
</tr>
<tr>
<td>Illness or injury</td>
<td>1</td>
<td>2</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Trauma</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>School</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Family Turmoil</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Other (including moving) or multiple</td>
<td>2</td>
<td>0</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19</strong></td>
<td><strong>23</strong></td>
<td><strong>70</strong></td>
<td><strong>112</strong></td>
</tr>
</tbody>
</table>

In summary, the major worries endured by this sample of children were found to be disproportionate according to income category.

4.3.3.iv Comparison of risk levels of a combination of independent variables on behaviour

Previously, a series of statistical tests were completed to examine main effects only, or the combination of two variables on the dependent variables. Now, two series of analyses compared a combination of risks, as described below.

4.3.3.iv (a) Comparisons of behavioural scores according to levels of risks

A series of ANOVA tests were conducted for the two total Behaviour Rating Scales (Parents' and Teachers') and for each of the subscales. These analyses were conducted by examining the main
and interaction effects of the independent variables on Behaviour scores. The subscales used in the analyses were selective in that all the subscales were included using the Teachers’ rating scale, but only Hyperactivity was included from the Parents’ rating scale because it was the only subscale that had any indication of being influenced by the independent variables during previous calculations such as correlations or ANOVA examining main effects only.

As noted previously, independent variables included in these calculations were smoking during 3rd trimester (dichotomized variable according to whether exposed or not to smoking during 3rd trimester or essentially throughout pregnancy), current smoking status of the primary caregiver (dichotomized variable as to current smoker or not), T-ACE risk (Stage 2 administration), alcohol consumption patterns during pregnancy (three levels: abstainer, social drinker and heavy drinker) and marital status (dichotomized according to married or not currently married). The analyses were conducted separately for each of the five indicators of socioeconomic status (each of which had three levels of risk) since including all concurrently was restrictive on the analyses, with the result that the degrees of freedom were exhausted. Frequencies for numbers of people in each of the categories in these dependent variables is shown previously in Table 4.12, page 201.

There was a combined effect of tobacco exposure during pregnancy and high risk level on the T-ACE on the total Behaviour Rating Scale (Teachers’ rating), the total Behaviour Rating Scale (Parents’ rating) and on four subscales, Hyperactivity, Inattention, Anxiety and Physical Aggression. When separate analyses were completed for each gender, these cumulative effects were shown to be significant for boys only.
A statistically significant effect of the combination of prenatal tobacco exposure throughout pregnancy and current smoking by primary caregivers was observed on the total Behaviour Rating Scale (Teachers' rating) and on the subscale Hyperactivity. Analyzing by separate genders, the same combination of pre- and post-natal smoking was found to be statistically significant for Conduct Disorder for boys only.

4.3.3.iv (b) Comparisons between the most at-risk groups and least at-risk groups

As with the other dependent variables, a series of t-test analyses was completed comparing the most at-risk groups with the least at-risk groups. The least exposure to risk (for example, non-smoking during pregnancy) was compared with all other levels of exposure. Exposure to the least amount of risk was used as the base to which comparisons were made.
Table 4.24 Scores of children exposed to risks of both tobacco use during 2nd and 3rd trimester and T-ACE risk, compared with those with no tobacco exposure and low T-ACE risk.

<table>
<thead>
<tr>
<th>Behaviour (Teachers' ratings)</th>
<th>Tobacco smoking combined with either T-ACE risk level</th>
<th>Beta*</th>
<th>S.D.</th>
<th>S.E.</th>
<th>t (df=2)</th>
<th>p</th>
<th>95% Confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviour total score</td>
<td>High T-ACE risk</td>
<td>23.50</td>
<td>12.75</td>
<td>10.90</td>
<td>2.16</td>
<td>.033</td>
<td>1.98 to 45.02</td>
</tr>
<tr>
<td></td>
<td>Medium T-ACE risk</td>
<td>-.75</td>
<td>12.75</td>
<td>4.77</td>
<td>-.16</td>
<td>.876</td>
<td>-10.17 to 8.67</td>
</tr>
<tr>
<td>Subscales:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>High T-ACE risk</td>
<td>7.74</td>
<td>3.08</td>
<td>2.60</td>
<td>2.98</td>
<td>.003</td>
<td>2.61 to 12.88</td>
</tr>
<tr>
<td></td>
<td>Medium T-ACE risk</td>
<td>.73</td>
<td>3.08</td>
<td>1.14</td>
<td>.64</td>
<td>.523</td>
<td>-1.52 to 2.98</td>
</tr>
<tr>
<td>Inattention</td>
<td>High T-ACE risk</td>
<td>3.34</td>
<td>1.77</td>
<td>1.56</td>
<td>2.14</td>
<td>.034</td>
<td>.25 to 6.43</td>
</tr>
<tr>
<td></td>
<td>Medium T-ACE risk</td>
<td>-.285</td>
<td>1.77</td>
<td>.68</td>
<td>-.42</td>
<td>.678</td>
<td>-1.64 to 1.07</td>
</tr>
<tr>
<td>Anxiety</td>
<td>High T-ACE risk</td>
<td>4.67</td>
<td>2.40</td>
<td>2.36</td>
<td>1.98</td>
<td>.049</td>
<td>.007 to 9.33</td>
</tr>
<tr>
<td></td>
<td>Medium T-ACE risk</td>
<td>.13</td>
<td>2.40</td>
<td>1.03</td>
<td>.126</td>
<td>.900</td>
<td>-1.91 to 2.17</td>
</tr>
</tbody>
</table>

Note: the results of five subscales, Conduct Disorder, Emotional Disorder, Indirect Aggression and Prosocial Behaviour did not show statistically significant differences.

*Beta is the effect size in mean scores for the low risk group (that is, low T-ACE risk and non-smokers). Medium and high risk groups are compared with Beta.

To examine the effects of more than one risk, tobacco use was combined with T-ACE risk level. A comparison was made between three groups (low, medium and high T-ACE risk), all of which had women who smoked during their 2nd and 3rd trimester. The comparison was made within this smoking group amongst those who had low T-ACE risk level (with Beta set at 0) and those with medium and high T-ACE risk levels. As shown in the table above, smokers with medium T-ACE risk did not have statistically significantly different scores from smokers with low T-ACE risk on the teachers' version of the Behaviour Rating Scale. In contrast, the total Behaviour Rating Scale (t=2.16, df=2, p<.05) and four subscales showed statistically significant differences between the smokers with low T-ACE risk and those with high T-ACE risk. The subscales showing statistically significant differences in the behaviour scores are Hyperactivity (t=2.98, df=2, p<.01),
Inattention ($t=2.14$, df=2, $p<.05$), Physical Aggression ($t=2.43$, df=2, $p<.05$), and Anxiety ($t=1.98$, df=2, $p<.05$). Combining the risks of continuing to smoke throughout pregnancy and high T-ACE risk level for alcohol drinking appeared to affect behaviour, at least on these subscales.

No statistically significant differences between the low and high T-ACE risk smoking groups were observed in the behavioural scores of four other subscales, Indirect Aggression, Conduct Disorder, Emotional Disorder and Prosocial Behaviour. Observed power for some of these analyses was low, with the high risk group having a small sample size ($n=4$) for each of these subscales. In the case of Indirect Aggression, power was only .14 and sample size calculation indicated a sample size of 39 ($\alpha=.05$, power=.75) would have been required to show significance for the same effect size. Similarly, sample size required for Conduct Disorder was calculated to be 14 ($\alpha=.05$, power=.75), for Emotional Disorder it would need to be 10 ($\alpha=.05$, power=.75) and for Physical Aggression doubling the sample size to 8 ($\alpha=.05$, power=.75) would have been required for the effect sizes to have reached significance.

The final step in these analyses was to include all three independent variables, alcohol exposure, tobacco exposure and socioeconomic background in the model. This analysis can be visualized as cube shaped, with the three dimensions being alcohol exposure, tobacco exposure and socioeconomic background. Two extremes were compared: at one extreme, a cell that combined the highest risk of these three dimensions, and at the other extreme, a cell that combined children exposed to the least risk. A t-test comparison was made between the combined high risks and the combination of no or lesser risks.
The high risk group consisted of women who had a high T-ACE risk level, drank alcohol during their pregnancy and who smoked cigarettes throughout pregnancy and had the lowest socioeconomic background. In t-test analyses, children exposed to this combination of risks had statistically significantly different total Behaviour scores (Teachers' ratings) than those non-risk categories.

Each of the socioeconomic indicators was tested in this model separately and the tests showed statistically significant differences for four of the five socioeconomic indicators: income levels \( (t=4.01, \ df=47, \ p<.001, \ \text{mean difference}=18.31, \ S.D.=17.05) \), mothers' education \( (t=2.64, \ df=24, \ p<.01, \ \text{mean difference}=12.66, \ S.D.=15.39) \), fathers' education \( (t=2.86, \ df=20, \ p<.01, \ \text{mean difference}=11.27, \ S.D.=11.07) \), fathers' occupation \( (t=1.54, \ df=26, \ p<.05, \ \text{mean difference}=12.66, \ S.D.=16.51) \). The only socioeconomic indicator that did not show statistical significance in the t-test analysis was mothers' occupation \( (t=1.93, \ df=36, \ p=.061, \ \text{mean difference}=7.81, \ S.D.=13.10) \).

Similarly, t-tests were completed to compare high risks and low risks for each of the subscales. Because the behavioural subscales means differed according to gender, analyses were completed for boys and girls separately. The same combination of high risk for T-ACE, alcohol consumption and cigarette smoking was combined with each of the socioeconomic variables and compared with the low risk groups. The Hyperactivity subscale was most often observed to have statistically significant differences between the high risk and low risk groups, as each of the socioeconomic indicators were included in the model. For females, statistically significant differences were found for the subscale Hyperactivity (parents' ratings) when either income or fathers' education were
added to the model as indicator of socioeconomic background (income t=1.5, df=25, p<.05; fathers' education t=2.56, df=10, p<05). Two other socioeconomic indicators showed results that near statistically significant levels for Hyperactivity amongst females (for both mothers' education and fathers' occupation, p=.06) but increasing the small cell sizes amongst the high risk groups, from 7 to 12 in the case of mothers’ education and from 5 to 6 in the case of fathers’ occupation would have increased the power to a level adequate for such a calculation. For males, Hyperactivity mean scores differences did not reach significance (at α=.05) when any of the socioeconomic indicators were included in the model, although in three cases they nearly reached statistical significance (for example, mothers’ education p=.057). After exploring the data further, it was found that two outliers were affecting the results to a large extent. When these outliers were removed from the analyses, the high risk and low risk groups were statistically significant different for males Hyperactivity subscale scores when two indicators of socioeconomic background were included in the model, mothers’ education (t=2.17, df=19, p<05) and fathers’ occupation (t=1.98, df=21, p<01).

For males, mean scores of subscale Inattention showed statistically significant differences between the high and low risk groups when income was added to the model (t=1.7, df=25, p<.05); similarly with the subscale Indirect Aggression when mothers’ education was included (t=1.8, df=16, p<01). Other subscales yielded results that nearly reached statistical significance and with small increases in sample sizes would have increased power to a level by which such mean score differences would have been statistically significant. For example, in four cases mothers’ education cell sizes and power were small, including Hyperactivity for males and females and Prosocial Behaviour for both
males and females. Sample size calculations show that with the same effect size only small increases in sample sizes are required to show statistically significant results (for example, increasing one risk group from 17 to 24 and the other from 5 to 7 for Prosocial Behaviour). Similarly, sample size was small for other subscales, including Conduct Disorder (amongst males) with income as the socioeconomic indicator, Anxiety (females) and Prosocial Behaviour (females) with mothers’ occupation, Conduct Disorder (females) and Inattention (females) for fathers’ education, and Conduct Disorder (females) and Hyperactivity (females) for fathers’ occupation.

By gender, for males there were statistically significant differences in scores for the total Behaviour Rating Scale when income was included ($t=2.2$, $df=25$, $p<.05$) and when mothers’ education ($t=1.99$, $df=20$, $p<.01$) was included in the model of high risk categories. By excluding the two cases with high scores not related to maternal education or income (outliers), Statistically significant differences were observed in scores when another socioeconomic indicator, fathers’ education, was included in the analyses ($t=3.37$, $df=16$, $p<.01$), only after the exclusion of two outliers that had extreme scores. For females, total Behaviour Rating Scale scores were found to be statistically significantly different only when mothers’ occupation was included in the model as an indicator of socioeconomic background ($t=1.74$, $df=16$, $p<.01$).
Chapter V Conclusions

There are multiple environmental, personal and biological factors that may contribute to a child's well-being. Environmental conditions and prenatal insults appear from this study to influence the child. These include prenatal exposure to alcohol and to tobacco and the socioeconomic background of their parents or caregivers.

Data were collected and observed on academic abilities, health and behaviour of children who were exposed prenatally to varying amounts of alcohol or tobacco and who were raised in families of differing socioeconomic backgrounds. The study had the advantage of prospective data collection for the independent variables from a randomly selected cohort of women who lived in a pre-defined geographic area. The geographic area was diverse in that it included urban and rural areas, people with an extensive range of household incomes, and both aboriginal and Caucasian women. The sample was selected from women who delivered their babies within a one-year period and lived within a defined geographic region of Vancouver Island. Outcome data were collected from the offspring of the randomly selected sample when these children were approximately 8 to 9 years of age.

About one-half (51.7%) of the children were exposed to alcohol at some time during the prenatal stage, and 7.9% were exposed to heavy use by their mothers either drinking more than 2 drinks per day or binge drinking. Nearly one-third (32.8%) were exposed to tobacco through their mothers' smoking sometime during the pregnancy, and 22.3% were exposed throughout the whole pregnancy. The maternal behaviours themselves co-varied (for example, prenatal and postnatal
smoking, or prenatal alcohol and tobacco use) and, therefore, it is difficult in behavioural research to assess each risk independently. For example, the research literature research indicated reasonably consistent results regarding the association between prenatal tobacco exposure and certain behaviours, many in studies with very large samples. For the most part, these studies excluded alcohol use and while it was observed that in some countries alcohol use by women was limited, it would be difficult to be conclusive about either of these lifestyle behaviours without examining the outcomes of the other. Similarly, socioeconomic background was found to be associated with prenatal tobacco and alcohol use and caution should be taken when drawing conclusions about the effects of alcohol or tobacco use without including socioeconomic variables as covariates. Many of the longitudinal studies on prenatal alcohol use have selected their subjects purposefully from clinics catering to women from disadvantaged backgrounds, making it difficult to generalize to broader populations.

In the present study, results have been reported on the academic, health and behavioural outcomes of children who were exposed to a range of risks, from no alcohol or tobacco exposure to heavy use of both and to varying socioeconomic backgrounds.

Academic abilities were measured by testing the children and by asking parents and teachers about their children's abilities. Abilities in three core subjects, reading, spelling and arithmetic, were measured. Arithmetic and spelling scores did not differ in relationship to prenatal alcohol exposure. A statistically significant association was observed between reading scores and absolute alcohol consumption per day before pregnancy. Children whose mothers drank heavily during
pregnancy had statistically significant lower reading scores than those whose mothers drank socially or abstained altogether. Social drinking was not found to affect test scores on any academic abilities.

Tobacco use during pregnancy was positively correlated with reading and spelling scores and these relationships were confirmed by multivariate analysis, although conservative alpha levels suggested that caution should be taken in interpreting these results. These unexpected findings cannot be explained.

With respect to academic abilities and socioeconomic indicators, both mothers’ and fathers’ education were positively correlated with reading scores, and father’s education was correlated with spelling scores. Multivariate analysis showed that mothers’ and fathers’ level of education had an effect on spelling scores. Mother’s occupation was observed to be positively correlated with reading scores.

This study was not able to establish any findings with respect to arithmetic abilities. The observed power to make such calculations was small and a larger sample would be required or larger variance in the mean scores before any conclusions could be made about the relationships. The literature on children of heavy drinkers or alcoholic women, and on children with FAS, commonly showed arithmetic to be associated with such drinking. It was not possible to draw such conclusions from the present study.
Previous longitudinal and cross-sectional studies on the effects of alcohol have drawn their samples from varying populations and in many studies it would be difficult to discriminate between socioeconomic effects and maternal behaviour. Longitudinal studies in France, Germany, Sweden, Canada and U.S.A. were found, but since many of these studies selected their samples from predominantly inner-city, socially and economically disadvantaged neighbourhoods, it is difficult to make comparisons and draw conclusions.

Generally, however, the results of the present study regarding academic abilities are consistent with other studies, many of which observed that those moderately exposed to alcohol did not have lower academic scores, and that lower academic scores were associated with heavy drinking patterns. For example, Conry (1990) found that in her study of 19 children in an isolated B.C. community who had been diagnosed with FAS or FAE, those with FAE did not have lower I.Q. scores. Two longitudinal studies in Ottawa (Fried et al., 1992b) and in Cleveland (Greene et al., 1991a, 1990) found no adverse results with respect to I.Q. testing of children at ages 5 to 6 years old. Both of these studies included women who drank moderately during their pregnancies. Researchers of the Seattle longitudinal study (Streissguth et al., 1994a, 1990; Streissguth et al., 1993) found that the offspring of women who drank ≥5 drinks (binge drinking) on at least one occasion prior to pregnancy had lower reading scores, that is consistent with findings of this thesis, although it is difficult to make strict comparisons because of the timing of maternal alcohol consumption and types of outcome measures used.

Other longitudinal studies such as the Detroit study (Jacobson et al., 1998, 1993b) have
populations and drinking patterns so different from the Vancouver Island Pregnancy Follow-up Study that differences in results might be expected. For example, in Detroit a cohort from a predominately black disadvantaged population was tested, but only up to age 13 months. Results showed that binge drinking at least weekly more than doubled the risk of lower cognitive scores. There were no women in the Vancouver Island Pregnancy Follow-up Study who had admitted to binge drinking on a weekly basis. Jacobson et al. (1993b) concluded that when confounding variables were included in the analyses with the frequent high level of drinking, only 1 to 2% of the variance in infant outcome could be explained by prenatal alcohol exposure, although in the higher risk women (higher alcohol levels, maternal age over 30 at childbirth), prenatal alcohol exposure could explain up to 7% of the variance in outcome. They suggested a threshold of four drinks per day for reducing verbal and language skills, but little effect of prenatal alcohol exposure could be observed below that threshold level.

The Vancouver Island Pregnancy Follow-up Study did not attempt to establish a threshold for prenatal alcohol exposure. It did find from comparing the scores of children exposed to a collective group of risk factors (high T-ACE risk, heavy drinking during pregnancy and fathers' low education) that there were statistically significantly different results in spelling and reading scores than for those in the low risk categories of these variables.

This study also found that fathers' education had an effect on reading and spelling scores. Spelling scores were best explained when both parents' education level were brought into the statistical model. The Seattle longitudinal study (Streissguth et al, 1994a, 1990; Streissguth et al., 1993)
found that exposure to alcohol use daily during the middle trimester yielded a 7-point decrement on total I.Q. scores at age 7.5 years, but that effect was exacerbated by lower fathers' education. Dissimilar to the Vancouver Island cohort, the Seattle cohort who were prenatally exposed to binge drinking also had lower arithmetic scores. Neither study showed decrements in spelling scores among those exposed to binge drinking.

The effect of the combination of mothers' and fathers' level of education on spelling scores and the correlation between mothers' and fathers' level of education on reading scores may be a proxy for the influence of home environment. Greene (1991a) found that even amongst a predominantly disadvantaged cohort, home environment was more predictive of lower cognitive development scores than either prenatal alcohol or tobacco exposure. The present study did not observe home environment directly, but from the academic testing of this cohort, it can be concluded that parental education appears to contribute to reading and spelling scores. Adding high levels of prenatal alcohol exposure or high T-ACE risk scores to the list of risks experienced by these children contributed to their lowered scores in reading and spelling.

Conclusions that could be drawn from this study are that reading and spelling skills appear to be influenced by parental education and by prenatal exposure to heavy alcohol use by the mothers. Social levels of drinking do not appear to have any effect on academic abilities amongst this cohort.

This is one of the few studies to examine health status as an outcome of prenatal alcohol exposure.
at levels other than heavy drinking. A number of adverse health conditions have been found in
children with FAS. Streissguth and her colleagues in Seattle (Streissguth et al., 1993) suggested
that they have included health outcomes in their maternal interviews of women, however,
published results of their health outcomes have not been found.

The Vancouver Island Pregnancy Follow-up Study found that low birth weight was associated
with both prenatal alcohol exposure and prenatal tobacco exposure, but by 8 years of age, no
differences were observed between the size of the children exposed and those not exposed
prenatally to either tobacco or alcohol. With respect to catch-up after birth of children born with
low birth weight, these results are consistent with the research literature. Many studies have
included measurements of physical size, with inconsistent results, although more often studies of
the offspring of heavy drinkers or alcoholic women have found continued or persistent retarded
growth, while studies of the offspring of moderate drinkers have found that children’s growth
caught up to their non-exposed peers by early elementary school age. Most studies that found that
children caught up in growth, in spite of being low birth weight, drew their samples from more
socially and economically advantaged populations. Barrison and Wright (1984) observed that
social background and prenatal alcohol and tobacco exposure had interactive effects on birth
weight.

This study observed a negative association between child health and either actual alcohol use or
alcohol risk level measured by the T-ACE. Contrasting those with the least risk (abstainers or
those at the lowest T-ACE risk level) to those with the highest risk (heavy alcohol use or highest
T-ACE risk levels) it was found that the latter were statistically significantly less healthy, measured either by number of visits to medical professionals or parents’ rating of health.

Prenatal tobacco exposure during the 3rd trimester was found to be statistically significantly correlated with parents’ rating of their child’s health. Current maternal smoking appears to be associated with an increased use of medical services, measured by the number of visits to physicians and nurses during the past year. A combined effect of current level of smoking and amount of prenatal exposure was observed to be statistically significantly associated with child health rating. Smoking during pregnancy and current smoking were found to covary, indicating that the long-term continuous effect of tobacco exposure may have adverse health outcomes. The same analyses using total medical visits as an indicator of health did not reach significance, but such results are inconclusive because power for that calculation was low.

Indicators of socioeconomic background were found to be associated with health, an expected result given the widespread understanding of the relationship between health or illness and social inequalities. Mothers with lower education levels and with lower occupation levels gave lower ratings of their children’s health. Also, fathers’ occupation and household income were found to be associated with lower health ratings. The findings of this study are consistent with those of numerous studies exploring the association between health status and disadvantaged socioeconomic backgrounds.

An additive effect of mothers’ occupation level and prenatal tobacco exposure was found to have
adverse effects on health, according to parents' ratings. Combining the risks of tobacco exposure and other indicators of socioeconomic background are inconclusive because of low power to complete the analyses. It was observed that children at lowest risk for poor health: were exposed to the lowest risk of alcohol use (children of abstainers), had mothers with the lowest T-ACE risk level, are not currently exposed to their mothers' second-hand smoke, and are being raised in families with higher socioeconomic backgrounds. Statistically significant relationships were found between health measures and alcohol use during pregnancy, T-ACE risk scores, current parental smoking and socioeconomic background.

Behavioural outcomes of this cohort were specific in terms of which behavioural problems are associated with the various risks. Prenatal exposure to heavy alcohol use was found to be associated with several behavioural problems. For all subscales and for the total Behaviour Rating Scale scores, there were no differences in behaviour between those whose mothers who abstained from alcohol and those who were social drinkers. There were differences between those whose mothers drank socially (1 or fewer drinks a day) and those who drank heavily (either 2 or more drinks a day and/or binge drinking) on the total Teachers' Behaviour Rating Scale and on five of the eight subscales, including Hyperactivity, Inattention, Emotional Disorder, Physical Aggression and Indirect Aggression. It can be concluded from these data that social drinking does not affect these behaviours but that heavy drinking does affect them.

These results concur with what has been described in the literature in many respects. The two most often described behavioural problems associated with children with FAS are hyperactivity
and inattention, although these behaviours may be so closely linked that one may be a manifestation of the other (McGee et al., 1985). Inattention has been shown in many of the longitudinal studies to persist as the children mature, unlike some of the physical characteristics attributed to prenatal alcohol exposure.

The review of the literature found that some studies have observed relationships between prenatal alcohol exposure and hyperactivity and inattention and some have not. Studies that have most often found an association between prenatal exposure and hyperactivity or inattention are those whose study population were children of alcoholics or children diagnosed with FAS or FAE. Studies that included moderate drinkers more commonly have not found the same adverse relationship between prenatal alcohol exposure and hyperactivity or attention deficits. The present study distinguishes between three levels of drinking, abstaining, social drinking, and heavy drinking. It observed no differences in these behavioural characteristics in the offspring of abstainers compared with social drinkers, but did find differences in five behavioural subscales between social drinkers and heavy drinkers. This is consistent with the research literature in that an association has been found between heavy drinking and hyperactivity and inattention, but it is uncommon to observe such association with smaller amounts of drinking.

As well as the Hyperactivity and Inattention subscales, those same distinctions between the three categories of drinking behaviour were found to distinguish the outcomes on the subscale scores for Emotional Disorder, Physical Aggression, Indirect Aggression and Prosocial Behaviour. The contrast between Prosocial Behaviour subscale scores of the children of heavy drinkers and social
drinkers was observed to be statistically significant only at $p = .05$ and therefore should be considered with caution. If reliable, these results would mean that those who were prenatally exposed to higher amounts of alcohol had lower Prosocial Behaviour subscale scores. The measurement of Prosocial Behaviour (the only positive behaviour tested) has been an addition to the particular Behaviour Rating Scale used for the National Longitudinal Study on Children and Youth in Canada (Canada. Human Resources Canada and Statistics Canada, 1996) and it does not appear that this behaviour has been tested in relationship to prenatal alcohol exposure to date. For this reason, the finding of this study that prenatal alcohol exposure and Prosocial Behaviour appear to be new with this study and require replication.

Exposure to tobacco pre- or postnatally was correlated with the scores of two behaviours, Prosocial Behaviour and Conduct Disorder. For Prosocial Behaviour there was a negative association, with both prenatal and postnatal exposure observed to have a main effect on the scores for this subscale. There is no literature on this subscale, as mentioned, because this is a recent addition to the Behaviour Rating Scale designed for the Canadian NLSCY. An additive effect with pre- and postnatal exposure was associated negatively with Conduct Disorder in boys. This is consistent with the literature in its findings that Conduct Disorder was linked with prenatal tobacco exposure and that the more serious manifestations of Conduct Disorder (such as pre-delinquent, delinquent and criminal behaviour) were consistently associated with prenatal tobacco exposure, especially with boys. Some of these studies could be criticized for their methods in that they selected samples from boys who had already been referred to clinics for the treatment of Conduct Disorder, or alternatively, many years later retrospectively linked delinquent behaviour to
maternal tobacco during pregnancy. The present study observed that among this cohort the sons of women who smoked during pregnancy and who currently smoke have higher Conduct Disorder scores than the sons not exposed to maternal smoking. The same association was not found for daughters of smokers, although Conduct Disorder mean scores for girls were much lower and had smaller effect size with respect to prenatal tobacco exposure.

No other behaviour subscales are associated with maternal smoking in this study. From the literature review, it was observed that some research links prenatal maternal smoking with attention deficit or impulsivity, but in many of these studies prenatal alcohol exposure was not treated as a covariate. One of the few studies that collected and analysed on tobacco and alcohol, the Ottawa Prenatal Prospective Study (Fried et al., 1992a, 1992b, 1997, 1998, Fried, 1989a), found impulsivity, attention and behavioural problems amongst those exposed to pre- and postnatal tobacco. Their sample may have similarities to the Vancouver Island population in that they are both Canadian, although the Ottawa population has been described by its authors as predominately middle-class and well-educated. The Vancouver Island population is more diverse, albeit within the Canadian context. The results of the Vancouver Island Pregnancy Follow-up Study are inconsistent with the Ottawa results with respect to tobacco exposure and behavioural problems in general, and regarding impulsivity and attention specifically.

Indicators of socioeconomic background associated with scores on the total Behaviour Rating Scale and with some subscales were household income and fathers’ and mothers’ occupation levels. Specific behaviours observed to be related to income and parental occupation levels were
Hyperactivity, Inattention, Indirect Aggression, Physical Aggression, Conduct Disorder and Prosocial Behaviour. Children raised in families with lower incomes were found to have endured a disproportionate number of major worries such as death or divorce.

The Vancouver Island cohort was categorized according to the trimester in which they were exposed to their mothers' smoking, and further subdivided according to their mothers' T-ACE risk levels. For the total Behaviour Rating Scale and for three subscales, those whose mothers smoked and were in the high T-ACE risk group showed statistically significantly more behaviour problems than those whose mothers smoked and were in the medium T-ACE risk group. Comparisons between children exposed to the medium and to low risk categories (no tobacco exposure and low risk T-ACE levels) did not show statistically significant differences. The three subscales showing statistically significant differences between the high and medium risk levels are Hyperactivity, Inattention and Anxiety. No differences were observed between the medium and low risk groups. When socioeconomic indicators were included in the analyses, again the results showed increased behavioural problems of those in the groups defined as high risk because of a combination of insults during pregnancy and current risks during childhood.

In conclusion, prenatal alcohol exposure was associated with lower reading abilities. Parents' education level was associated with lower reading abilities and spelling abilities. Lower reading and spelling scores were associated with the combination of being prenatally exposed to alcohol and having a father with lower education level. Although both prenatal alcohol and prenatal tobacco exposure were associated with lower birth weight, these smaller sizes were not sustained
over time. Health was found to be associated with prenatal alcohol use and by a combination of prenatal tobacco exposure and current maternal smoking and with socioeconomic background. Exposure to heavy alcohol use prenatally was found to be associated with the scores on several behavioural subscales, including Hyperactivity, Inattention, Emotional Disorder, Physical Aggression and Indirect Aggression. Prenatal tobacco exposure was associated with Conduct Disorder subscale scores. Household income and parents' occupation levels were associated with most of the same behaviour subscales. Contrasts between various levels of risk revealed that only heavy alcohol use was associated with reading or spelling scores, health and scores on various behavioural subscales. In the absence of other risk factors, there was little evidence of associations between prenatal exposure to social drinking or low risk level and lower academic ability scores, lower health rating, or with any behavioural problems. These findings are consistent with most other longitudinal studies. Prenatal alcohol exposure to high levels of alcohol use has been associated with adverse academic and behavioural outcomes in children, and prolonged tobacco exposure has been found to have adverse health outcomes. Few studies, including the results of this study, have observed adverse outcomes resulting from moderate (1 or fewer drinks daily) prenatal alcohol exposure.
Chapter VI  Implications

There are implications from this study for researchers, policy-makers and health practitioners. The implications fall into two categories, prevention programming and research.

Alcohol and tobacco exposure during pregnancy and socioeconomic background were observed to be associated with academic abilities, health and some behaviours. The conclusions from this study and from others indicate that in the absence of other risks, there is very little evidence that one or fewer drinks a day during pregnancy (moderate or social drinking) affects academic abilities, behaviour or health. This suggests that efforts need to focus on the prevention of alcohol use beyond those levels during pregnancy, both in terms of surveillance by primary caregivers and in community-based programming. All women can be screened for risk behaviour during pregnancy but health programmes aimed at reducing the prevalence of heavy alcohol and tobacco use can be targeted to those most in need of support.

There has been a vast amount of public information available through the media and through specific public health campaigns such as warning signs in establishments where alcohol is sold. Because of this, there are likely to be few people who remain unaware of the link between alcohol and adverse outcomes in infants and children. Concentration of efforts in public education, primary care and social service should shift from public awareness to prevention efforts for those who drink heavily, either two or more drinks daily or binge drinking. Rather than general education programs that perhaps erroneously suggest that all alcohol use during pregnancy has adverse outcomes, efforts would be better served by concentrating on those women who continue
to drink heavily during pregnancy.

Targeted prevention programs for heavy alcohol users and tobacco users should be initiated by increasing efforts by all primary care providers to draw attention to this issue, beginning with simply discussing these behaviours with women and their partners. In most areas of British Columbia, prenatal classes are provided by private or non-government organizations, at a cost to the pregnant woman and are not available until the last trimester of pregnancy. Under this organizational scheme, it is not possible to intervene early in the pregnancy to reduce these risk behaviours. Government programs that provide pregnancy coaches or midwives specifically for socially disadvantaged women who use alcohol, tobacco and drugs would be another option. One such example is the Pregnancy Outreach Program (POP) that is a public health strategy initially established in British Columbia in 1988 (Asante & Robinson, 1990). The POP is a community-based intervention program aimed at educating and maintaining contact with pregnant women, especially those with socially disadvantaged backgrounds.

Programs that continue from early pregnancy to childhood may keep women and their families connected with the health and social systems, through subsequent pregnancies and through early child developmental stages. Many programs have limitations so that programs women attend during pregnancy are not accessible once the children are born or reach a certain age. Such health programs risk losing touch with the woman until she becomes pregnant again, and even then often not until she is well on into her pregnancy. To achieve positive and lasting outcomes, such programs would require attention to social and individual determinants of health, academic success
and a reduction of behavioural problems in children.

Secondary prevention comes with school, social service and family interventions. Implications of this study may lie with the suggestion of one principal from a school that had a child who was a participant of this study. Anecdotally, he suggested that in the past 20 years educators have learned to work with all students regardless of their abilities coming into school or of the problems they have endured, including prenatal alcohol exposure and they have been able to raise the standards of reading, spelling and arithmetic of each child. He suggested that this may be one of the reasons the Vancouver Island Pregnancy Follow-up Study did not show lowered arithmetic scores associated with prenatal alcohol exposure. In similar fashion, other professionals may alleviate some secondary problems related to behavioural outcomes by being better aware of the causes of children's problem behaviour.

The final implications of this study pertain to research. The cumulative effects of various risks, such as socioeconomic disadvantages and prenatal maternal behaviours, should be explored further. An objective method of exploring the outcomes might be the use of routinely collected information through, for example, the B.C. Reproductive Care Program.

To date, no threshold for prenatal drinking has been established. Rather than seeking a specific threshold, this study and other research suggest that it might be more productive to understand the interaction of maternal behaviours, complex conditions such as socioeconomic background, and any other risks to the child. An ecological approach to understanding the outcomes of prenatal
alcohol exposure is suggested in the theoretical guides of this research and by the results of this study. Several previous studies have drawn conclusions about the outcomes of prenatal alcohol exposure from very limited samples. Numerous studies on prenatal tobacco exposure have drawn conclusions without considering a common co-abuse factor, alcohol. Population-based studies that include various other risk behaviours and that include socioeconomic background may have more to contribute than seeking specific thresholds that do not consider confounding variables.
Chapter VII  Limitations of the study

The main limitation of this study was its sample size. The sample size appeared adequate for comparisons between groups, but when the sample was divided according to risks, some of the cells were insufficiently large given the effect sizes of the variables under study.

The second limitation of this study relates to measurement and is common to many studies. This study relied on self-report of both alcohol and tobacco use. To date, it has been necessary to rely on self-report of the mother about her own use of alcohol because no other reliable, non-invasive biological markers for the extent of alcohol exposure have been found. Researchers have attempted to use more objective markers such as measurement of ethanol in meconium of newborns, but for various reasons these have proven no more reliable than self-reporting. In the Vancouver Island Pregnancy Study, two measures were used, self-report of alcohol consumption, by trimester and by each type of alcohol such as beer or wine, and the T-ACE risk test that is a measure of risk level of alcohol use before pregnancy. The T-ACE risk test was administered twice, once during pregnancy, and once after the child was born. These were shown to have an stability correlation of .50. In some of the analyses, one of the T-ACE tests (more often the one administered during pregnancy) was found to be associated with the variable under study, while at other times the T-ACE did not have an association. At other times, actual alcohol consumption level, but not T-ACE risk level from Stage 1 or from Stage 2 administration, was found to be associated with certain variables. The use of multiple measures, and prospective reporting, appeared to be the best solutions for this study. However, there is a degree of uncertainty about the reliability of self-reporting about alcohol use.
Although self or parental rating of health has been widely used as a measure of health, various factors have been observed to influence responses, including level of stress of the rater (Mechanic, 1964), being a single parent (Angel & Worobey, 1988) or mother's heavy alcohol intake or drug use during pregnancy (Seagull et al., 1996). This scale has been widely used by health researchers (Ratner et al., 1998); however, it is not possible to be conclusive about whether the status or the perceptions differ according to the characteristics of this sample.

Measurement of cognitive functioning was limited. Measurement was restricted to testing by interviewers who were trained in the use of the WRAT-3 tool, but who were not education or psychology professionals. Assessments to measure higher cognitive functioning by trained educational psychologists were beyond the financial budget of this study.

A limitation of the study was ignoring other covariates in the statistical models for analyses. Maternal marijuana use during pregnancy, nutrition both at the time of pregnancy and current food intake of the child, and current alcohol use by mothers are examples of variables that could influence child outcomes measured in this study. Although limited by the data collected, these could be explored further.

Most longitudinal studies of the effects of prenatal alcohol exposure have selected their samples from specific populations. This study is unique in its population-based random sample. Even with this sample selection, there is concern that the underlying characteristics of the mothers who
continue to drink alcohol and smoke tobacco throughout their pregnancies influence the outcomes of their children. It may be other variables descriptive of these women, rather than the prenatal alcohol and tobacco exposure, that contribute to the outcomes.

Finally, testing children at approximately 8 years of age has limitations. Some behaviours, health problems and difficulties with academic abilities might be best assessed at later ages. Further follow-up of this cohort could overcome that limitation.
Bibliography


Cherpitel, C.J. 1995. Analysis of cut points for screening instruments for alcohol problems in the


276


Day, N.L., and G.A. Richardson. 1993. Cocaine use and crack babies: science, the media and


283


Florey, C. du V. 1988. Weak associations in epidemiological research: some examples and their


286


Green, L.W. 1991. Everyone has a theory, few have a measurement. Health Education Research 6 (2):249-50.


292


293


Mattson, S.N., Terry L. Jernigan, and E.P. Riley. 1994. MRI and prenatal alcohol exposure:
Images provide insight into FAS. *Alcohol Health & Research World* 18 (1):49-52.


Mayfield, D., G. McLeod, and P. Hall. 1974. The CAGE questionnaire: validation of a new


310


Rantakallio, P., and M. Koiranen. 1987. Neurological handicaps among children whose mothers...


U.S. Department Of Health And Human Services.


317


Sexton, M., and J.R. Hebel. 1984. A clinical trial of change in maternal smoking and its effect on


319


tract illness in early life. *Archives of Disease in Childhood* 62:786-91.


326


Veen, S., M.H. Ens-Dokkum, A.M. Schreuder, S.P. Verloove-Vanhoeck, R. Brand, and J.H.


328


cigarette smoking have increased fecundability? American Journal of Epidemiology 129 (5):1079-83.


Williamson, D. 1999. The conceptualization and measurement of socioeconomic status: What are health researchers talking about? Presented at the Peter Wall Institute of Exploratory Workshop on Socioeconomic Status and Health. Vancouver, B.C.


Appendices

Appendix A: Questions relating to alcohol use appended to the Provincial Prenatal Record
Appendix B: Parents' and teachers' questionnaires
Appendix A: Questions relating to alcohol use appended to the Provincial Prenatal Record.
Amended Medical Record Data Form questions.

1. Have you ever had a drink of alcohol?
   [1] No  Proceed to next section
   [2] Yes

2. How old were you when you had your first drink?  ____________ years

3. What did you prefer to drink at that time - beer, wine or liquor?  ____________

4. How old were you when you first got drunk?  ____________ years

5. How many drinks did it take to make you feel high then?  ____________

6. What did you prefer to drink before you knew you were pregnant - beer, wine or liquor?

*7. Before you knew you were pregnant, how many drinks did it take to make you feel high?  ____________

*8. At that time, had people ever annoyed you by criticizing your drinking?

*9. At that time, had you felt you ought to cut down on your drinking?

*10. At that time, had you ever had a drink first thing in the morning to steady your nerves or get
     rid of a hangover?

*Questions 7-10 comprise the T-ACE screening questionnaire (Sokol et al., 1989).
Appendix B: Parents’ and teachers’ questionnaires
VANCOUVER ISLAND PREGNANCY FOLLOW-UP STUDY

Parent questionnaire

We would like to ensure you that your responses to this questionnaire will be kept strictly confidential and used only for statistical purposes. Your participation is voluntary. You may refuse to answer all or any of the questions in this questionnaire.

Researchers:
Anne George, Institute of Health Promotion Research, U.B.C. Phone 604-822-1879
Dr. R.W. Armstrong, Children’s & Women’s Health Centre of B.C.
Dr. L.W. Green, Institute of Health Promotion Research, U.B.C.

University of British Columbia
1999
Questionnaire for mother, or other primary caregiver

A. Child’s background

1. Child’s age ______

2. Child’s birth date: ______ (day) ______ (month) 19______ (year)

3. Sex: □ Male □ Female

4. What is your relationship with child:
   □ Birth mother → go to question 6.
   □ Adoptive mother
   □ Foster mother
   □ Stepmother
   □ Birth father
   □ Adoptive father
   □ Foster father
   □ Step father
   □ Other: please specify _____________________________________________

5. Are you a primary caregiver of the child? □ Yes □ No

6. What is your marital status?
   □ Single (never married)
   □ Married
   □ Separated
   □ Divorced
   □ Common-law
   □ Widowed

7. Has anyone other than you alone, or you and the child’s father, been the main caregivers of
   this child for long periods of time since her/his birth?
   □ Yes □ No → go to question 11.

   Who? ____________________________________________________________
   When? (How old was the child?) ______________________________________

8. Did you live with this child when he/she was born?
   □ Yes → go to question 11. □ No
9. At what age did he/she start living with you full-time? _____ years and ____ months

10. What was the reason this child did not live with you from birth?
   - [ ] You adopted her/him
   - [ ] She/he is a stepchild
   - [ ] She/he was put in your care by a child welfare agency (foster care)
   - [ ] She/he was put in your care by another type of agency
   - [ ] She/he was sick and had to remain in a hospital or other institution
   - [ ] You had to leave her/him in the care of someone else for a while, before you could take charge of her/him
   - [ ] Other

11. During her/his lifetime, how long has this child lived with any of the following adults:
   - [ ] Birth mother and father together? ________
   - [ ] Birth mother alone? ________
   - [ ] Birth father alone? ________
   - [ ] Birth mother and other? ________
   - [ ] Birth father and other? ________
   - [ ] Other relatives, but not birth mother or father? ________
   - [ ] Other relatives, as well as the mother or father? ________
   - [ ] Foster parents? ________
   - [ ] Adoptive parents? ________
   - [ ] Shared parenting arrangement? (specify) ________ length of time ________
   - [ ] Other? (specify) ________ length of time ________
   - [ ] Other? (specify) ________ length of time ________

12. Other than yourself, who else lived with this child when he/she was born (e.g., father, sisters and brothers, aunts)?

   __________  __________  __________  __________

13. Other than yourself, who else lives with this child now (e.g., father, sisters & brothers, aunts)?

   __________  __________  __________  __________

14. What ages are each his or her brothers and sisters?
   - Brothers: ages ______  ______  ______  ______  ______
   - Step-brothers: ages ______  ______  ______  ______  ______
   - Sisters: ages ______  ______  ______  ______  ______
   - Step-sisters: ages ______  ______  ______  ______  ______
15. (a) Does this child have any brothers or sisters who do not regularly live in this household, excluding step brothers and sisters?

☐ Yes  ☐ No → go to question 16.

(b) How many? ______

(c) What are their ages? ______  ______  ______

(d) Where do they live, or who do they live with? ______  ______  ______

16. What is your current living situation?

☐ Single family residence (alone, or with spouse or partner)
☐ Shared residence, with friends
☐ Shared residence, with parents
☐ Shared residence, with other relatives
☐ Shared residence, other ______________________________________

17. Returning to work or school after your child's birth.

(a) Do you work outside the home or go to school now?

☐ Yes, I work → number of hours a week ______
☐ Yes, I go to school → number of hours a week ______
☐ No, I do not work outside the home or go to school → go to question 19.

(b) After the birth of this child, how long did you stay at home before returning to work outside the home or school?

☐ Not applicable, I was not his/her parent at time of birth → go to question 19.
 or ________ months after child was born

(c) When you started to work or go to school after your child's birth, how many hours a week did you usually work? ________________________________

(d) Please describe what type of child care arrangements you have had over the years for this child while working or going to school.

______________________________

______________________________

18. What is your job or occupation? ________________________________

19. If not presently employed, what was your last occupation or job? ________________________________
20. Does your husband/partner work outside the home?  □ Yes  □ No

*Father's occupation:*
(a) What is the occupation or job of your child’s *birth father*? (If not employed, what was his last occupation or job?) ____________________________

(b) What is the occupation or job of your child’s *adopted father*, that is the father he or she lives with now? (If not employed, what was his last occupation or job?) ____________________________

□ Not applicable → child lives with her/his birth father.

21. Thinking of your total family income, from which of the following sources did your household receive any income in the past 12 months? *Tick all that apply.*

□ Wages or salaries
□ Income from self-employment
□ Dividends and interest (e.g., on bonds, deposits, etc.)
□ Unemployment insurance (EI, UI)
□ Workers’ Compensation
□ Benefits from Canada or other government pension plan
□ Retirement pensions, superannuation and annuities
□ Old age security and guaranteed income supplement
□ Band council or other aboriginal benefits
□ Child tax benefit
□ G.S.T. rebate
□ Social assistance or welfare
□ Child support
□ Alimony
□ Retraining program
□ Disability pension (e.g., GAIN)
□ Other (e.g., other government, rental income, scholarship, student loans)
□ None

22. From the list in question 22 above, which is your main source of income? ________________

23. What is your total household income before taxes and deductions?

□ less than $10,000 per year
□ $10,000 - $14,999
□ $15,000 - $19,999
□ $20,000 - $29,999
□ $30,000 - $39,000
□ $40,000 - $49,000
□ $50,000 - $59,000
□ $60,000 - $69,000
□ $70,000 - $70,000
□ over $80,000
24. Since your child was born (our last interview with you), have you gone back to school?  
- Yes  - No  → go to question 26.

Which school or program?  
How long was the program?

25. What is the highest level of schooling your child’s parents have completed?

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Birth Mother</th>
<th>Birth Father</th>
<th>Adopted Mother</th>
<th>Adopted Father</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 9 or less</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Between grades 10 and 12</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>High school graduate</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Some trade, technical or vocational school or business college</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Some community college, or nursing school</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Some university</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Diploma or certificate from trade, technical or vocational school or business college</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Diploma or certificate from community college, or nursing school</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Bachelor or undergraduate degree or teacher’s college (e.g., B.A., B.Sc., B.A.Sc., B.Ed.)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Master’s (e.g., M.A., M.Sc., M.Ed.)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Degree in Medicine, Dentistry, Veterinary Medicine, Optometry or Law</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Earned doctorate (e.g., Ph.D., D.Sc., D.Ed.)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Don’t know</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
B. Child's health and family health.

26. Rating child's health:
   (a) In general, how would you rate your child's health compared to others of the same age?

   [ ] Excellent  [ ] Very good  [ ] Good  [ ] Fair  [ ] Poor

   (b) What are your reasons for this rating?

27. Rating your own health:
   (a) In general, compared to other people your age, how would you rate your own health?

   [ ] Excellent  [ ] Very good  [ ] Good  [ ] Fair  [ ] Poor

   (b) What are your reasons for this rating?

28. Rating health of brothers and sisters:
   In general, how would you rate the health of other children in your family compared to most other children's health? (Please do not include foster children.)

   [ ] Not applicable - no other children in family → go to question 30.

   (a) Oldest brother or sister:

   [ ] Excellent  [ ] Very good  [ ] Good  [ ] Fair  [ ] Poor

   (b) What are the reasons for this rating?

   (c) Youngest brother or sister:

   [ ] Excellent  [ ] Very good  [ ] Good  [ ] Fair  [ ] Poor

   (d) What are the reasons for this rating?
29. Over the past few months, how often has your child been in good health?

☐ Almost all the time
☐ Often
☐ About half the time
☐ Sometimes
☐ Almost never

30. In your opinion how **physically active** is your child compared to other children of the same age and sex?

☐ Much more
☐ Moderately more
☐ Equally
☐ Moderately less
☐ Much less

31. In your opinion how much more **sleep** does your child seem to need compared to other children of the same age and sex?

☐ Much more
☐ Moderately more
☐ Equally
☐ Moderately less
☐ Much less

32. Please describe any **health problems** your child has now, or has had in the past?

________________________________________________________________________

________________________________________________________________________

33. Has your child had any **major illnesses** since birth?

☐ Yes  ☐ No → go to question 35.

Details
________________________________________________________________________

________________________________________________________________________

34. **Hospitalization:**

(a) Since birth, how many times has your child been in the hospital?

______________ (if 0, go to question 37.)

(b) During the past **12 months**, was your child ever been an overnight patient in a hospital?

☐ Yes  ☐ No → go to question 36.

(c) For what reason?

☐ Respiratory illness or disease
☐ Gastrointestinal illness or disease
☐ Injuries
☐ Other (specify)________________________

344
35. Other than during the past 12 months, has your child been in the hospital since birth?
- Yes
- No → go to question 37.

Details (what was the reason; how long, how old was your child at the time?)

36. In the past year, how many times have you seen or talked on the telephone with any of the following about your child's physical, emotional or mental health?

A general practitioner? .............................................. (number of times)
A pediatrician? ......................................................... (number of times)
Another medical doctor? .............................................. (number of times)
A public health nurse or nurse practitioner? .................... (number of times)
A dentist or orthodontist? ............................................ (number of times)
A psychiatrist or psychologist? ..................................... (number of times)
A social worker? .......................................................... (number of times)
Child welfare worker or children's aid worker? ................. (number of times)
Any other person trained to provide treatment or counsel, e.g., a speech therapist, or a social worker? .... (number of times)

37. Does he/she take any of the following prescribed medications on a regular basis:
- Ventolin, inhalers or puffers for asthma?
- Ritalin?
- Tranquilizers or nerve pills?
- Anti-convulsants or anti-epileptic pills?
- Other (specify) ............................................................

38. Has your child ever experienced any event or situation that has caused him/her a great amount of worry or unhappiness?
- Yes
- No → go to question 40.

What event or situation?

39. **Sight:** Does your child wear glasses or contact lenses?
- No
- Yes → At what age did she/he start wearing them? __________

40. **Hearing:** Does your child have a hearing problem?
- No
- Yes → Details
41. **Speech:** Is your child usually understood when speaking with others?
   - Yes  
   - No  
   - Details

42. **Mobility:** Is your child usually able to walk without difficulty and without mechanical support such as braces, a cane or crutches?
   - Yes  
   - No  
   - Details

43. **Hands and fingers:**
   (a) Is your child usually able to grasp and handle small objects such as a pencil or scissors?
   - Yes  
   - No  
   - Details

   (b) Does he/she require the help of another person because of limitations in the use of hands or fingers?
   - Yes  
   - No  
   - go to question 45.

   (c) Does he/she require the help of another person with:
      - Some tasks?
      - Most tasks?
      - Almost all tasks?
      - All tasks?

44. **Feelings:** Would you describe your child as being usually:
   - Happy and interested in life?
   - Somewhat happy?
   - Somewhat unhappy?
   - Unhappy with little interest in life?
   - So unhappy that life is not worthwhile?

45. **Memory:** How would you describe his/her usual ability to remember things? Is he/she:
   - Able to remember most things?
   - Somewhat forgetful?
   - Very forgetful?
   - Unable to remember anything at all?

46. **Thinking:** How would you describe his/her usual ability to think and solve day-to-day problems? Is he/she:
   - Able to think clearly and solve problems?
   - Having a little difficulty?
   - Having some difficulty?
   - Having a great deal of difficulty?
   - Unable to think or solve problems?
47. **Pain and Discomfort:**
   (a) Is your child usually free of pain or discomfort?
      - No  - Yes → go to question 49.
   (b) How would you describe the usual intensity of his/her pain or discomfort?
      - Mild?  - Moderate?  - Severe?
   (c) How many activities is your child prevented from doing because of his/her pain or discomfort?
      - None?  - A few?  - Some?  - Most?

48. **Injuries:** The following questions refer to injuries, such as a broken bone, bad cut or burn, head injury, poisoning, or a sprained ankle, which were serious enough to require medical attention by a doctor, nurse, or dentist.
   (a) Has your child had any serious injuries?
      - Yes  - No → go to question 50.
   (b) How many times was he/she injured? _____ times
   (c) For the most serious injury, what type of injury did he/she have?
      - Broken or fractured bones
      - Burn or scald
      - Dislocation
      - Sprain or strain
      - Cut, scrape or bruise
      - Concussion → go to question 50
      - Poisoning by substance or liquid → go to question 50
      - Internal injury → go to question 50
      - Dental injury → go to question 50
      - Other
      - Multiple injuries
(d) What part of his/her body was injured?

☐ Eyes
☐ Face or scalp (excluding eyes)
☐ Head or neck (excluding eyes and face or scalp)
☐ Arms or hands
☐ Legs or feet
☐ Back or spine
☐ Trunk (excluding back or spine) (including chest, internal organs, etc.)
☐ Shoulder
☐ Hip
☐ Multiple sites
☐ Other (specify) ________________________________

(e) What happened? For example, was the injury the result of a fall, motor vehicle collision, etc.?

☐ Motor vehicle collision-pedestrian
☐ Motor vehicle collision-riding bicycle
☐ Other bicycle accident
☐ Fall (excluding bicycle or sports)
☐ Scalded by hot liquids or food
☐ Accidental poisoning
☐ Self-inflicted poisoning, or other intentionally self-inflicted injuries
☐ Natural/environmental factors (for example, animal bite, sting)
☐ Fire/flames or fumes
☐ Near drowning
☐ Other ________________________________

(f) Where did the injury happen? For example at home, on the street, in a playground, at school?

☐ Inside respondent’s own home/apartment
☐ Outside respondent’s home, apartment, including yard, driveway, parking lot or in shared areas related to home such as apartment hallway or laundry room
☐ In or around other private residence
☐ Inside school/daycare centre or on school/centre grounds
☐ At an indoor or outdoor sports facility (other than school)
☐ Other building used by general public
☐ On sidewalk/street/highway in respondents’s neighbourhood
☐ On any other sidewalk/street/highway
☐ In a playground/park other than school
☐ Other ________________________________

348
49. 
**Asthma:**
(a) Has your child ever had asthma that was diagnosed by a health professional?
☐ Yes ☐ No → go to question 51.

(b) Does this condition or health problem prevent or limit his/her participation in school, at play or any other activity normal for a child his/her age?
☐ Yes ☐ No

Asthma (continued)
(c) Has he/she had an attack of asthma in the last 12 months?
☐ Yes ☐ No

(d) Has he/she had wheezing or whistling in the chest at any time in the last 12 months?
☐ Yes ☐ No

50. **Long-term conditions:** In the following questions, long-term conditions refer to conditions that have lasted or are expected to last 6 months or more.

Does your child have any of the following condition?
☐ Allergies?
☐ Bronchitis?
☐ Heart condition or disease?
☐ Epilepsy?
☐ Cerebral palsy?
☐ Kidney condition or disease?
☐ Mental handicap?
☐ Learning disability?
☐ Emotional, psychological or nervous difficulties?
☐ Any other long-term condition?
☐ (Please specify) ___________________________

51. **Food:** What did your child eat yesterday?

Breakfast: _______ _______ _______ _______ _______ _______

Lunch: _______ _______ _______ _______ _______ _______

Dinner: _______ _______ _______ _______ _______ _______

Snacks, etc. _______ _______ _______ _______ _______ _______
52. Weight and height:

(a) Height of child (approximately)?
   Weight of child (approximately)?
   □ don’t know
(b) Height of child’s birth mother?
   Weight of child’s birth mother?
   □ don’t know
(c) Height of child’s birth father?
   Weight of child’s birth father?
   □ don’t know

C. Environment

If you are not the birth mother, please skip to question 57.

53. Did you suffer from any health problems after your child’s birth?
   □ Yes    □ No → go to question 55.
   ↓
   What problems?
   ________________________________
   For how long? ______ days or ______ months or ______ year

54. After your child’s delivery, did you suffer from postpartum depression?
   □ Yes    □ No → go to question 56.
   ↓
   For how long? ______ days or ______ months or ______ year

55. Did you breast-feed even if only for a short time with your child?
   □ Yes    □ No → go to question 57.
   ↓
   For how long?
   □ less than 1 week
   □ 1-4 weeks
   □ 5-8 weeks
   □ 9-12 weeks
   □ 3-6 months
   □ 7-9 months
   □ 10-12 months
   □ 13-16 months
   □ more than 16 months
56. **Smoking:** Do you smoke cigarettes?
   - ☐ No, I never smoked cigarettes except for a few puffs → go to question 62.
   - ☐ No, I used to smoke but I quit → go to question 58.
   - ☐ Yes, I do smoke cigarettes → go to question 59.

57. (a) When did you quit? __________________________

   (b) Before you quit, how often did you smoke? __________

   (c) Before you quit, how many cigarettes did you smoke per day? ________

58. How often do you smoke?
   - ☐ Every day
   - ☐ Most days
   - ☐ Few times a week
   - ☐ Few times a month

59. On the days that you smoke, approximately how many cigarettes do you have? ________

60. Do you smoke in the house? ☐ Yes ☐ No

61. Does anyone else who lives in the house smoke? ☐ Yes ☐ No

62. Approximately how many times a day is your child exposed to second-hand smoke from people smoking in your house or elsewhere indoors? This means spending at least 10 minutes in a room or an enclosed area where someone is smoking. ________ (times)

63. Do you ever drink alcohol?
   - ☐ Yes → go to question 65.
   - ☐ No, I used to drink alcohol, but have quit now → go to question 67.
   - ☐ No, I have never had alcohol, except for a few sips → go to question 71.

64. On average, how often do you drink alcohol (e.g., every day, once a week or month)?
    ______________________

65. **Alcohol quantity?** For each day last week, how many drinks did you have?
   
   Monday _____ Tuesday _____ Wednesday _____ Thursday _____
   
   Friday _____ Saturday _____ Sunday _____

66. Have you ever felt you should cut down on your drinking? ☐ Yes ☐ No
67. Have people annoyed you by criticizing your drinking? □ Yes □ No

68. Have you ever felt bad or guilty about your drinking? □ Yes □ No

69. Have you ever had a drink first thing in the morning to steady your nerves or get rid of a hangover? □ Yes □ No

70. On average, how often does your child's father drink alcohol (each day or week or month)? □ don't know

If you are not the birth mother, skip to question 74.

71. Prenatal classes:
Did you attend prenatal classes during any of your pregnancies?
□ No → go to question 73.
□ Not applicable, I had no other pregnancies → go to question 73.
□ Yes

Which children? (Tick all that apply.)
□ During the pregnancy with this child.
□ For one of your children born earlier than this child.
□ For one of your children born later than this child.

72. Did you attend any other programs or regular classes, such as Pregnancy Outreach Programs, at the time of your pregnancy with your child?
□ Yes □ No → go to question 74.

Which programs?
□ Pregnancy Outreach Program
□ Other (specify) ____________________________
□ Other (specify) ____________________________
□ Other (specify) ____________________________
□ Other (specify) ____________________________

73. When your child was young, did you attend any parenting groups, such as Nobody's Perfect, or groups at a local health or women's centre or friendship centre?
□ Yes □ No → go to question 75.

Which programs did you attend?
74. Since your child was born, did he/she attend any programs, such as Infant Development Programs or special early childhood programs which were recommended to you because of any special problems or needs he/she had?
   - Yes ☐ No ☐ go to question 76.

Which programs?
   - Infant Development Program
   - Other (specify) ________________________________
   - Other (specify) ________________________________
   - Other (specify) ________________________________
   - Other (specify) ________________________________

D. Child's Education.

75. What type of school is your child currently in?
   - Public school?
   - Catholic school, publicly funded?
   - Private school?
   - Not in school - child taught at home (home-schooling)
   - Not in school - child is in an institution
   - Other (specify) __________________________________

76. What grade is your child in? ________________________________

77. Did he/she attend kindergarten? ☐ Yes ☐ No

78. Preschool or playschool:
   (a) Did he/she attend playschool or preschool prior to kindergarten?
      - Yes ☐ No ☐ go to question 80.
   (b) For how long: from age _____ to age _____ (or _____ months or _____ years)
   (c) What type of school was it? ________________________________

353
79. **Repeating grade:** Since beginning school, has your child repeated a grade?
   - □ Yes   □ No → go to question 81.

   What grade(s) has he/she repeated? ________________

80. **Skipping grade:** Since beginning school, has your child skipped a grade?
   - □ Yes   □ No → go to question 82.

   What grade(s) has he/she skipped? ________________

81. Are there any subjects at school which seem to cause him/her more difficulty? For instance, does he struggle with some subjects, or need extra help with homework?
   - □ Yes   □ No → go to question 83.

   Which subjects cause difficulty?
   □ Reading
   □ Arithmetic
   □ Spelling
   □ Writing
   □ Other (specify) ________________________________

82. Has your child been referred to any special education programs (including challenge programs), learning assistance, or other special services (e.g., speech therapy)?
   - □ Yes   □ No → go to question 84.

   Which ones? ________________________________

83. **Changes in schools:**
   How many times has he/she changed schools since starting school? ___ times (if 0, go to question 85.)

   What was the reason for changing (If changed more than once, put number beside each response according to number of times that response is applicable.)
   □ Family or child moved
   □ Child not progressing well
   □ Child not getting along well with others
   □ Concerns about standards and quality of teaching at the school
   □ Wanted a specific program
   □ Other (specify) ________________________________

84. Aside from school changes, how many times in your child’s life has he/she moved, that is, changed his/her usual place of residence? ________ times
85. Since your child started school, do you think that he/she has had any emotional or
behavioural problems?

☐ Yes ☐ No → go to question 87.

What kinds of problems? __________________________________________________________

86. Does your child have any learning disabilities?

☐ Yes ☐ No → go to question 88.

Please describe? _________________________________________________________________

87. Does any one else in the family have learning disabilities?

☐ Mother
☐ Father
☐ Brothers or sisters

Learning disability

E. Child’s Activities.

88. What activities does your child do outside of school hours, and how often does he/she do
these activities?

☐ Take part in organized sports? ____________________________ How many hours per week?

☐ Watch T.V. or videos? ____________________________

☐ Play video or computer games? ____________________________

☐ Go to day-care? ____________________________

☐ Read or be read to? ____________________________

☐ Play alone? ____________________________

☐ Play with friends? ____________________________

☐ Play with brothers/sisters? ____________________________

☐ Go to clubs or groups (e.g., Scouts, Brownies, Boys
& Girls club, Neighbourhood house, church groups) ____________________________

☐ Music or dance classes ____________________________

☐ Attend arts or crafts groups or lessons ____________________________

☐ Homework or tutoring for school ____________________________

☐ Activities at Friendship Centre ____________________________
89. Are there any other activities that your child likes to do which we did not mention in the last question?

Approximately how many hours per week? _____

Approximately how many hours per week? _____

90. About how many days a week does he/she do things with friends, outside of school?

- Never
- 1 day a week
- 2-3 days a week
- 4-5 days a week
- 6-7 days a week

91. During the past 6 months, how well has your child been getting along with other kids, such as friends or classmates (excluding brothers or sisters)?

- Very well, no problems
- Quite well, hardly any problems
- Pretty well, occasional problems
- Not too well, frequent problems
- Not well at all, constant problems
- Not applicable

92. During the past 6 months, how well has your child been getting along with his/her brother(s) or sister(s)?

- Very well, no problems
- Quite well, hardly any problems
- Pretty well, occasional problems
- Not too well, frequent problems
- Not well at all, constant problems
- Not applicable

93. Does your child have aunts, uncles, other relatives or other adults in his/her life who are really interested in how well he/she is doing?

- Yes
- No → go to question 95.

Who? ____________________________________________

94. Do you have other adults, such as your spouse, friends, relatives, or social workers who you
could call on for support if you are having difficulty in parenting because of your child’s behaviour?

☐ Yes  ☐ No  → go to question 96.

Who (use initials) ____________________________  ____________________________  ____________________________  ____________________________

95. How satisfied are you with the level of support in parenting which you get from these people/this person?

☐ Very satisfied  ☐ Fairly satisfied  ☐ A little satisfied  ☐ A little dissatisfied  ☐ Fairly dissatisfied  ☐ Very dissatisfied
96. Using the answers *never or not true, sometimes or somewhat true, or often or very true*, how often would you say that your child shows any of the following characteristics:

<table>
<thead>
<tr>
<th></th>
<th>Never or not true</th>
<th>Sometimes or somewhat true</th>
<th>Often or very true</th>
<th>don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Shows sympathy to someone who has made a mistake?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Can't sit still, is restless, or hyperactive?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Destroys his/her own things?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Will try to help someone who has been hurt?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Steals at home?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Seems to be unhappy, sad or depressed?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Gets into many fights?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Volunteers to help clear up a mess someone else has made?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Is distractible, has trouble sticking to any activity?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. When mad at someone, tries to get others to dislike that person?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Is not as happy as other children?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Destroys things belonging to his/her family, or other children?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. If there is a quarrel or dispute, will try to stop it?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Fidgets?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Is disobedient at school?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Can't concentrate, can't pay attention for long?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Is too fearful or anxious?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. When mad at someone, becomes friends with another as revenge?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Is impulsive, acts without thinking?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Tells lies or cheats?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>21.</td>
<td>Offers to help other children (friend, brother or sister who are having difficulty with a task?)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Is worried?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Has difficulty awaiting turn in games or groups?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td>When another child accidentally hurts him/her (such as bumping into him/her), assumes that the other child meant to do it, and then reacts with anger and fighting?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.</td>
<td>Tends to do things on his/her own - is rather solitary?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.</td>
<td>When mad at someone, says bad things behind the other’s back?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td>Physically attacks people?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.</td>
<td>Comforts a child (friend, brother, or sister) who is crying or upset?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.</td>
<td>Cries a lot?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.</td>
<td>Vandalizes?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31.</td>
<td>Gives up easily?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32.</td>
<td>Threatens people?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33.</td>
<td>Spontaneously helps to pick up objects which another child has dropped (e.g., pencils, books, etc.)?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34.</td>
<td>Cannot settle to anything for more than a few moments?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.</td>
<td>Appears miserable, unhappy, tearful, or distressed?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36.</td>
<td>Is cruel, bullies or is mean to others?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37.</td>
<td>Stares into space?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38.</td>
<td>When mad at someone, says to others: let’s not be with him/her?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39.</td>
<td>Is nervous, high-strung or tense?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40.</td>
<td>Kicks, bites, hits other children?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41.</td>
<td>Will invite bystanders to join in a game?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42.</td>
<td>Steals outside the home?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43.</td>
<td>Is inattentive?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44.</td>
<td>Has trouble enjoying him/herself?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>45. Helps other children (friends, brother or sister) who are feeling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sick?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46. When mad at someone, tells the other one’s secrets to a third</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>person?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47. Takes the opportunity to praise the work of less able children?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank you very much for helping with this research.
TEACHER'S QUESTIONNAIRE

VANCOUVER ISLAND
PREGNANCY
FOLLOW-UP STUDY

Researchers:
Anne George, Institute of Health Promotion Research, U.B.C. Phone 822-1879
Dr. R.W. Armstrong, B.C. Children's & Women's Hospital, Vancouver
Dr. L.W. Green, Institute of Health Promotion Research, U.B.C.

University of British Columbia
1999

Questionnaire regarding (name of child) __________________________

TEACHER'S QUESTIONNAIRE

361
1. How long have you known this child? ________________________________

2. Are you his or her full-time teacher?
   □ No  □ Yes ➔ go to question 3

   Approximately how many hours do you see him/her each week? ________

3. Since she/he started school in the fall, about how many days has he/she been away from school for any reasons?
   □ 0 days
   □ 1 to 3 days
   □ 4 to 6 days
   □ 7 to 10 days
   □ 11 to 20 days
   □ more than 20 days

4. In comparison to other children you have observed in this school context, please rate this child’s overall ability to learn school materials. Use the 7 point scale below. Please circle one number between 1 and 7.

   below average  above average

<table>
<thead>
<tr>
<th>lowest 5%</th>
<th>10%</th>
<th>20%</th>
<th>middle 30%</th>
<th>20%</th>
<th>10%</th>
<th>highest 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

5. In your opinion, how physically active is he/she compared to other children the same age and sex?
   □ Much more
   □ Moderately more
   □ Equally
   □ Moderately less
   □ Much less
   □ Don’t know
6. In your opinion, how often does this child have behavioural problems compared to other children the same age and sex?

- [ ] Much more
- [ ] Moderately more
- [ ] Equally
- [ ] Moderately less
- [ ] Much less
- [ ] Don’t know

7. Compared to other children of the same age as this child, how does she or he currently rate in each of the following abilities? Please circle the appropriate number.

<table>
<thead>
<tr>
<th>Subject or skill</th>
<th>above average</th>
<th>average range</th>
<th>slightly below average</th>
<th>very low</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. pre-reading, reading, language skills</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>b. numbers, arithmetic, math skills</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>c. movement, physical education, sports abilities</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>d. citizenship, social interaction</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>e. school, academic motivation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

8. Using the answers never or not true, sometimes or somewhat true, or often or very true, how often would you say that this child shows any of the following characteristics:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>never or not true</th>
<th>sometimes or somewhat true</th>
<th>often or very true</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Shows sympathy to someone who has made a mistake</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>2. Can’t sit still, is restless, or hyperactive</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>3. Destroys his/her own things</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>4. Will try to help someone who has been hurt</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>5. Steals</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>6. Seems to be unhappy, sad or depressed</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>7. Gets into many fights</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>8. Volunteers to help clear up a mess someone else has made</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>9.</td>
<td>Is distractible, has trouble sticking to any activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>When mad at someone, tries to get others to dislike that person</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Is not as happy as other children</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Destroys things belonging to his/her family, or other children</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>If there is a quarrel or dispute, will try to stop it</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Fidgets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Is disobedient at school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Can't concentrate, can't pay attention for long</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Is too fearful or anxious</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>When mad at someone, becomes friends with another as revenge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Is impulsive, acts without thinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Tells lies or cheats</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>Offers to help other children (friend, brother or sister) who are having difficulty with a task</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Is worried</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Has difficulty awaiting turn in games or groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td>When another child accidentally hurts him/her (such as bumping into him/her), assumes that the other child meant to do it, and then reacts with anger and fighting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.</td>
<td>Tends to do things on his/her own - is rather solitary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.</td>
<td>When mad at someone, says bad things behind the other's back</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td>Physically attacks people</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.</td>
<td>Comforts a child (friend, brother, or sister) who is crying or upset</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.</td>
<td>Cries a lot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.</td>
<td>Vandalizes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31.</td>
<td>Gives up easily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32.</td>
<td>Threatens people</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>33. Spontaneously helps to pick up objects which another child has dropped (e.g., pencils, books, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34. Cannot settle to anything for more than a few moments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35. Appears miserable, unhappy, tearful, or distressed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36. Is cruel, bullies or is mean to others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37. Stares into space</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38. When mad at someone, says to others: let’s not be with him/her</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39. Is nervous, high-strung or tense</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40. Kicks, bites, hits other children</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41. Will invite bystanders to join in a game</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42. Is inattentive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43. Has trouble enjoying him/herself</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44. Helps other children (friends, brother or sister) who are feeling sick</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45. When mad at someone, tells the other one’s secrets to a third person</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46. Takes the opportunity to praise the work of less able children</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank you for your assistance with this research.