# THE SCHOOL READINESS OF CHILDREN BORN TO MOTHERS MAINTAINED ON METHADONE DURING PREGNANCY

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN PSYCHOLOGY

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# ABSTRACT

*Introduction.* Research from the early 1980s indicates that there are different neurodevelopmental differences between methadone-exposed and non-exposed infants. However, the extent to which these difficulties translate to later problems in the domain areas of physical health, social-emotional adjustment, approaches to learning, language, and cognition for children born to mothers maintained on methadone during pregnancy, is largely unknown. Accordingly, this research aimed to compare school readiness outcomes between children prenatally exposed to methadone and comparison children at age 4.5 years across five key developmental domains. A secondary aim was to assess the impact of known neonatal, and socio-familial risk factors associated with this population on school readiness outcomes of methadone-exposed children at age 4.5 years.

*Research Methods.* Sixty seven children born to mothers maintained on methadone and 81 comparison children were followed prospectively from birth to age 4.5 years. At age 4.5 years, all children underwent a comprehensive school readiness assessment of health and physical development; social-emotional skills; approaches to learning; language; and cognition. A score < 1SD below the comparison group mean was used to classify children as unready in any one domain. Measures of socio-familial risk were collated from aspects of the maternal interview at the term assessments, based on risk indices used in the research of other at-risk populations.

*Results.* Methadone-exposed children performed worse than comparison children across all school readiness domains. They also had higher odds of being classed as “unready” in each school readiness domain, relative to the control group. They were also more likely to have multiple readiness problems ($p$ =<.0001). The most common pattern of comorbidity identified, was among children classified as unready in terms of cognition and general knowledge. However, after controlling for confounding and selection factors, methadone-exposure was not significantly associated with school readiness at age 4.5 years. Maternal smoking during pregnancy, maternal benzodiazepine use during pregnancy, and socio-familial risk were significant covariates of low school readiness at age 4.5 years, independent of group.

*Discussion.* By age 4.5 years, a larger proportion of methadone-exposed than control children were experiencing school readiness difficulties across five key developmental domains. Prenatal methadone exposure alone was not a sufficient explanation for these problems. Findings suggest that readiness outcomes were largely explained by a range of confounding and selection factors, including the extent of socio-familial risk, and poly-drug use during pregnancy. The results raise concerns for the later school performance of methadone-exposed children and emphasise the importance of early and targeted intervention services prior to school entry for this population.

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# ABBREVIATIONS

| | |
|---|---|
| MMT | Methadone Maintenance Treatment |
| NAS | Neonatal Abstinence Syndrome |
| CNS | Central Nervous System |
| BSID | Bayley Scales of Infant Development |
| MDI | Mental Development Index |
| PDI | Psychomotor Development Index |
| ME | Methadone-Exposed |
| IBR | Infant Behaviour Record |
| SBIS | Stanford Binet Intelligence Scale |
| GCI | General Cognitive Index |
| KABC | Kaufman Assessment Battery for Children |
| VSMS | Vineland Social Maturity Scale |
| SES | Socio-Economic Status |
| Beery-VMI | Beery Buktenia Developmental Test of Visual-Motor Integration |
| SDQ | Strengths and Difficulties Questionnaire |
| PKRS-II | Phelps Kindergarten Readiness Scale II |
| CELF-P | Clinical Evaluation of Language Fundamentals – Preschool. |
| WPPSI-R | Wechsler Preschool and Primary Intelligence Scales – Revised. |
| OR | Odds ratio |
| CI | Confidence Interval |

# 1 INTRODUCTION

Opioid dependence in New Zealand has become a significant problem, with around 10,000 adults using opiates almost daily (Adamson et al., 2012). Living with an opioid-dependent parent may have a negative impact on a child's development, due to the health and social harms associated with illegal drug use (Ministry of Health, 2007). Whilst opioid substitution treatment options in New Zealand are well-established, as many as half of the opioid-dependent adults in this country remain untreated (Adamson et al., 2012). This suggests that many children are possibly living with parents using both legal and illegal opiates. Knowing about the effect that parent drug use may have on child development is essential to aid the understanding of their developmental needs.

## *1.1 Methadone Maintenance Treatment*

After the cessation of World War II, heroin abuse in New York City intensified, leading to an increase from 7.2 per 10,000 to 35.8 per 10,000 fatalities due to intravenous heroin abuse within a decade. The majority of these deaths were of people between the ages of 15 and 35 years, making heroin injection the leading cause of death for young adults at that time (Joseph, Stancliff, & Langrod, 2000). Today, opiate-dependency is a universal problem, with the United Nations estimating a worldwide prevalence of opioid use as 0.4% of adults in 2007 (Adamson et al., 2012). The estimated prevalence of daily opioid dependency in adults aged 15–64 in New Zealand is 0.3%, with more estimated to use opiates irregularly (Adamson et al., 2012). It is of note however, that Christchurch has a higher proportion of opioid-dependent adults than other New Zealand regions. The South Island also has an opioid overdose death rate that is three times that of the North Island

(Adamson et al., 2012). To decrease the prevalence of heroin abuse, and reduce the risks associated with the drug-addiction lifestyle and culture, methadone was introduced in the 1960's as a drug treatment for illicit opiate dependency (K. Johnson, Gerada, & Greenough, 2003; Joseph et al., 2000; Vucinovic et al., 2008). Methadone is a synthetic, long-acting opioid that is useful in the treatment of heroin addiction because of its longer half-life. This allows patients to have relief from drug cravings and thereby reduce their drug-seeking behaviour (Cleary et al., 2010). Methadone maintenance treatment (MMT) lets patients develop tolerance to the euphoric and analgesic effects of methadone, and block the effects of heroin, preventing impaired everyday functioning (Dole, 1988). Methadone maintenance is also the only treatment available for opiate dependence in New Zealand. It was recently estimated that almost 5000 individuals in New Zealand were enrolled in methadone maintenance treatment for opiate addiction (Deering et al., 2011). Worldwide, there are about 1 million individuals enrolled in MMT (Kleber, 2008). Also in New Zealand and around the world, pregnant women seeking opiate-dependency treatment are encouraged to enrol in MMT (Huestis & Choo, 2002; Joseph et al., 2000).

### *1.1.1 Methadone Maintenance During Pregnancy*

Opiates are among the most common drugs of abuse during pregnancy, with an estimated prevalence ranging from 1–2% to 21% (Minozzi, Amato, Vecchi, & Davoli, 2008; Vucinovic et al., 2008). There is a risk that the effects of poor health and nutrition, as well as blood-borne viruses related to heroin use can be transferred to the developing foetus (Burns, Mattick, Lim, & Wallace, 2007). Due to the risks involved with continued heroin use during pregnancy, MMT has been the approved treatment for pregnant, heroin-addicted women since the 1970's (Huestis & Choo, 2002). While there are limited places and lengthy waiting lists on MMT programmes in this country, pregnant women are given priority in accessing MMT (Ministry of Health, 2008). In New Zealand, it is rare for pregnant opiate-dependent women to remain untreated, and these women are almost always enrolled in methadone maintenance treatment. Around 25–30 women who are enrolled in MMT give birth in Christchurch each year (Davie-Gray, 2011). As part of their course, pregnant women enrolled in MMT are typically provided access to specialist antenatal care, and more frequent check-ups compared to untreated pregnant women who continue to use illicit opiates (Cleary et al., 2010; Rosen & Johnson, 1982). For the health benefits of the mother and baby, careful monitoring of methadone dose is an important health care concern for medical staff. Other maternal benefits of MMT for opiate-dependency include closer monitoring from health professionals, less likelihood of relapse (K. Johnson et al., 2003), better nutrition, and lower likelihood of transmission of infectious diseases such as HIV and hepatitis (Joseph et al., 2000).

The benefits to the newborn of methadone as the preferred treatment for heroin-dependence during pregnancy have been acknowledged through several short term studies of exposed neonates and are reviewed in the following sections (pp. 4-5). Less well studied compared to the neonatal outcomes of MMT, is the neurodevelopmental outcome of infants, preschool children, and school-aged children that have had prenatal methadone exposure. A review of existing studies concerned with the developmental outcomes of children born to mothers maintained on methadone is provided below (pp. 5-19).

## *1.2 Neurodevelopmental Outcomes of Prenatal Methadone Exposure*

The advent of MMT for pregnant women has raised issues relating to the neurobehavioural outcomes of prenatal opiate exposure. To date, the perinatal and infant outcomes of prenatal methadone exposure have been studied reasonably well compared to the developmental outcomes of older children. Research examining the outcomes of preschool and school-aged children exposed prenatally to methadone is relatively sparse. The existing literature has been reviewed to acknowledge the effects of prenatal methadone exposure on the development of infants and children. Outcome studies of opiate-exposed children from birth to age 13 years will also be reviewed, to establish the importance of conducting further follow-up studies of this high risk group of children.

### *1.2.1 Neonatal Outcome Studies*

Studies of exposed neonates have shown that methadone use, compared to heroin, promotes a safer, less complicated pregnancy, with more maternal attendance at check-ups and antenatal care (Cleary et al., 2010). Other improvements for the neonate are also observed when the mother is enrolled in MMT, including higher birth weights than heroin-exposed infants (Hulse, Milne, English, & Holman, 1997). While heroin abuse during pregnancy exposes the developing foetus to fluctuations of intoxication followed by abstinence, methadone, because of its 24- to 36-hour half-life, does not induce these fluctuations, which allows for a more stable growing environment for the foetus (Huestis & Choo, 2002; Joseph et al., 2000). Methadone-exposed infants however, do still have a lower average birth weight compared to non-exposed infants (Kandall et al., 1976; Lifschitz, Wilson, Smith, & Desmond, 1985). It has also been found that compared to non-exposed infants, methadone-exposed infants at birth have a significantly smaller head circumference for their gestational age (Lifschitz et al., 1985). However through regression analysis in one study, head size was not found to be related to methadone exposure, but to birth weight and maternal nutritional status (Lifschitz et al., 1985).

Other studies of perinatal outcomes of methadone exposure have focused on the passive addiction of the foetus to the drug, and the extent of subsequent withdrawal the neonate experiences. Compared to the heroin-exposed foetus, the growth and health of the methadone-exposed foetus during pregnancy are better. However, compared to heroin-exposed infants, methadone-exposed infants are more likely to suffer a prolonged neonatal abstinence syndrome (NAS), (K. Johnson et al., 2003; Volpe, 2008). Neonatal abstinence syndrome consists of a disturbance of the central nervous system (CNS) characterised by tremors or jitteriness, hyperirritability, gastrointestinal dysfunction, high-pitched crying, poor feeding due to an uncoordinated sucking reflex, and respiratory distress among other autonomic symptoms (Huestis & Choo, 2002). A recent study revealed the increasing incidence of NAS among newborns, with the equivalent of one infant born per hour in the United States with signs of drug withdrawal (Patrick et al., 2012). Neonatal abstinence syndrome is able to be treated with the appropriate pharmacotherapy and can be managed within the first few weeks of life (Joseph et al., 2000). However, the cost of treating these infants has increased from $39,400 in the year 2000 to $53,4000 in 2009 (Patrick et al., 2012).

It is still not clear however, whether NAS duration or severity have any adverse effects on the children’s later developmental outcome (Kaltenbach & Finnegan, 1986). Such longer-term follow-up studies assessing the risks of prenatal exposure to methadone, with respect to later cognitive and behavioural development, are rare, and have not been conclusive. However the high number of methadone-exposed infants that experience NAS symptoms spurs the need to properly establish whether there are any long-term impacts of prenatal drug exposure for these infants.

### *1.2.2 Infant and Child Outcome Studies*

Areas of development that may be affected by prenatal drug exposure include physical and motor, cognitive, behavioural and social-emotional development. Physical development refers to body growth, and development of the brain and CNS (Papalia & Feldman, 2011). Motor development refers to innate motor abilities such as infant reflexes, and in older children, fine and gross motor skills such as turning a page or kicking a ball (Bukatko, 2008). Cognitive development includes mental processes involved in attention and memory, concept formation, and in problem solving. Behavioural development is encompassed by how children learn through the reinforcement or punishment of certain behaviours, shaping the way they act (Bukatko, 2008). Social-emotional development includes the infant's ability to form an attachment relationship with its caregiver and communicate through emotions, and later to regulate one's own emotions. This also includes the child's understanding of the "self" and other individuals and groups (Papalia & Feldman, 2011). A number of studies tracking the development of infants and older children exposed to methadone *in utero* have not addressed the effect of prenatal methadone on these different areas of development. Instead, most studies have focused primarily on children's general cognitive and motor development, using measures such as the Bayley Scales of Infant Development (Bayley, 1969). The Bayley Scales of Infant Development (BSID) is a standardised assessment, and contains subscales designed to measure infant mental and psychomotor abilities. The Mental Development Index (MDI) measures sensory discrimination and perception, the infant's knowledge of object constancy, their ability to think abstractly, and also assesses their memory, problem solving, early verbal communication, and early number concepts (Bayley, 1969). The Psychomotor Development Index (PDI) evaluates the infant's body control, and their fine and gross motor skills

(Bayley, 1969). In this early version of the BSID, each subscale assesses more than one area of infant development, making the BSID an assessment of an infant's general developmental status, potentially overlooking certain specific areas of development, such as social development. However, its use in early studies assessing children of methadone maintained women is prominent in the literature.

Studies of preschool children prenatally exposed to methadone are rare, and existing studies often combine the results of children that have been prenatally exposed to methadone or heroin, making the effects of methadone on development difficult to pinpoint. Studies that have reviewed the effect of prenatal methadone on child development are also often restricted to measuring general mental ability through the use of IQ tests or similar. Even more scarce is research examining the effect of prenatal methadone exposure on the development of school-aged children, with few longitudinal studies retaining their samples long enough for the children to reach school age. An overview of studies assessing the outcome of infants and children prenatally exposed to methadone is displayed in Table 1 (pp. 9-13).

*Physical Development of Methadone-Exposed Children.* Several early studies of methadone-exposed infants have compared the growth of these children to non-exposed control infants, mainly focussing on measures of height, weight, and head circumference (Hunt, Tzioumi, Collins, & Jeffery, 2008; H. L. Johnson, Glassman, Fiks, & Rosen, 1990; Lifschitz et al., 1985; Rosen & Johnson, 1982; Strauss, Starr, Ostrea, Chavez, & Stryker, 1976; Wilson, Desmond, & Wait, 1981). These studies provide mixed results about the physical development of infants that have been exposed to methadone in utero (see Table 1, p. 9-14). Firstly, the study by Strauss et al. (1976) measured methadone-exposed infant development in relation to a non-exposed comparison infants at ages 3, 6 and 12 months. Sixty methadone-exposed infants were enrolled in the study at birth, and the sample retention at 12 months was 42%. Strauss et al. did not find any significant differences between groups on head circumference. It was noted that there were no significant differences between methadone- and non-exposed infants on measures of height or weight, but there were trends for methadone-exposed infants to score below the 10$^{th}$ percentile on these measures.

Wilson et al., (1981) compared the development of 69 methadone-exposed infants to non-exposed infants at ages 1.5, 3, 6, 9 and 12 months. The study had a good retention rate of 93% of methadone-exposed infants to the 12 month follow-up. Similar to the study by Strauss et al. (1976), Wilson et al. noted that methadone-exposed infants tended to have lower weights and were shorter than non-exposed infants; however this difference did not reach significance. Wilson et al. also reported a significantly higher incidence of sleep disturbances and excessive crying by methadone-exposed infants compared to non-exposed infants.

Table 1

*Neurodevelopmental Outcomes of Infants and Children Prenatally Exposed to Methadone*

| Domain of Development Assessed | Author | Study Design | No. of ME Newborns Enrolled | Retention of Sample at Last Assessment | Age of Children at Follow Up | Measure(s) Used | ME Child Neurodevelopmental Status |
|---|---|---|---|---|---|---|---|
| **Physical** | Strauss et al. (1976) | Longitudinal | 60 | 25 (42%) | 3, 6, 12 months | Growth parameters | Height and weight were below the 10th percentile for a greater proportion of ME infants than controls. There were no differences in head circumference between groups. |
| | Wilson et al. (1981) | Longitudinal | 69 | 64 (93%) | 1.5, 3, 6, 9, 12 months | Physical and neurological exam of growth and health | No differences between ME infants and control infants in height or weight at 12 months of age. |
| | Rosen & Johnson (1982) | Longitudinal | 62 | 39 (63%) | 6, 12, 18 months | Physical and neurological exam of growth and health | Higher incidence of ME infants with a head circumference below the third percentile. More eye disorders, and significantly higher incidence of infection was present in the ME group. |
| | Hunt et al. (2008) | Case Control | 133 | 79 (59.4%) | 18 months, 3.2 years. | Growth parameters | No difference between ME and control infants on weight or head circumference at either age. ME infants were significantly shorter than controls at both ages assessed. |
| | Johnson et al. (1990) | Longitudinal | 62 | 39 (63%) | 3 years | Head circumference | Significantly more ME children had head circumferences below the 10th percentile. |

*Notes:* ME, Methadone-Exposed. Table continued over pages 10-14.

Table 1

*Neurodevelopmental Outcomes of Infants and Children Prenatally Exposed to Methadone Continued*

| Domain of Development Assessed | Author | Study Design | No. of ME Newborns Enrolled | Retention of Sample at Last Assessment | Age of Children at Follow Up | Measure(s) Used | ME Child Neurodevelopmental Status |
|---|---|---|---|---|---|---|---|
| **Physical cont.** | Lifschitz et al. (1985) | Longitudinal | 33 | 26 (79%) | 3.4 years | Growth parameters | No significant differences found between groups on height, weight or head circumference. |
| **Motor** | Strauss et al. (1976) | Longitudinal | 60 | 25 (42%) | 3, 6, 12 months | BSID | PDI scores within normal limits. PDI scores declined over time, becoming significantly lower than non-exposed control infants at age 12 months. |
| | Wilson et al.(1981) | Longitudinal | 69 | 64 (93%) | 9 months | BSID<br>IBR | PDI scores were within the normal range, but significantly lower than the non-exposed control infants. IBR showed fine motor coordination was significantly poorer than comparison infants. |
| | Rosen & Johnson (1982) | Longitudinal | 62 | 39 (63%) | 6, 12, 18 months | BSID | At age 6 months, PDI scores were normal, but lower than control infants. At ages 12 and 18 months, PDI scores significantly lower than control infants. Twenty percent of infants considered developmentally delayed. |

*Notes:* ME, Methadone-Exposed. BSID, Bayley Scales of Infant Development; IBR, Infant Behaviour Record. Table continued over pages 11-14.

Table 1

*Neurodevelopmental Outcomes of Infants and Children Prenatally Exposed to Methadone Continued*

| Domain of Development Assessed | Author | Study Design | No. of ME Newborns Enrolled | Retention of Sample at Last Assessment | Age of Children at Follow Up | Measure(s) Used | ME Child Neurodevelopmental Status |
|---|---|---|---|---|---|---|---|
| **Motor Cont**. | Johnson et al. (1984) | Longitudinal | 62 | 34 (55%) | 24 months | BSID | PDI scores within normal limits, but significantly lower than control infants. Thirty-nine percent of infants were considered developmentally delayed. |
| | Hans (1989) | Longitudinal | 42 | 30 (71%) | 4, 8, 12, 18, 24 months | BSID<br>IBR | Normal PDI scores shown at all ages. At 24 months PDI scores of ME infants were significantly lower than control infants. ME infants at 24 months showed significantly more coordination problems on the IBR. |
| | Hunt et al. (2008) | Case Control | 133 | 79 (59%) | 18 months, 3.2 years | BSID<br>McCarthy Motor Scale | No significant difference on PDI for ME or control infants at 18 months.<br>ME children scored significantly lower than controls on the motor scale at age 3.2 years. |
| **Cognitive** | Strauss et al. (1976) | Longitudinal | 60 | 25 (42%) | 3, 6, 12 months | BSID | No significant difference on MDI between ME and control infants. |

*Notes:* ME, Methadone-Exposed. BSID, Bayley Scales of Infant Development; IBR, Infant Behaviour Record. Table continued over pages 12-14.

Table 1

*Neurodevelopmental Outcomes of Infants and Children Prenatally Exposed to Methadone Continued*

| Domain of Development Assessed | Author | Study Design | No. of ME Newborns Enrolled | Retention of Sample at Last Assessment | Age of Children at Follow Up | Measure(s) Used | ME Child Neurodevelopmental Status |
|---|---|---|---|---|---|---|---|
| **Cognitive cont.** | Wilson et al.(1981) | Longitudinal | 69 | 64 (93%) | 9 months | BSID | No significant difference on MDI between ME and control infants. |
| | Rosen & Johnson (1982) | Longitudinal | 62 | 39 (63%) | 6, 12, 18 months | BSID | At age 6 months, MDI scores within normal range. By ages 12 and 18 months, MDI scores declined to become significantly lower than control infants. |
| | Johnson et al. (1984) | Longitudinal | 62 | 34 (55%) | 24 months | BSID | No significant difference on MDI for ME or control infants. |
| | Hans (1989) | Longitudinal | 42 | 30 (71%) | 4, 8, 12, 18, 24 months | BSID<br>IBR | Normal MDI at ages 4, 8 and 12 months. At age 18 months, MDI scores significantly lower than control infants. At age 24 months, MDI scores were not significantly different to control infants. |

*Notes:* ME, Methadone-Exposed. BSID, Bayley Scales of Infant Development; IBR, Infant Behaviour Record. Table continued over pages 13-14.

Table 1

*Neurodevelopmental Outcomes of Infants and Children Prenatally Exposed to Methadone Continued*

| Domain of Development Assessed | Author | Study Design | No. of ME Newborns Enrolled | Retention of Sample at Last Assessment | Age of Children at Follow Up | Measure(s) Used | ME Child Neurodevelopmental Status |
|---|---|---|---|---|---|---|---|
| **Cognitive cont.** | Hunt et al. (2008) | Case Control | 133 | 79 (59.4) | 18 months, 3.2 years | BSID, SBIS, Reynell Language Scales. | MDI scores for ME infants significantly lower than control infants. ME children had significantly lower IQ scores than comparison children. ME children at age 3.2 years had lower scores on the Reynell Expressive and Receptive Language Scales. |
| | Johnson et al. (1990) | Longitudinal | 62 | 39 (63%) | 3 years, 6 years | Merrill-Palmer Scale of Mental Tests, McCarthy GCI. | ME children scored significantly lower than drug-free children on the Merrill-Palmer Scale at age 3. At age 6, the ME children had a significantly lower mean GCI than comparison children. |
| | Lifschitz et al. (1985) | Longitudinal | 33 | 26 (79%) | 3.4 years | McCarthy GCI | Mean GCI score was not significantly different between groups. |
| | de Cubas & Field (1993) | Cross-Sectional | 20 | N/A | Ages 6-13 | SBIS, KABC | No significant differences between groups. |

*Notes:* ME, Methadone-Exposed. BSID, Bayley Scales of Infant Development; SBIS, Stanford Binet Intelligence Scale; GCI, General Cognitive Index; KABC, Kaufman Assessment Battery for Children. Table continued over page 14.

Table 1

*Neurodevelopmental Outcomes of Infants and Children Prenatally Exposed to Methadone Continued*

| Domain of Development Assessed | Author | Study Design | No. of ME Newborns Enrolled | Retention of Sample at Last Assessment | Age of Children at Follow Up | Measure(s) Used | ME Child Neurodevelopmental Status |
|---|---|---|---|---|---|---|---|
| **Social-Emotional** | Hunt et al. (2008) | Case Control | 133 | 79 (59%) | 18 months, 3.2 years. | VSMS | Measures of social competence were significantly lower for ME infants compared to control infants at both ages assessed. |
| | de Cubas & Field (1993) | Cross-Sectional | 20 | N/A | Ages 6-13 | Roberts Apperception Test for Children. | ME children had significantly higher levels of anxiety, aggression, feelings of rejection, and maladaptive thinking than control children. |
| **Behavioural** | Wilson et al.(1981) | Longitudinal | 69 | 64 (93%) | 9 months | IBR | ME infants were rated as significantly less attentive than control group. No between-group differences in activity levels were noted. |
| | Hans (1989) | Longitudinal | 42 | 30 (71%) | 4, 8, 12, 18, 24 months | IBR | Neither activity level nor attention span of ME infants were significantly different to control infants. |
| | de Cubas & Field (1993) | Cross-Sectional | 20 | N/A | Ages 6-13 | Achenbach CBLC | ME children had significantly more hyperactivity, depression, aggression, internalising and externalising behaviour, and somatic complaints than the control group. |

*Notes:* ME, Methadone-Exposed; IBR, Infant Behaviour Record; GCI, General Cognitive Index; VSMS, Vineland Social Maturity Scale; CBLC, Child Behaviour Checklist.

Rosen and Johnson (1982) also studied the physical development of methadone-exposed infants compared to non-exposed infants. This longitudinal study followed 62 methadone-exposed infants through the ages 6, 12 and 18 months. Retention to the last follow up assessment was 63%. While no significant difference was found between exposed- and non-exposed infants on a measure of head circumference, methadone-exposed infants were more likely to have a head circumference below the $3^{rd}$ percentile. Rosen & Johnson also found that physical abnormalities and infection were significantly more common in methadone-exposed infants than comparison infants. Abnormalities included eye disorders such as strabismus and nystagmus, and infections were mostly otitis media ("glue-ear").

The study by Hunt et al. (2008) measured the height, weight and head circumference of methadone-exposed infants at 18 months and again at preschool age. The methadone-exposed group comprised of 133 infants at 18 months, and retention to the preschool follow-up assessment was 50%. At both ages, methadone-exposed children did not differ from non-exposed children on measures of weight or head circumference. However, at 18 months, and at preschool age, methadone-exposed children were found to be significantly shorter than non-exposed children.

Two other studies of the physical development of methadone-exposed preschool children found few differences between methadone-exposed children and comparison groups (H. L. Johnson et al., 1990; Lifschitz et al., 1985). Lifschitz et al. studied the development of methadone-exposed children, compared to a group of heroin-exposed children, and a group of non-exposed children. The sample sizes of the two opiate-exposed groups were relatively small, with 26 children in the methadone-exposed group, and 25 in the heroin-exposed group. The mean age of children at assessment was 3 years, 4 months. This study found that there were no significant differences between methadone-exposed, heroin-exposed or non-exposed children on measures of height, weight or head circumference. However, H.L. Johnson et al. found that methadone-exposed children were significantly more likely than control children to have circumferences below the 10th percentile. H.L Johnson et al. had a larger sample size than Lifschitz et al., with 39 methadone-exposed children assessed at age 3 years. This study did not measure height or weight of methadone-exposed preschool children compared to non-exposed children. Currently, there are no other studies that have assessed the physical development of methadone-exposed preschool children, and there are no studies that have assessed the physical development of methadone-exposed school age children.

*Motor Development of Methadone-Exposed Children.* Strauss et al. (1976) studied the motor development of methadone-exposed infants at 3, 6 and 12 months of age using the Psychomotor Development Index (PDI) from the BSID. Both methadone-exposed and non-exposed comparison children scored within the normal range at each age on the PDI. However, there was a trend for the PDI scores for the methadone-exposed children to decline over the 12 month period, becoming significantly lower than the PDI scores of the comparison group by age 12 months. Similarly, the study by Wilson et al. (1981) revealed that at 9 months of age, methadone- and non-exposed infants gained PDI scores within the normal range. However, the methadone-exposed group scored significantly lower than the comparison group on this measure. Assessment of fine motor coordination using the Bayley Infant Behaviour Record (IBR) revealed that methadone-exposed infants had significantly poorer control over fine motor skills than comparison infants (Wilson et al., 1981).

At 6 months of age, Rosen and Johnson (1982) found no differences between methadone-exposed infants and non-exposed infants on PDI scores. Later assessment of these same children at ages 12 and 18 months revealed methadone-exposed infants to have significantly lower scores than the comparison infants on the PDI. At age 24 months, significant differences have also been reported on the PDI (H. L Johnson, Diano, & Rosen, 1984). Using the same sample from Rosen and Johnson, Johnson et al. (1984) noted that 39% of the methadone-exposed infants were developmentally delayed; gaining scores more than one standard deviation (SD) below the mean on the PDI. At this 24 month follow-up, 55% of the methadone-exposed sample enrolled in the study had been retained.

A longitudinal study followed 42 methadone-exposed infants through ages 4, 8, 12, 18 and 24 months (Hans, 1989). The retention rate to the last follow-up assessment was 71%. The study found that PDI scores were within the normal range for methadone-exposed infants and control infants. This study also supported the suggestion that there is a decline in motor development with increasing age for methadone-exposed infants compared to controls, as methadone-exposed infants at 24 months of age gained a mean PDI score significantly lower than non-exposed infants. Also noted by Hans, was that methadone-exposed infants showed poorer fine and gross motor coordination assessed using the IBR.

In contrast, there were no significant differences on the PDI between methadone-exposed infants and control infants at 18 months in a more recent study (Hunt et al., 2008). At age 3 years, the study by Hunt et al. did note that methadone-exposed children gained significantly lower scores than drug-free comparison children on the McCarthy Motor Scale. This is a subscale of the McCarthy Scales of Children's Abilities (MSCA) designed to measure the child's distinct motor capabilities, measuring fine and gross motor coordination (Watkins & Wiebe, 1980). No further research has been conducted to ascertain whether preschool children exposed to methadone in utero have poorer motor development than non-exposed preschool children.

*Cognitive Development of Methadone-Exposed Children*. The outcomes of studies of the cognitive development of infants born to mothers maintained on methadone during pregnancy have also been mixed. Several studies found that there were no significant differences on the MDI between exposed and non-exposed infants at a variety of ages (Strauss et al., 1976; Wilson et al., 1981). Some studies found that cognitive development as measured with the MDI was in the "normal" range for both methadone-exposed and comparison infants at early follow-ups, but later follow-ups found significant between-group differences to emerge (Hans, 1989; Rosen & Johnson, 1982). For example, Rosen and Johnson (1982) reported a mean difference in standard scores of -5.69 between methadone-exposed and comparison infants on the MDI at age 6 months, and a mean difference of -10.38 at age 18 months. Similarly, Hans (1989) reported a mean difference in standard scores of -4.00 between methadone-exposed and comparison infants on the MDI at age 8 months, and a mean difference of -7.00 at age 18 months. Both studies however, found that MDI standard scores for methadone-exposed infants were not significantly different to those of non-exposed infants at age 24 months, with Rosen and Johnson reporting a mean difference in the standard scores between methadone-exposed and non-exposed infants of -6.90, and Hans (1989) reporting a mean difference of -4.00.

In their case-control study, Hunt et al. (2008) also found that methadone-exposed infants obtained significantly lower mean MDI scores than non-exposed infants at 18 months. At age 3 years, Hunt et al. measured child cognitive development using the Stanford Binet Intelligence Scale, and the Reynell Language Scales. This follow-up assessment showed that methadone-exposed children at age 3 years still showed poorer cognitive development that drug-free comparison children, obtaining IQ scores significantly lower than this group. Methadone-exposed children also scored significantly lower than the comparison group on the expressive language, and the verbal comprehension subscales of the Reynell Language Scales, indicating poor language understanding and development within the methadone-exposed group.

H.L. Johnson et al. (1990) measured the cognitive development of 3 year old children using the Merrill-Palmer Scale of Mental Tests, and 6 year old children using the McCarthy Scale of Children's Abilities' general cognitive index (GCI). Their results showed that methadone-exposed children had significantly lower intelligence scores at age 3 and significantly lower GCI scores at age 6 than drug-free comparison children. Another study also assessed the cognitive developmental outcome of methadone-exposed preschool children using the GCI. However, this study found that there were no significant differences between the GCI scores of methadone-exposed children compared to heroin-exposed or non-exposed comparison children (Lifschitz et al., 1985).

A study by de Cubas & Field (1993) assessed the IQ of twenty, 6–13 year old methadone-exposed children using the Stanford-Binet Intelligence Scale (SBIS), and the Kaufman Assessment Battery for Children (KABC). No significant differences between methadone-exposed and the non-exposed comparison group were found on either measure. It is possible that significant differences would have been obtained using a larger sample, however, the authors noted that methadone-exposed children subject to NAS at birth obtained significantly lower IQ scores on the SBIS than methadone-exposed children that had not suffered from NAS (de Cubas & Field, 1993). While not always yielding significant differences, it is clear that methadone-exposed infants and children perform more poorly than non-exposed comparison children on a range of measures of general cognitive development.

*Social-Emotional Development of Methadone-Exposed Children.* Compared to cognitive and motor development, social-emotional development is a relatively understudied developmental domain in the research field of opiate-exposed children. Only one recent study has assessed infant social-emotional development in methadone-exposed infants. Hunt et al. (2008) used the Vineland Social Maturity Scale (VSMS) to measure primary caregiver reports of infant social competence. Scores recorded on the VSMS were significantly lower for methadone-exposed infants than for non-exposed infants at age 18 months, suggesting that methadone-exposed infants exhibit less socially adaptive behaviour. Hunt et al. followed-up their infant sample, and measure the social-emotional development of methadone-exposed children at age 3 years, also using the VSMS. The results showed that methadone-exposed pre-school children had significantly poorer social competence than non-exposed comparison children as perceived by their primary caregiver's reports on the VSMS.

The social-emotional development of methadone-exposed school children was assessed by de Cubas & Field (1993). They measured social-emotional development with the Roberts Apperception Test for Children, which measures the child's perceptions of everyday situations, and assesses adaptive and maladaptive functioning. The study showed that methadone-exposed children scored significantly higher on measures of anxiety, aggression, feelings of rejection, and on maladaptive outcome than control children. This suggests that children prenatally exposed to methadone may be less well adjusted emotionally, and potentially less adept at reading social cues than their non-exposed peers. However given the rather small sample size in this study, further replication of this finding is needed. To date, no other studies have measured this area of development in the school-aged opiate-exposed population.

*Behavioural Development of Methadone-Exposed Children.* Infant adaptive and maladaptive behavioural development after prenatal methadone exposure is also relatively understudied compared to cognitive and motor development. Two early studies of the outcomes of methadone-exposed infants included behavioural measures (Hans, 1989; Wilson et al., 1981). Using the IBR, neither study found any difference between the activity levels of methadone-exposed and comparison infants (Hans, 1989; Wilson et al., 1981). However, Wilson et al. did find that methadone-exposed infants had significantly poorer attentional abilities than control infants, while Hans found no between group differences in infant attention. Using the Achenbach Child Behaviour Checklist (CBCL), de Cubas and Field (1993) found that methadone-exposed school-aged children showed significantly more problem behaviour than non-exposed children. These behaviours included hyperactivity, depression, aggression, internalising and externalising behaviour, and more somatic complaints.

The studies reviewed in Table 1 (pp. 9-14) indicate that some areas of development are at risk for infants and children who experience intrauterine methadone exposure. However, several differential findings noted between these studies could be due to a number of methodological differences and limitations which will now be discussed.

### *1.3 Methodological Limitations of Infant and Child Outcome Studies*

The majority of the studies examining the neurodevelopmental outcomes of infants exposed to methadone in utero were published in the 1980s, with a heavy focus on general cognitive and motor development and disability. These studies mostly used global assessment tools, most commonly, the BSID (Bayley, 1969). Whilst trends in cognitive and motor domains of infant and child development are evident, considerable discrepancies, such as differential findings on methadone-exposed child physical health outcome, and maladaptive behaviour outcome, are apparent. Several mixed findings across all domains of development likely reflect methodological problems inherent in almost all studies of children born to mothers maintained on methadone during pregnancy. Each of the infant outcome studies compared methadone-exposed infants to an appropriate control group of nondrug-exposed children from similar socioeconomic and racial backgrounds. However, there were several other issues with the methodology that limit the interpretation of the studies' results.

The first issue or limitation concerns sample size. Small sample size is a factor that may attribute to the diverse findings of children from drug-exposed populations. While not all results from the reviewed studies were statistically significant, there were still often slight differences between the methadone-exposed children and the non-exposed children. For example, Lifschitz et al. (1985) had 26 children in the methadone-exposed group and 25 children in the heroin-exposed group. These numbers may not have the statistical power to produce a significant result, even though differences were noted between the opiate-exposed groups and normal control children on measures of head circumference and cognition.

Sample attrition is another common methodological limitation inherent in the research of mothers maintained on methadone and their children. For example, the sample size in the Rosen and Johnson (1982) study dropped from 46 methadone-exposed infants to 34 infants in the Johnson et al. (1984) follow-up of the same groups of children, while the size of the comparison group remained at 22 infants for both assessments. Also, the data collected at the different age points in this study were not always repeat assessments of the same infants, with the authors noting the variable subject numbers across follow-ups. The inconsistent attendance of participants in their study could have potential drawbacks to gaining valid and generalisable results.

The infant outcome studies reviewed had a 64% mean retention rate of their originally recruited sample to their last follow-up. High attrition rates create difficulties when interpreting results, due to the possibility that those families that choose not to continue in such studies represent more high-risk or unstable families that may be characterised by greater social and family adversity, and potentially increased child risk. Another consequence of high attrition is the likelihood of type II errors due to inadequate statistical power to detect between group differences, possibly understating the need for developmental intervention of those infants falling behind at an early age.

A third limitation of existing studies of methadone-exposed infants and children is that the dose of methadone the mother was prescribed during pregnancy varied between studies. For example, Rosen and Johnson (1982) reported a mean daily maternal methadone dose of 42.9mg, while Hans (1989) reported a mean of less than 20mg per day. The dose of methadone exposed to each infant during pregnancy may have differential effects on their developmental outcome. Methadone dose is therefore a factor that may account for some of the mixed findings noted when reviewing these infant studies. Furthermore, in recent decades there has been a gradual increase in the daily dose of methadone provided to pregnant women, to help them manage the withdrawal symptoms of the drug (Wouldes & Woodward, 2010). Research in the field of MMT over the last 20 years suggests that higher doses of the opiate substitute methadone, achieves better outcomes for drug-dependent pregnant women (Berghella et al., 2003). The increase in prescribed methadone dose in recent years makes the comparison of more recent data with older studies difficult, and reiterates the need for further study of methadone-exposed children.

Another important issue for methadone-exposure studies to consider is poly-drug use. Most illicit drug-users are multiple or poly-drug users (Moe, 2002; Ornoy, Michailevskaya, Lukashov, Bar-Hamburger, & Harel, 1996). This makes it difficult to determine whether effects on child development are due to the drug in question, or a combination of substances that may have been used during pregnancy. The women in the studies reviewed above reported use of a variety of psychoactive drugs during their pregnancy, including methadone alongside heroin. For example, 95% of the women recruited from methadone clinics in the study by Lifschitz et al. (1985), were also using heroin regularly. Pregnant women maintained on methadone also commonly use other illicit drugs including cannabis, amphetamines, benzodiazepines and other opiates (Rosen & Johnson, 1982; Wilson et al., 1981), as well as licit substances such as alcohol and tobacco (H. L Johnson et al., 1984; Lifschitz et al., 1985). While it is common for many methadone maintained women to use more than one drug (Wilson et al., 1981), this makes the distinguishability of the specific effect of methadone on child development difficult.

A final limitation regarding the research of methadone-exposed children and their developmental outcomes is the lack of recent literature on the methadone-exposed child population. The majority of the literature is over 12 years old, and as mentioned above, dose differences may be inherent in studies that were from the late 1980s compared to studies from the 21$^{st}$ century. The studies reviewed also fail to broadly cover each developmental domain, with the majority focussing on general cognitive and motor development.

As discussed, methadone-exposed children tend to fall behind non-exposed control children on tests of general cognition. They generally show more behaviour problems, more physical disorders, and more social and emotional issues than control children. Domains of physical, social-emotional, and behavioural development of methadone-exposed infants and children are relatively understudied compared to the cognitive and motor domains. Nonetheless despite these methodological problems, there does appear to be a growing consensus that methadone-exposed infants and children lag developmentally. While there is not always a significant difference noted between methadone-exposed and comparison groups, some differences in each developmental domain are apparent.

General findings suggest that infants and children born to mothers maintained on methadone during pregnancy lag behind non-exposed children on measures of motor and cognitive development by between .25 and 1 SD (Hans, 1989; H. L Johnson et al., 1984; Rosen & Johnson, 1982). While these findings have been important in highlighting the general cognitive and motor developmental problems facing methadone-exposed infants, it is important to know if and how prenatal opiate-exposure might affect the outcome of all aspects of development, to understand the further development of these domains in older children. Furthermore, it is difficult to gain reliable assessments of an infant's prospective development with a narrow focus on global cognitive and motor development. Before a child reaches an age in which their abilities become more fine-tuned and new skills come on line developmentally, specific weaknesses may go undetected. These weaknesses may be uncovered however, as they grow and meet new challenges that test their developmental abilities. Beginning preschool is an example of an event which may expose the child's weaknesses that that were not previously apparent (Moe, 2002). For example deficits or impairment may be in skills that have yet to develop, such as executive functioning, or mental health and therefore may only emerge later. It may be that these deficits exist in methadone-exposed children, but are latent. Such "sleeper-effects" are an example of why it is important to continue longitudinal research past infancy, and examine the new issues that face substance-exposed children. It is important that these children receive assistance early in their childhood, before the challenges of school reveal potential academic difficulties.

The limitations in the literature surrounding this group of children imply that further research is needed to understand the extent to which these children are at risk. However, while limitations are inherent in several of the studies of methadone-exposed child development, they do still reveal that there are developmental difficulties facing methadone-exposed children.

One study assessed the development of the methadone-exposed school-age child (de Cubas & Field, 1993), providing evidence for the need of an intervention during the preschool years for these children, as they are at risk of an adverse developmental trajectory. Therefore, research of infants born to mothers maintained on methadone during pregnancy must be followed up to understand the developmental risk these children face as they grow. To date, research on preschool and school-aged children exposed prenatally to methadone is lacking, and must be completed to gain a full picture of the developmental needs of these children. An important developmental period to be studied, concerning children with prenatal exposure to methadone, is the time during which children are preparing for the transition to school, and their readiness for such a transition. Studies of the period of child preschool development are important, as detecting and recognising developmental delays early can assist in developing an appropriate intervention for children at risk. This could potentially alter their developmental pathway for the better, creating more favourable outcomes as older children, and a more successful adulthood. This begs the question of the school readiness of methadone-exposed children, and their neuro-developmental status before they reach school age.

## *1.4 School Readiness*

School readiness is comprised of several key developmental domains that encompass a child's learning and growth. School readiness, however, was not always considered an amalgamation of specific areas of development, and has only recently evolved into the concept we now recognise.

### *1.4.1 Perspectives on School Readiness*

School readiness is a concept that has been the focus of considerable debate in recent decades (G. J. Duncan et al., 2007; Shepard, 1997), with shifting perspectives on what constitutes the school ready child differing across time and continents. Several conceptualisations of school readiness have emerged, as different areas of development have been identified as relevant to the school readiness of a child. There have been three primary theoretical perspectives that have shaped notions of school readiness.

*The Idealist/Nativist Perspective.* The first model of school readiness, traced back to the early 20th century (Gessel, 1940), was the idealist/nativist perspective. This theory proposed that readiness was a phenomenon that occurred totally within the child as a maturational process (High, 2008). This view argued that a child's parents and experiences do not affect their development, but that development occurs through predictable stages, with the environment having little or no influence over this process. Therefore, children become ready for school endogenously, and are ready to enter school once they are mature enough to have developed peer relationships, self-discipline, and the ability to follow instructions. School readiness tests based on the idealist/nativist perspective often misclassified children as not ready, as the readiness criteria were based on specific stages of development. Therefore, children that had not yet attained certain developmental milestones were deemed “unready” for school (Janus & Offord, 2007).

*The Empiricist/Environmentalist Perspective.* An opposing theory of readiness that also developed before the 1950s, is the empiricist/environmentalist perspective. This model claimed that readiness was a direct result of what children had been taught, and could be determined by the skills and behaviours they exhibit, and their knowledge of concepts such as colours, shapes and numbers (High, 2008). This theoretical perspective of readiness provided a foundation for a number of specific syllabus-based assessment tasks that were as similarly strict as tests based on the idealist/nativist perspective. Thus, this also lead to a high proportion of children being classified as unready, because they did not possess enough general knowledge, or lacked certain behavioural skills (Janus & Offord, 2007).

Before 1950, assessment of school readiness was primarily used as a decision-making tool to either allow children school or kindergarten entry, or to delay it. The two school readiness constructs above provided a theoretical basis for children classified as unready, to be held back from starting school or kindergarten. It was thought that the solution to a child’s failure to achieve a standard level of readiness would be to give the child more time to mature or more time to develop their knowledge of basic concepts by remaining in less challenging programmes. As school readiness was viewed as a reflection of the child’s current abilities, any child not classed as ready at the time of testing, was not allowed to start school (Roberts, Lim, Doyle, & Anderson, 2011).

A national survey of schools across the United States, revealed that readiness tests were often used interchangeably with screening measures intended for referring children to special education (Gnezda & Bolig, 1988). The results of these tests were also frequently used to hold children out of school for an extra year to allow them more time to develop, rather than to ready the school for a heterogeneous group of children (High, 2008; Shepard, 1997). High levels of misclassification of children unready as based on readiness tests available at that time meant more and more children were denied school entry or placed unnecessarily in special education programs. This was not the intended use of readiness tests, as they were originally designed to predict a child's school success before they started school, and to improve instructional planning, with respect to accommodating children at different academic levels within the classroom (Shepard, 1997). As a consequence, by the late 1980s there was a shift away from the view that readiness was intrinsic to the child only.

*The Interactional/Relational Perspective.* The interactional/relational perspective of school readiness viewed readiness as a product of the reciprocal relationship between the child's genetic make-up, their developmental or maturational status, and their environmental experiences (High, 2008; Roberts et al., 2011). This theory focused on aiding all children to learn, holding that academic success also depended on the relationship between the school and the child, particularly on the mentorship of the teacher. The importance of early experience and relationships (such as parental influence) for early child development was also highlighted by this model.

Because children experience diverse environments, with different resources and learning opportunities, children entering school represent a diverse student body. Not all children on their first day of school will have the same knowledge of letters and numbers, nor exhibit identical social or cognitive skills (Carlton & Winsler, 1999; G. J. Duncan et al., 2007). Therefore, by 1989, the definition of school readiness was designed to highlight not only those children who were school ready, but also the schools that were ready for children, as well as the readiness of parents and communities to support children's learning (Roberts et al., 2011).

### *1.4.2 Domains of Readiness*

Around the same time that the interactional/relational perspective definition of school readiness was evolving in the late 1980s, specific areas of development were recognised as making unique contributions to child readiness. Readiness is now typically divided into five individual but associated domains, relevant to school-based learning (Copple, 1997). The five key indicator domains of school readiness are: (1) health and physical development, (2) emotional well-being and social-competence, (3) approaches to learning, (4) language and communication, and (5) cognition and general knowledge (High, 2008; Patrianakos-Hoobler et al., 2010; Roberts et al., 2011).

*Health and Physical Development.* Health and physical development includes the basic physical development of the child, such as growth patterns of height and weight, or any physical disabilities (High, 2008). This also includes the child's physical abilities to meet their own needs or have their needs met with assistance. Vision and the ability to hear are also important factors of this domain, as are proper nutrition and rest, ensuring that children have the energy, mobility, and concentration they need to explore their environment and impact their learning. Visual-motor, and visual-perceptual skills are also essential factors of this domain, as they are important predictors of academic achievement (Davis, Ford, Anderson, & Doyle, 2007).

*Emotional Well-being and Social Competence.* Emotional well-being and social competence (social-emotional skills), represents a child's ability to move into a structured school environment, from a less disciplined kindergarten or preschool setting (Roberts et al., 2011). It includes the child's knowledge of their own feelings and the feelings of others, and the ability to develop positive relationships with peers and adults, and work within a group

(High, 2008). These social competencies are important for later school success and adulthood; serving as a base for developing and maintaining friendships, embracing individual differences, solving conflicts and working well with others.

*Approaches to Learning.* Approaches to learning are manifested in all domains of school readiness and school syllabus areas and include curiosity, enthusiasm, confidence, creativity, culture and interests (High, 2008). Approaches to learning also encapsulates skills in executive functioning, including attention, self-control, problem-solving and working memory, which are all skills utilised when engaging in classroom activities (Roberts et al., 2011). Executive functioning becomes increasingly important as children develop through adolescence to adulthood. The ability to create and carry out plans, focus and shift ones attention and inhibit impulsive responses, are all important aspects that develop from an early executive function ability. This is important to be measured in children in order to identify early executive function deficits.

*Language and Communication Skills.* Language and communication skills include expressive language development, such as speech or the use of a nonverbal system of communication, and receptive language development which is the ability to comprehend language. Early literacy skills, such as an awareness of print, and understanding that writing can be used as a form of communication, is also essential (High, 2008). Language and communication skills are important for children, to be able to understand the material they are learning, to explain their thoughts and knowledge, to communicate their needs, interact socially, and describe events, thoughts and emotions (Papalia & Feldman, 2011).

*Cognition and General Knowledge.* Finally, cognition and general knowledge refers to a child’s knowledge of basic concepts such as the discrimination of colours, shapes, size, knowledge of numbers and counting, simple patterns, and acknowledging similarities and differences. A child's ability to take on and use new information is indicative of their cognitive skills and the ability to do so is somewhat dependent on the child's learning experience and opportunities during the preschool period (Roberts et al., 2011).

Although the five school readiness domains are distinctly different, there is a continual link of influence between the acquisition of skills or knowledge in any of the domains during early childhood development. Gaining skills in any one domain will increase the level of skill in another domain (Papalia & Feldman, 2011). Therefore, children with a high level of skill in one domain are likely to show high levels of skill in the other domains as well. It would be expected that children with a delay within one domain of school readiness, will show delays across several school readiness domains.

Given that studies of children exposed to methadone have often highlighted difficulties in school-readiness related areas such as general cognition and motor skills, it is likely these children are less ready for school than non-exposed children. Furthermore, methadone-exposed children are largely understudied in current research, with little known about their preschool development across the five school readiness domains. This provides good reason to study this population of children, and describe their school readiness compared to non-exposed children.

### *1.5 School Readiness in Opiate-Exposed Samples*

As previously discussed, opiate-exposed preschool children tend to score less well than non-exposed children on developmental measures of growth, general cognition, motor skills, social-emotional skills and behaviour ratings. These developmental domains fall within the school readiness domains of physical health and development, cognition and general knowledge, and social-emotional skills. It is important to understand the total school readiness profile of opiate-exposed children to identify their particular strengths and weaknesses across key school readiness indicators. Researching these children will help to understand the developmental challenges they may face, and help prevent further school readiness delays and assist their transition to school. A few studies have attempted to measure the school readiness of opiate-exposed children. Specifically, an early cross-sectional study by Wilson et al. (1979) assessed the school readiness of preschool children prenatally exposed to heroin. Providing an almost complete picture of child school readiness, this study included measures of child cognition, perception, speech, and physical growth, and included measures of parenting attitudes, and child social and environmental experiences. The groups of children studied included those children prenatally exposed to heroin (*N*=22), and three comparison groups consisting of a drug environment comparison group (*N*=20) comprising of children with no prenatal drug exposure, but living in a drug "culture" or lifestyle; a high-risk comparison group (*N*=15), comprising of children suffering from intrauterine growth retardation, foetal distress or birth complications and children born preterm; and a typical socioeconomic (SES) control group (*N*=20), comprising children selected from a school readiness programme in the area.

In terms of physical growth, children in the heroin-exposed group had significantly lower weight and a smaller mean head circumference than all other comparison groups, and

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the SES group was significantly taller than all groups. Results of the psychometric tests of cognitive abilities revealed that the heroin-exposed group often scored within the normal range, but their scores were lower overall compared to the other groups. The typical SES control group scored significantly higher than the other at-risk groups on the cognition measures. IQ however, as measured by the Columbia Mental Maturity Scale, did not differ between the groups.

Measures of behaviour based on parent report and the assessor’s ratings of behaviour during the physical examination revealed that the heroin-exposed group was more likely to be rated as impulsive, temperamental, aggressive, and more active. Groups did not differ in terms of attention, cooperation or alertness.

A number of methodological limitations of the study by Wilson et al. (1979) can be noted. One limitation is that the measure of maternal drug use was based solely on self-report. Self-report of maternal drug use can be biased, and may skew the results limiting the generalisability of the study. Another limitation concerns poly-drug use. Thirty-three percent of the women in the heroin-exposed group also reported concomitant drug abuse in addition to using heroin during pregnancy. The effects of poly-drug exposure during pregnancy may produce differential child school readiness outcomes, compared to methadone-exposure alone. Finally, the sample sizes of each of the comparison groups were a limitation to this study, due to statistical power constraints that are inherent when using small samples. This study’s strengths included the use of multiple measures to gather more information on children’s school readiness. Also, the use of several comparison groups provides insight into the effects of drug exposure and other risk factors to development such as home environment or birth complications.

A more recent prospective longitudinal study examined the effects of prenatal cocaine and opiate exposure, as well as the effect of postnatal environment on children's intelligence and school readiness (Pulsifer, Radonovich, Belcher, & Butz, 2004). A group of drug-exposed children (*N*=104), and a group of demographically matched comparison children (*N*=35) were assessed between the ages of 4 and 5 years. Child measures included the SBIS (Fourth Edition), and the Bracken Basic Concept Scale-Revised. Measures of the home environment were based on caregiver intelligence and overall academic achievement, measured by a short form of the Wechsler Adult Intelligence Scale-Revised, and the Wide Range Achievement-Test Revised Level II Reading Subtest.

Results of this study revealed no differences in child intelligence or school readiness for children with prenatal exposure to opiates only, cocaine only, or both cocaine and opiates. Therefore the three drug-exposed groups were combined for further analysis. No difference was found between the drug-exposed and the non-exposed groups on measures of school readiness or intelligence. The small sample size of the control group in this study may be a reason there were no statistically significant differences between the drug-exposed and non-exposed groups on intelligence or school readiness measures. However, the caregivers of children in the drug-exposed group scored significantly lower than the caregivers of the non-exposed group on intelligence and reading tests. Caregiver IQ was significantly correlated with child IQ for the drug-exposed group, but not for the non-exposed group. Similarly, caregiver reading scores were significantly correlated with child school readiness for the drug-exposed group, but not for the non-exposed group, suggesting that a confounding factor such as socio-familial and environmental factors risk may be moderating the effect of child outcome.

The study by Pulsifer et al. (2004) emphasises the important influence of home environment on the developmental outcomes of the drug-exposed child. For example, regression analysis revealed that prenatal drug exposure was not individually accountable for child intelligence or school readiness scores, but that caregiver reading level predicted the most variance in child intelligence and readiness for school (Pulsifer et al., 2004). This result highlights the importance of a stimulating environment for young children in order to improve their development and provide learning opportunities before schooling begins.

While the studies by Wilson et al. and Pulsifer et al. provide some idea of the school readiness status of opiate-exposed children, the school readiness outcomes of methadone-exposed preschool children are not yet known. These studies also do not administer measures covering each of the five school readiness domains. Given the dearth of research on the population of opiate-exposed preschool children, it is understandable that data available for the school readiness of these children is also lacking.

The identification of the five school readiness domains outlined under the interactional/relational perspective came into development around the same time that most literature on the developmental outcome of methadone-exposed infants was published. Due to the recency of the shifting perspective on school readiness, and the lack of research following methadone-exposed children past infancy, there is little information available about the school readiness of methadone-exposed children across the five domains. The studies by Wilson et al. (1979) and Pulsifer et al. (2004) do, however, note that prenatal opiate-exposure may not be the sole contributing factor accounting for differences found between opiate-exposed and non-exposed children on measures of school readiness. It is also likely that high-risk family contexts and risk factors associated with maternal drug-dependence are important contributing factors to the opiate-exposed preschool child's preparedness for school.

## *1.6 Socio-Familial and Environmental Risk Factors Associated with School Readiness*

Children exposed to teratogenic drugs in utero face not only direct biological risk from the prenatal substance exposure, but also a number of unfavourable environmental factors both before and after birth; with these adverse risk factors in turn, heightening their risks for poor developmental outcome (Lester & Lagasse, 2010). Specifically, drug-using women are more likely to exhibit a high-risk lifestyle, characterised by poor nutritional habits, high rates of infection and disease, poverty, as well as licit and illicit poly-drug use (K. Johnson et al., 2003; Vucinovic et al., 2008). A lack of research exists investigating the relative contributions of biological and environmental mechanisms affecting the developmental outcomes of methadone-exposed children. However, some studies have documented observed differences between opiate-exposed children that have been raised by their opiate-dependent parents at home, versus those who were adopted into non-using families shortly after birth. Heroin-exposed preschool children and infants in a cross-sectional study (Ornoy et al., 1996), were analysed as two groups; those living at home with their biological mother (*N*=39), and those who had been adopted (*N*=44). When analysed as a single group, the heroin-exposed children (*N*=83) performed below the “normal” control group (*N*=47) on measures of cognition, and had a higher incidence of behavioural disorders. When analysed as two separate groups, the heroin-exposed children raised at home had significantly lower cognition and motor development scores than heroin-exposed children that had been adopted. A mean standard score difference of between 8 and 16 was found on the cognition and motor measures respectively, between heroin-exposed children raised by their biological family compared to those raised by adoptive families. A much smaller proportion of adopted heroin-exposed children (20%) showed behavioural problems, compared to 74% of the heroin-exposed children living at home.

Similarly, a Norwegian follow-up study examined preschool children prenatally exposed to heroin (Moe, 2002). As part of this study they examined the differential effects of family and environment on child cognitive outcome. Regression analyses were conducted to distinguish drug exposure effects from environmental influences for both heroin-exposed children raised at home and adopted. It was found that mental developmental index score at one year of age made a significant, independent contribution to the child's general cognitive index (GCI) score at age 4.5 years. Whether the child was either raised at home with their biological mother, or adopted, was not predictive of the child's GCI score at age 4.5 years. However, a child being raised at home with an opiate-dependent mother was predictive of poor perceptual motor performance at age 4.5 years, compared to heroin-exposed children that had been adopted. The results of this study differ from the results of the study by Ornoy et al. (1996), suggesting that adverse home environments do not predict poor general cognitive outcome, but do predict poor perceptual performance outcome. Moe (2002) suggests that adequate caregiving is not strong enough to eliminate the biological risk factors associated with prenatal opiate exposure.

These studies however, show that children prenatally exposed to opiates are at risk for adverse developmental outcomes, not only due to the effects of the prenatal drug exposure, but also because of socio-familial and environmental risk factors commonly associated with the lifestyle of drug-dependent women. While these two studies have examined environmental influences accounting for the outcome of heroin-exposed children, little research has been published on the relative contributions of biological and environmental mechanisms that place methadone-exposed children at an increased risk of adverse developmental outcomes.

A longitudinal study by H.L. Johnson et al. (1990), studied the resiliency factors of 36-month old children born to mothers maintained on methadone during pregnancy (*N*=39), and a drug-free comparison group (*N*=23) who were living in similar socio-economic conditions. The study compared children of similar SES on head circumference, and compared the two groups on results of the Merrill-Palmer Scale, the McCarthy GCI, and on a neurological evaluation, in order to determine what common factors were inherent in children showing “resilience” against their biological, socio-familial and environmental risk factors.

One resiliency factor that was found to differentiate between the thriving methadone-exposed children and the delayed methadone-exposed children was familial stability. Instances of family disorder, including child neglect and family violence, were significantly higher in the group of methadone-exposed children that were falling behind on cognitive and physical measures. All methadone-exposed children in this study lived in similar socio-economic areas and experienced similar levels of prenatal methadone and poly-drug exposure. These results indicate that a stable, warm, supportive family environment where children can continue to be stimulated and engaged in learning may be an important contributing factor in successful child developmental outcomes.

## *1.7 Research Aims*

Starting school is recognised as an important developmental milestone throughout the world. Assessing the school readiness of preschool children is important for psychologists, teachers and other health authorities, and may provide insight into potential areas of vulnerability among groups of at-risk children. Specifically, the identification of areas of weakness among methadone-exposed children may be helpful in informing the design of interventions to assist these children to overcome the added challenges of school. The school readiness assessment of methadone-exposed children will also inform parents and teachers of the areas of difficulty these children are facing, to plan for assistance with teaching these children and prevent the accumulation of further difficulties.

To date, school readiness has not been assessed in this high risk group of children born to, and largely being raised by, mothers maintained on methadone, although they display a number of developmental difficulties from infancy to childhood. This study extends on previous research by undertaking a detailed examination of the five school readiness domains. This research aims to provide a comprehensive evaluation of the extent of these children's difficulties as they make the important transition to the learning and social environment of primary schooling.

The specific research aims were to:

1. Describe a cohort of typically developing Canterbury children's performance across a number of key school readiness domains. These included measures of health and physical development, social-emotional skills, approaches to learning, language and communication, and cognitive skills and general knowledge.
2. Compare the school readiness of children exposed to methadone prenatally and a group of comparison children, at age 4.5 years.
3. Identify neonatal, child, family and socio-familial covariates of school readiness at age 4.5 years.

# 2 METHOD

## *2.1 Research Design*

This research draws on data from a prospective longitudinal study of the neuro-developmental outcomes of children exposed to methadone during pregnancy (Canterbury Child Development Research Group; Principle Investigator: Professor Lianne Woodward). Two groups of women were recruited to the study (as described below), and were interviewed during their pregnancy, or at the time of their child's birth. The children enlisted in this study have been followed from birth, and assessed at term age, at 18 months, and at 2 years of age. The data collection point which is the focus of this thesis is the 4.5 year follow-up evaluation, which included measures of school readiness within the larger neurodevelopmental assessment.

The author was involved in the child assessment procedure, collecting data measuring language and communication, and administering several other tasks from the larger neurodevelopmental assessment, for a total of 32 consecutive child assessment results for this thesis. The author also scored the majority of the child assessment battery for each of these 32 children, and completed data scoring and data entry for the entire sample, on several measures. The sample for this study consisted of the first 67 consecutive methadone-exposed children, and the first 81 consecutive non-exposed control children. Data collection for the remainder of the children in this study is currently ongoing.

## *2.2 Sample*

The study sample consisted of two groups of children born at Christchurch Women's Hospital between 2003 and 2008. Exclusion criteria for both groups included very preterm birth (less than 33 weeks gestation), HIV, foetal alcohol syndrome, congenital abnormality, and a non-English speaking parent. The analysis for this thesis also excluded children who did not primarily speak English at home.

*Methadone-Exposed Group*. The first group of children in the study were born to mothers enrolled in methadone maintenance treatment during their pregnancy. These mothers were recruited into the study during their second and third trimester. Excluding death (5 stillbirths), 121 mother-infant dyads were eligible for inclusion in the study. Of these, 100 (83%) were successfully recruited, 2 were missed and 19 declined to participate. Recruited infants had a mean gestational age of 38.7 +/- 1.6 weeks. Information about mother's daily methadone over the course of her pregnancy was obtained from both hospital and drug service records.

Mean methadone dose levels by trimester were: 52.8mg/day (range: 0-195) for trimester 1; 60.5mg/day (0-195) for trimester 2; and 64.8mg/day (2.8-195) for trimester 3. Sample retention to age 2 for this group was 95%. The school readiness data analysed in this thesis is on data collected up to the month of November 2011, and is of the first 67 methadone-exposed children enrolled in the larger study. The sample of methadone-exposed children used in this thesis is comprised of 56.7% male participants. The mean age of the methadone-exposed participants at assessment was 4 years, 7 months (range: 4 years, 1 month to 5 years, 6 months). Retention to the 4.5 year follow-up to date is 91%.

*Comparison Children.* The second group of study children consisted of 112 non-methadone exposed comparison children and their mothers. These mother-infant dyads were randomly identified from the delivery booking schedule of Christchurch Women's Hospital between 2003 and 2008. The same exclusion criteria as for the methadone group were employed. A total of 173 eligible mother-infant dyads were identified, and of these, 110 (65%) were recruited in their third trimester of pregnancy or at birth; 41 declined to participate, and 20 could not be traced. These comparison infants had a mean gestational age of 39.1 +/- 1.6 weeks. Comparison of the socio-economic profile of these families with regional census data showed that these families were generally representative of the Canterbury region, from which they were recruited. Retention to the follow-up evaluation at age 2 for the comparison group was 99%. The comparison sample included in this thesis consisted of the first consecutive 81 comparison children enrolled in the larger study assessed at age 4.5 years. This group was comprised of 44.4 % male participants. The mean age of the control children at assessment was 4 years, 6 months (range: 4 years, 2 months to 5 years, 6 months). Retention of the comparison group to age 4.5 years to date is 92%.

### *2.3 Procedure*

At age 4.5 years (range: 4.0 to 5.5 years) the children in this study participated in a comprehensive neurodevelopmental assessment. The majority of children completed their assessment at the University of Canterbury Child Development House, or during a home visit if more convenient for the family. The measures were administered by trained research staff, including a clinical psychologist and the author. These researchers were blind to child group status and history. During the assessment, a second researcher interviewed the child's parent or primary caregiver in a separate room.

### *2.4 Measures*

*2.4.1 School Readiness.* The measures that were used to assess each domain of school readiness during the 4.5 year assessments are described below.

*Health and Physical Development.* Children's health and physical development was measured using information gathered from the caregiver interview, and from direct child assessment at age 4.5 years. Caregivers answered questions regarding their child's vision and hearing abilities, toilet training, and general physical health conditions (see Appendix A). Significant health problems were identified through the maternal report of the child's number visits to health care providers within the past year. A child was determined as having a significant health problem if they sought professional health care more than once a month (>12 times per year). A child was considered not to be toilet trained if the primary caregiver reported that they did not stay clean and dry every day. Children that could not go to the toilet on their own were also defined as not toilet trained.

Motor development and visual perception were directly assessed using the Beery-Buktenia Developmental Test of Visual-Motor Integration – 5$^{th}$ Edition (Beery-VMI), (Beery & Beery, 2006). This standardised measure is designed to assess child visual-motor abilities and their hand-eye coordination. The participant uses paper and pencil to recreate geometric shapes which increase in difficulty as the task progresses. The task is designed to measure the extent to which children can integrate their visual and motor skills, and can identify children that may need to obtain special assistance for their visual-motor development. This measure has good psychometric properties with proven reliability and validity (Beery & Beery, 2006). A child was defined as having a visual-motor delay if their score on the Beery-VMI was more than 1 SD below the mean Beery-VMI score of the comparison group.

A child was considered not school ready in terms of their health and physical development if they either visited a health care provider more than 12 times a year, were not toilet trained, or if they scored 1 SD below the comparison group mean on the Beery-VMI.

*Social-Emotional Skills.* Emotional well-being and social competence were measured using the caregiver-completed Strengths and Difficulties Questionnaire (SDQ; see Appendix B), (Goodman, 1997). The SDQ can be used to measure prosocial behaviour and psychopathology of 3 to 16 year olds, by assessing a child's overall strengths and difficulties. The SDQ is a 25-item questionnaire that consists of five subscales. The five subscales measure inattention/hyperactivity, emotional symptoms, conduct problems, peer relationship difficulties, and prosocial behaviour. Each of the subscales contains five items, with the parent's responses scored on a 3-point Likert scale ranging from not true (0) to certainly true (2). The SDQ is a well-validated parent-rated questionnaire, with reliability and validity confirmed using a large sample of over 10,000 British children, (Goodman, 2001). For the purposes of this analysis, school readiness was assessed by measuring the four areas of child difficulty; inattention/hyperactivity, emotional difficulty, conduct difficulty, and peer difficulty. Children that scored a total difficulties score more than 1 SD above the comparison group mean, were classified as not school ready.

*Approaches to Learning.* Approaches to learning were assessed using the Phelps Kindergarten Readiness Scale II (PKRS-II), (Phelps, 2003). The PKRS has been validated as a measure that is predictive of later child school achievement, and thus can be effective in identifying preschool children at risk of later academic difficulties (Augustyniak, Cook-Cottone, & Calabrese, 2004; J. Duncan & Rafter, 2005). The PKRS assesses three domains of functioning. These include Verbal, Perceptual, and Auditory Processing. As well as providing a score for each domain, the PKRS also provides a total readiness score for each child. The Verbal Processing domain includes an assessment of the child's meaning vocabulary and their ability to recognise and understand verbal relationships. The Perceptual Processing domain involves assessing the child's ability to visually compare shapes, and to recreate shapes of increasing complexity. The Auditory Processing domain assesses the child's ability to differentiate between sounds and to recall auditorily presented material (Phelps, 2003). Importantly, this measure assesses executive functioning. Aspects of executive functioning measured throughout the PKRS-II include attention and working memory, through tasks such as digit- and sentence-recall (Roberts et al., 2011). A child was defined as not school ready in terms of their approaches to learning, if their total readiness score was more than 1 SD below the comparison group mean.

*Language and Communication.* Language and communication development were assessed using the Clinical Evaluation of Language Fundamentals – Preschool (CELF-P) (Wiig, Secord, & Semel, 1992). This measure provides separate standardised scores for the child's receptive language, or verbal comprehension abilities and their expressive language abilities. This measure also has well-established reliability and validity coefficients (Wiig et al., 1992). The receptive language subscale consists of three subtests. These subtests measured the child's knowledge of linguistic concepts, comprehension of basic concepts such as prepositions, and their comprehension of sentence structure. Children were defined as having receptive language delay if their receptive language score was more than 1 SD below the receptive language mean of the comparison group. The expressive language scale consists of three subtests. These subtests measured the child's ability to recall sentences read to them in a story-book context, formulate the names of objects in a picture, and complete sentences started by the assessor with the appropriate word and sentence structure.

The CELF-P also provided a total language score. Children were defined having a total language delay if their total language score was more than 1 SD below the mean total language score of the comparison group. Children classified as having total language delay were considered not school ready.

*Cognitive Skills and General Knowledge.* General cognitive functioning was estimated using the Wechsler Preschool and Primary Intelligence Scales-Revised (WPPSI-R), (Wechsler, 1989). For this study, a short form of the WPPSI-R was used to provide a standardised measure of intelligence. The WPPSI-R provides performance and verbal IQ scores, as well as a full scale IQ score. This measure included four subtests, block design and picture completion, which are performance tests, and comprehension and arithmetic, which are verbal tests. The block design test consists of the child copying patterns of coloured blocks, which increase in difficulty throughout the task. The picture completion task consists of the child notifying which part of a picture is missing. The comprehension test involves the assessor asking the child questions of general knowledge, and the arithmetic test involves the assessor asking the child simple maths and counting questions. This short form is a reliable alternative to the full WPPSI-R for testing child IQ, as the full WPPSI-R is potentially too arduous for preschool children (Tsushima, 1994). The short form has high half-split reliabilities (.92-.93) and correlations (r=.92) with the full version of the WPPSI-R (LoBello, 1991; Tsushima, 1994). Children were considered not school ready if their full scale IQ score was more than 1 SD deviation below the mean IQ score of the comparison group.

*Overall School Readiness.* The total number of school readiness domains that were impacted in children in each study group was summed to provide a measure of the extent of overall school readiness risk for methadone-exposed and comparison children. The number of domains in which each child was not considered school ready provided a measure of their overall school readiness at age 4.5 years.

### *2.4.2 Socio-Familial Risk*

To provide an overall measure of socio-familial risk at birth, a composite measure comprising five dichotomous variables was summed, based on information collected from hospital databases and parent interviews at term, 18 months and two years (see Appendix C). Maternal socio-familial risk selection factors were minority ethnicity (e.g. Maori, Pacific Islander, Asian or African), early motherhood (e.g. mother under 21 years at time of childbirth), low maternal education (e.g. no high school or tertiary qualifications), low socio-economic status (SES), and single parent family at birth. Family SES was assessed using the revised Elley-Irving Socio-Economic Index (Elley & Irving, 2003). Socio-economic status was dichotomised into high or low SES. Parents were classed as low family SES if they were unemployed, or working unskilled, semi-skilled and skilled jobs. Parents were classed as high family SES if they were working professional, managerial or technical jobs.

For each socio-familial risk indicator, a score of 0 or 1 was assigned for each child, with a score of 1 indicating exposure to this risk, and 0 indicating no risk. These scores were then summed to provide a cumulative risk score. This five-point socio-familial risk index score was used in analysis to determine the extent to which socio-familial risk might explain potential school readiness inequities between methadone-exposed and comparison children, and was entered in analyses as a single confounding variable. This measure was based on previous risk indices used when researching the influence of socio-familial risk with other high-risk populations (Foster-Cohen, Friesen, Champion, & Woodward, 2010; Roberts et al., 2011; Whitaker et al., 1996). As well as several measures of socio-familial risk, poly-drug use during pregnancy was measured by self-report in the maternal interview during the infant's term assessment (see Appendix C).

### *2.5 Statistical Analyses*

Data were analysed using SPSS Statistics 19. Analyses were conducted in four steps. First, characteristics of the methadone-exposed sample at term age and their school readiness results at age 4.5 years were compared to the non-exposed sample using independent samples t-tests for continuous variables, or the chi-squared statistic for dichotomised variables.

Second, to compare the proportion of methadone-exposed children to control children who were experiencing difficulties across the five school readiness domains, each of the domain measures were dichotomised. Risks for poor developmental outcomes in each domain were presented as odds ratios. The effect size of the difference between the methadone-exposed and control group on school readiness within each domain was determined using chi-square tests.

Third, the extent to which between group differences could be explained by the extent of socio-familial risk was examined using univariate regression analyses. Cross-tabulations with chi-square tests were used to investigate patterns of vulnerabilities across school-readiness domains

The final step in the statistical analyses was to determine the independent contributions of socio-familial risk and methadone-exposure to overall school readiness outcome using regression analyses. This analysis was conducted to investigate whether methadone-exposure in utero explains more variance in school readiness outcome at age 4.5 years, than socio-familial risk factors, or if the combination of prenatal methadone exposure and socio-familial risk are most predictive of child school readiness.

### *2.6 Ethical Approval*

Ethics consent for the 4.5 year follow-up was obtained from the Upper South B Regional Ethics Committee (Ref. no. URB07/10/042). Informed, written consent was obtained from all participants (see Appendix D).

## 3 RESULTS

### *3.1 Sample Characteristics*

Table 2 (p. 52) describes the infant, and familial characteristics of the two study groups of mothers and their infants at term age. The characteristics of the infants from both the methadone-exposed and comparison groups were described using measures of gestational age, birth weight, birth length and head circumference. The proportion of methadone-exposed infants that received drug treatment for NAS after birth is also reported. Data were available for all 148 children, with the exception of three comparison children for whom birth length data were missing, and one comparison child for whom head circumference data was missing. This data was missed due to the infants being born at home.

Table 2 shows that both methadone-exposed infants and comparison infants were born on average at around 39 weeks gestation (range: 33–43 weeks; $p$=.29). Despite the similarity in gestational age of infants in the two study groups, infants born to mothers enrolled in methadone maintenance during pregnancy tended to be smaller than the comparison infants, with methadone-exposed infants being lighter ($p$=.001), shorter ($p$=.003), and having a smaller head circumference compared to non-exposed infants ($p$=.007). A substantial proportion of the methadone-exposed children received pharmacological treatment for NAS (83.6%).

Table 2

*Characteristics of Methadone-Exposed and Comparison Infants and Mothers at Term Age*

| | Methadone-exposed group (*N*=67) | Control Group (*N*=81) | $t/\chi^2$ (*df*) | *p* |
|---|---|---|---|---|
| *Infant Clinical Data (Term Age)* | | | | |
| *M (SD)* gestational age (weeks) | 38.74(1.57) | 39.03(1.72) | -1.07 (146) | .29 |
| *M (SD)* birth weight (*g*) | 3082.31(428.09) | 3370.73(560.31) | -3.46 (146) | .001 |
| *M (SD)* birth length (*cm*) | 50.47 (2.88) | 51.99 (3.15) | -3.02 (143) | .003 |
| *M (SD)* head circumference (*cm*) | 33.97 (1.60) | 34.65 (1.36) | -2.75 (145) | .007 |
| (%) NAS treatment | 83.6 | - | | |
| *Socio-familial Data (Maternal)* | | | | |
| (% ) No formal education | 79.0 | 19.7 | 46.71 (1) | <.0001 |
| (%) Low SES | 97.0 | 23.8 | 79.92 (1) | <.0001 |
| (%) Single parent | 49.3 | 8.6 | 30.66 (1) | <.0001 |
| *M (SD)* Maternal age | 29.97 (4.90) | 31.72 (4.95) | -2.05 (131) | .04 |
| (%) Mental Health Disorder | 49.3 | 16.0 | 18.87 (1) | <.0001 |
| *Maternal Ethnicity* | | | | |
| (%) Maori | 25.8 | 14.1 | | |
| (%) NZ European | 74.2 | 77.5 | | |
| (%) Pacific Islander | 0.0 | 1.4 | | |
| (%) African/Asian | 0.0 | 7.0 | 7.61 (3) | .06 |
| *M (SD) Cumulative Socio-Familial Risk Score* | 2.55 (0.91) | 0.78 (1.23) | 9.78 (145) | <.0001 |

Also shown in Table 2, were the maternal characteristics of the sample at birth or term equivalent age. Characteristics of the mothers of methadone-exposed infants and comparison infants are described using measures of education level, SES, marital status, maternal age, and ethnicity. Data were available for 133 mothers.

Results show that significantly more mothers enrolled in the methadone maintenance programme during pregnancy, compared to non-methadone using mothers, left school before age 16 without formal qualifications ($p$<.0001). They were also significantly more likely to be of low family SES ($p$<.0001) and to be a single parent ($p$<.0001). At the time of their child's delivery, mothers in the methadone maintenance programme were significantly younger than the comparison mothers ($p$=.04). Finally, some ethnic differences were also seen between mothers of the two study groups. In the group of women enrolled in methadone maintenance, 25.8% were Maori and the remaining 74.2% were New Zealand European. In comparison, there was a greater ethnic spread amongst the group of control women, including women from the Pacific Islands (1.4%), and Asia and Africa (7%). However Maori and New Zealand European women still represented a large proportion of the group with 14.1 and 77.5% respectively. Between group differences in ethnicity were not significant, however were trending towards significance ($p$=.055). Mothers and infants in the methadone-exposed group had a significantly higher mean cumulative socio-familial risk score than the comparison mothers and infants ($p$ <.0001). On average, methadone-exposed infants were exposed to 2.5 socio-familial risk factors, and comparison infants were exposed to 0.78 of these risk factors.

### *3.2 Poly-Drug Use*

Other maternal drug use, including both licit and illicit drug use during pregnancy was examined. This data is presented in Table 3 (p. 55). Ninety-three percent of mothers maintained on methadone during pregnancy smoked cigarettes. This proportion was significantly higher at $p$ <.0001, than the proportion of mothers in the comparison group (16.3%). Mothers maintained on methadone had almost 63 times the odds of smoking during pregnancy compared to comparison mothers (OR = 62.5; $p$ <.0001). The average number of cigarettes smoked per day was also higher for mothers maintained on methadone, with a mean of 13.6 cigarettes per day, compared to a mean of 1.5 cigarettes per day smoked by the mothers in the comparison group ($p$ <.0001). The proportion of mothers that drank alcohol during pregnancy in the comparison group was 21.3%, compared to 19.4% of the mothers maintained on methadone during pregnancy. Comparison mothers had only slightly higher odds of drinking alcohol during pregnancy than mothers maintained on methadone (OR = 0.89; $p$ = .78).

Table 3

*Proportions of Maternal Licit and Illicit Drug Use During Pregnancy for Women Maintained on Methadone, and Comparison Mothers*

| | Mothers Maintained on Methadone | Comparison Mothers | Mean Difference/OR (95% CI) | *p* |
|---|---|---|---|---|
| *M (SD)* Cigarettes smoked per day | 13.56 | 1.48 | 12.08 (9.90-14.26)* | <.0001 |
| (%) Cigarette use | 92.5 | 16.3 | 62.5 (21.74-200.00)** | <.0001 |
| (%) Alcohol use | 19.4 | 21.3 | 0.89 (0.40-2.00)** | .78 |
| (%) Opiate use | 23.9 | 0.0 | | |
| (%) Stimulant use | 19.4 | 0.0 | | |
| (%) Benzodiazepine use | 29.9 | 0.0 | | |
| (%) Cannabis use | 44.8 | 1.3 | 62.5 (8.4-500.00)** | <.0001 |

*Notes:* OR, Odds Ratio. Odds ratios for opiate use, stimulant use, and benzodiazepine use could not be computed, as no mothers in the comparison group reported use of these substances during pregnancy.
* Mean difference, ** Odds Ratio

Illicit drugs were more commonly used during pregnancy by mothers maintained on methadone than comparison mothers. Twenty-three percent of mothers maintained on methadone also used other opiates during pregnancy, compared to zero mothers in the comparison group. A higher proportion of mothers maintained on methadone during pregnancy also used stimulants (19.4%) and benzodiazepines (29.9%) compared to the comparison group, in which no mothers used either stimulants or benzodiazepines during pregnancy. Cannabis was used by 44.8% of mothers maintained on methadone during pregnancy, compared to 1.3% of mothers in the comparison group (OR = 62.5; $p$ <.0001). The proportion of mothers that used illicit drugs during pregnancy was significantly higher among mothers maintained on methadone, for all illicit drugs reported ($p$<.0001).

### *3.3 School Readiness Domain Outcomes*

The performance of methadone-exposed and comparison children across all measures of school readiness was compared. The mean differences and odds ratios are reported for the methadone-exposed and the comparison children, on measures of each school readiness domain. The proportions of children from each group that were considered school ready are reported in Tables 4 to 8.

*Health and Physical Development.* Table 4 (p. 58) shows the difference between methadone-exposed and control children on measures of health and physical development. Methadone-exposed children were characterised by poorer health and physical development than control children. Methadone-exposed children were more likely than control children to have a significant health problem, indicated by their high number of health care visits (OR = 9.01; $p$ =.002). Methadone-exposed children also had a higher tendency than comparison children not to be toilet trained, however this difference did not reach significance (OR = 3.56; $p$ =.07). Examination of the proportions of children whose Beery-VMI scores classified them as having a visual-motor delay showed that methadone-exposed children were significantly more likely than comparison children to be at risk of a visual-motor delay at age 4.5 years (OR = 5.65; $p$ <.0001). According to the health and physical development readiness score, 62.5% of children in the methadone-exposed group were not school ready, compared to 24.4% of children in the control group.

Table 4

*Health and Physical Development of ME Children Compared to Non-Exposed Control Children*

| Measures | Methadone-Exposed | Control | OR (95% CI) | *p* |
|---|---|---|---|---|
| (%) Children receiving medical attention >12 times per year | 18.5 | 2.5 | 9.01 (1.93-41.67) | .005 |
| (%) Not toilet trained | 12.1 | 3.8 | 3.56 (0.90-14.08) | .07 |
| (%) Delay in Visual Motor Functioning Beery-VMI | 54.5 | 17.5 | 5.65 (2.67-12.05) | <.0001 |
| Total Physical Health School Readiness: | | | | |
| (%) Ready | 37.5 | 75.6 | 5.18 (2.51-10.67) | <.0001 |
| (%) Not Ready | 62.5 | 24.4 | | |

*Notes:* ME, Methadone-exposed; OR, Odds Ratio; CI, Confidence Interval. Methadone-exposed group (*N* = 65); Control group (*N* = 80) as interview data was not obtainable for these participants.

*Social-Emotional Skills*. As shown in Table 5 (p. 60), the total difficulties score was significantly higher for methadone-exposed children compared to comparison children (mean difference = 4.94; $p$ <.0001). Fifty-five percent of methadone-exposed children had a total difficulties score over 1 SD higher than the mean of the comparison group, classifying over half of the children in the methadone-exposed group as unready in terms of their social-emotional development. In comparison, only 14.8% of non-exposed children had total difficulties scores that classified them as unready according to their social-emotional skills.

Methadone-exposed children were significantly more likely to have high levels of emotional, conduct and peer difficulties, and inattention/hyperactivity than the comparison children on the SDQ. A higher mean score for inattention/hyperactivity was reported for children born to mothers maintained on methadone during pregnancy compared to comparison children, which was the highest mean difference between groups reported using the SDQ (mean difference = 1.81; $p$ <.0001). Conduct difficulties were more highly reported for methadone-exposed compared to comparison children (mean difference = 1.57; $p$ <.0001). Caregivers of methadone-exposed children reported a mean score of emotional difficulties that was 0.79 higher than was reported for comparison children by their caregivers ($p$ =.005). Peer difficulties had the least difference reported between caregivers of methadone-exposed and control children, with a mean difference of 0.77 ($p$=.001).

Table 5

*Social-Emotional/Behavioural Adjustment Outcomes of ME Children Compared to Non-Exposed Control Children*

| Measures | Methadone-Exposed | Control | Mean Difference/OR (95% CI) | *p* |
|---|---|---|---|---|
| *M (SD)* Emotional difficulties Score | 1.96 (2.00) | 1.19 (1.31) | 0.79 (0.24-1.33)* | .005 |
| *M (SD)* Inattention/Hyperactivity Score | 4.24 (2.27) | 2.42 (2.14) | 1.81 (1.09-2.53)* | <.0001 |
| *M (SD)* Conduct difficulties Score | 2.51 (1.96) | 0.93 (1.06) | 1.57 (1.07-2.08)* | <.0001 |
| *M (SD)* Peer difficulties Score | 1.63 (1.66) | 0.86 (1.16) | 0.77 (0.31-1.24)* | .001 |
| *M (SD)* Total difficulties Score, SDQ | 10.33 (5.20) | 5.39 (3.95) | 4.94 (3.23-6.65)* | <.0001 |
| Social-Emotional School Readiness: | | | | |
| (%) Ready | 45.5 | 85.2 | 6.90 (3.16-15.10)** | <.0001 |
| (%) Not Ready | 55.2 | 14.8 | | |

*Notes:* ME, Methadone-exposed; CI, Confidence Interval. Methadone-exposed group (*N* = 66) as SDQ data was unobtainable for one participant.
* Mean Difference (95% CI), ** Odds Ratio (95% CI).

*Approaches to Learning*. Mean differences between methadone-exposed children and comparison children on measures of approaches to learning are shown in Table 6 (p. 62) Methadone-exposed children had a lower mean score than comparison children on all three subtests of the PKRS-II. Specifically, the mean difference between the methadone-exposed group and the comparison group on the subtest of auditory processing, which showed the largest between-group difference of the three subtests, was -3.36 ($p$ <.0001). The mean difference between the methadone-exposed group and the comparison group for verbal processing was -2.82 ($p$ <.0001). The mean difference between the methadone-exposed group and the comparison group for the subtest of perceptual processing was -2.93 ($p$ <.0001). The mean total readiness score of the methadone-exposed group was -19.36 lower than the mean total readiness score of the comparison group ($p$ <.0001).

Just over half of the children in the methadone-exposed group were considered school ready according to their approaches to learning, while 85.2% of control children were considered school ready in this domain. Methadone-exposed children had almost five times the odds of not being school ready in this domain compared to non-exposed children (OR = 4.78; $p$ <.0001).

Table 6

*Approaches to Learning Outcomes of ME Children Compared to Non-Exposed Control Children*

| Measures | Methadone-Exposed | Control | Mean Difference/OR (95% CI) | *p* |
|---|---|---|---|---|
| *M (SD)* Verbal Processing Score | 7.49 (3.57) | 10.31(3.19) | -2.82 (-3.94-1.69)* | <.0001 |
| *M (SD)* Perceptual Processing Score | 6.03 (3.68) | 8.96 (3.49) | -2.93 (-4.13-1.73)* | <.0001 |
| *M (SD)* Auditory Processing Score | 5.46 (3.36) | 8.82 (3.39) | -3.36 (-4.49-2.23)* | <.0001 |
| *M (SD)* Total Readiness Score, PKRS-II | 76.81 (22.97) | 96.17 (18.62) | -19.36 (-26.28-26.45)* | <.0001 |
| Approaches to Learning School Readiness: | | | | |
| (%) Ready | 58.7 | 87.2 | 4.78 (2.08-10.98)** | <.0001 |
| (%) Not Ready | 41.3 | 12.8 | | |

*Notes:* ME, Methadone-exposed; CI, Confidence Interval. Methadone-exposed group (*N* = 63), control group (*N* = 78) as PKRS-II data was unobtainable from several participants.
* Mean Difference (95% CI), ** Odds Ratio (95% CI)

*Language and Communication.* The proportions of children with language delays in each group can be viewed in Table 7 (p. 64). Examination of the proportions of children whose scores classified them as having a receptive, expressive, or total language delay, showed that methadone-exposed children were significantly more likely than comparison children to have a delay in each of the language domains.

Seventy-six percent of methadone-exposed children had a receptive language delay, compared to 23.3% of comparison children. Methadone-exposed children had just over seven times the odds of having a receptive language delay compared to control children (OR = 7.09; $p$ <.0001). More methadone-exposed than comparison children had an expressive language delay (70.9% vs. 29.1% respectively). Methadone-exposed children had almost six times the odds of having an expressive language delay compared to comparison children (OR = 5.89; $p$ <.0001). Methadone-exposed children were also significantly more likely to have a total language delay compared to comparison children (OR = 8.58; $p$ <.0001). As total language delay determined language and communication school readiness, the same proportions of children in the methadone-exposed and comparison groups that had a total language delay were not classified as school ready in this domain (62.1% and16.0% respectively).

Table 7

*Language and Communication Outcomes of ME Children Compared to Non-Exposed Control Children*

| Measures | Methadone-Exposed | Control | OR (95% CI) | *p* |
|---|---|---|---|---|
| (%) Receptive language delay | 76.7 | 23.3 | 7.09 (3.13-16.13) | <.0001 |
| (%) Expressive language delay | 70.9 | 29.1 | 5.89 (2.82-12.20) | <.0001 |
| (%) Total language delay, CELF-P | 62.1 | 16.0 | 8.58 (3.96-18.61) | <.0001 |
| Language and Communication School Readiness: | | | | |
| (%) Ready | 37.9 | 84.0 | 8.58 (3.96-18.61) | <.0001 |
| (%) Not Ready | 62.1 | 16.0 | | |

*Notes:* ME, Methadone-exposed. CI, Confidence Interval. Methadone-exposed group (*N* = 66), as CELF-P data was unobtainable from one participant.

*Cognition and General Knowledge.* Table 8 (p. 66) shows the mean difference in IQ scores between the methadone-exposed and comparison groups. Methadone-exposed children scored significantly lower than comparison children on the WPPSI-R, with a mean difference of -14.66 ($p$ <.0001). The results obtained by this measure classified just over half of the children in the methadone-exposed group as school ready in terms of cognition and general knowledge. This was in comparison to almost 90% of control group children who were classified as school ready in this domain. Methadone-exposed children had six times the odds of not being classified as school ready in terms of their cognition skills and general knowledge compared to comparison children (OR = 6.11; $p$ <.0001).

Table 8

*Cognition and General Knowledge of ME Children Compared to Non-Exposed Control Children*

| Measures | Methadone-Exposed | Control | Mean Difference/OR (95% CI) | *p* |
|---|---|---|---|---|
| *M (SD)* Full Scale IQ Score | 96.16 (14.94) | 110.83 (14.80) | -14.66 (-19.51-9.81)* | <.0001 |
| Cognition and General Knowledge School Readiness: | | | | |
| (%) Ready | 53.7 | 87.7 | 6.11 (2.70-13.85)** | <.0001 |
| (%) Not ready | 46.3 | 12.3 | | |

*Notes:* ME, Methadone-exposed; CI, Confidence Interval.
* Mean Difference (95% CI), ** Odds Ratio (95% CI).

Results thus far indicate that methadone-exposed children have more health concerns and perform more poorly than comparison children across measures of the five domains of school readiness. However, what is not clear from this analysis is the extent to which children in each group were subject to problems across multiple school readiness domains. To examine this issue, proportions of children that were not classified as school ready in each of the domains were compared between the methadone-exposed and comparison groups. Results are reported before and after adjustment for socio-familial risk, to determine the extent to which socio-familial risk contributed to rates of unreadiness. To determine the extent to which some children might be subject to multiple difficulties, this analysis was followed by an examination of the proportion of children in each group who had comorbid difficulties across the five school readiness domains.

### *3.4 Overall School Readiness Outcome*

The proportions of methadone-exposed and comparison children who had particular areas of unreadiness across the five school readiness domains were compared (see Table 9, p. 68). Methadone-exposed children had increased odds for unreadiness in all five domains of school readiness prior to adjustment for socio-familial risk ($p$ <.0001). Language and communication was the domain with the highest increase in odds for unreadiness for methadone-exposed children compared to comparison children, with an odds ratio of 8.58 ($p$ <.0001), as shown in Table 9 (p. 68). Methadone-exposed children had almost seven times the odds of being unready in terms of social and emotional skills (OR = 6.90; $p$ <.0001). They had five times the odds of being unready in terms of health and physical development (OR = 5.18; $p$ <.0001). In terms of approaches to learning, they had almost five times the odds of being unready (OR = 4.78; $p$ <.0001).

Table 9

*Proportions of Children in Each Group With Vulnerabilities Across the Five Domains of School Readiness*

| School Readiness Domain | Methadone-Exposed Group (*N*=67) | Control Group (*N*=81) | OR (95% CI) | *p* | OR (95% CI), Adjusted for Socio-familial risk | *p* |
|---|---|---|---|---|---|---|
| Health and physical development | 62.5 (65) | 24.4 (79) | 5.18 (2.51-10.67) | <.0001 | 2.16 (0.86-5.43) | .10 |
| Social-emotional skills | 55.2 (66) | 14.8 (81) | 6.90 (3.16-15.10) | <.0001 | 3.00 (1.17-7.71) | .02 |
| Approaches to learning | 41.3 (63) | 12.8 (78) | 4.78 (2.08-10.98) | <.0001 | 2.47 (0.91-6.69) | .08 |
| Language and communication | 62.1 (66) | 16.0 (81) | 8.58 (3.96-18.61) | <.0001 | 4.10 (1.64-10.22) | .003 |
| Cognition and general knowledge | 46.3 (67) | 12.3 (81) | 6.11 (2.70-13.85) | <.0001 | 2.17 (0.81-5.81) | .12 |

*Note:* OR, Odds Ratio; CI, Confidence Interval. Data are presented as % (*N*) unless otherwise stated

After adjustment for socio-familial risk, the odds of unreadiness for each domain were attenuated, remaining significant only for the domain of social-emotional skills (*p* = .02), and the domain of language and communication (*p* = .003). Odds ratios ranged from 2 to 4 after adjustment for socio-familial risk, and between group differences across all five school readiness domains ranged from *p* = .003 to *p* = .12. While odds of unreadiness for methadone-exposed children in health and physical development, approaches to learning, and cognition and general knowledge were not significantly different to comparison children after adjustment for socio-familial risk, the differences were trending on significance.

In terms of comorbid difficulties, methadone-exposed children were more likely to have multiple school readiness difficulties, compared with control children ($\chi^2 = 41.54$, $p < .0001$). As shown in Table 10 (p. 70), 21.7% of children in the methadone-exposed group had four school readiness difficulties, compared to 8% of the control group. Over 18% of the methadone-exposed group compared to 1.3% of the control group were impaired across all five school readiness domains.

Table 10

*Number of School Readiness Domains in Which Children Were Not School Ready*

| Number of Domains of Unreadiness | Methadone-Exposed Children | | Comparison Children | |
|---|---|---|---|---|
| | (*N*) | (%) | (*N*) | (%) |
| 0 | 8 | 13.3 | 48 | 64.0 |
| 1 | 12 | 20.0 | 9 | 12.0 |
| 2 | 9 | 15.0 | 9 | 12.0 |
| 3 | 7 | 11.7 | 2 | 2.7 |
| 4 | 13 | 21.7 | 6 | 8.0 |
| 5 | 11 | 18.3 | 1 | 1.3 |

Further exploratory analysis showed that there were several different patterns of comorbidities. This analysis was restricted to the methadone-exposed group only (Table 11, p. 71). For example, 68.6% of methadone-exposed children that were not school ready in terms of social-emotional skills were also not ready with respect to health and physical development. Almost 85% of children not ready in terms of approaches to learning also showed vulnerability in the domain of language and communication. The school readiness domain with the highest proportion of children showing comorbid vulnerability was cognition and general knowledge, with 69% also not ready in approaches to learning and over 90% not ready in terms of their language and communication development.

Table 11

*Proportions of ME Children with Coexisting Vulnerabilities in Each of the Five Domains of School Readiness*

| | Health and Physical Development | Social-Emotional Skills | Approaches to Learning | Language and Communication | Cognition and General Knowledge |
|---|---|---|---|---|---|
| Health and Physical Development | | 60.0 (24) | 56.8 (21) | 76.9 (30)* | 65.0 (26)* |
| Social-Emotional Skills | 68.6 (24) | | 52.9 (18) | 61.1 (22)* | 58.3 (21) |
| Approaches to Learning | 87.5 (21) | 72.0 (18)* | | 84.6 (22) | 76.9 (20) |
| Language and Communication | 76.9 (30)* | 55.0 (22)* | 57.9 (22) | | 68.3 (28) |
| Cognition and General Knowledge | 86.7 (26) | 70.0 (21) | 69.0 (20) | 90.3 (28) | |

*Notes:* ME; Methadone-exposed; **p* <.05. Data are presented as % (*N*).

To examine the extent to which school readiness outcomes were explained by a range of confounding and selection factors independent of child group status, hierarchical multiple regression analysis was performed. Selection of potentially confounding variables was based on group differences noted in the sample characteristics at term, and on previous research outlining the common socio-familial differences that may be inherent between drug-using and nondrug-using families. As a first step, to determine which variables were most associated with school readiness outcome at age 4.5 years, Pearson's product moment correlation was performed. The results of this analysis are shown in Table 12 (pp. 73-74).

Infant variables entered included birth weight, head circumference, and NAS treatment. The socio-familial risk index, maternal mental health, and other maternal drug use during pregnancy were entered as socio-familial variables. Maternal cigarette use was entered as the average number of cigarettes smoked per day during pregnancy. Use of other substances such as alcohol, cannabis, opiates, illicit benzodiazepines and stimulants were dichotomised (use/non-use).

Results from the correlation analysis (Table 12, pp. 73-74) showed that school readiness outcome at age 4.5 years was significantly associated with several socio-familial variables. Average maternal tobacco use during pregnancy was most highly correlated with child unreadiness at age 4.5 years ($r$ = .55, $p$ = <.0001). High socio-familial risk was also highly associated with unreadiness ($r$ = .52, $p$ = <.0001), as were group status ($r$ = .51, $p$ = <.0001), infant NAS treatment ($r$ = -.48, $p$ = <.0001), and maternal mental health disorder ($r$ = .33, $p$ = <.0001). Maternal cannabis use was also significantly correlated with school readiness outcomes at age 4.5 years ($r$ = .21, $p$ = .02).

Table 12

*Correlation Matrix of Potential School Readiness Covariates at Age 4.5 Years*

| | School Readiness | Group Status | Birth weight | Head circ. | NAS tx | SF risk | Tobacco | Cannabis | Alcohol | Benzos | Opiates | Stimulants | Maternal mental health |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| School Readiness | | .51** | -.15 | -.09 | -.48** | .52** | .55** | .21* | .02 | .37** | .07 | .09 | .33** |
| Group Status | .51** | | .22** | .28** | .86** | .63** | .67** | .53** | .02 | .43** | .38** | .34** | .36** |
| Birth weight | -.15 | .22** | | .65** | .35** | -.18* | -.30** | -.27** | -.01 | -.19* | -.15 | -.12 | -.05 |
| Head circ. | -.09 | .28** | .65** | | .29** | -.18* | -.16 | -.25** | -.02 | -.27** | -.14 | -.09 | -.22** |
| NAS tx | -.48** | .86** | .35** | .29** | | -.52** | -.63** | -.42** | .04 | -.34** | -.26** | -.25** | -.36** |
| Socio-familial risk | .52** | .63** | -.18* | -.18* | -.52** | | .54** | .36** | .05 | .37** | .24** | .23** | .34** |
| Tobacco | .55** | .67** | -.30** | -.16 | -.63** | .54** | | .37** | .03 | .23** | .24** | .14 | .21* |
| Cannabis | .21* | .53** | -.27** | -.25** | -.42** | .36** | .37** | | .03 | .52** | .41** | .31** | .13 |

*Notes:* Head Circ.; head circumference. Tx; treatment. SF risk; Socio-familial risk. Benzos; Benzodiazepines. $p < .05$*, $p < .01$**. Table 12 continued over page

Table 12

*Correlation Matrix of Potential School Readiness Covariates at Age 4.5 Years Continued*

| | School Readiness | Group Status | Birth weight | Head circ. | NAS tx | SF risk | Tobacco | Cannabis | Alcohol | Benzos | Opiates | Stimulants | Maternal mental health |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alcohol | .02 | .02 | -.01 | -.02 | .04 | .05 | .03 | .03 | | -.004 | .09 | .14 | .07 |
| Benzos | .37** | .43** | -.19* | -.27** | -.34** | .37** | .23** | .52** | -.004 | | .31** | .37** | .21* |
| Opiates | .07 | .38** | -.15 | -.14 | -.26** | .24** | .24** | .52** | .09 | .31** | | .35** | .15 |
| Stimulants | .09 | .34** | -.12 | -.09 | -.25** | .23** | .14 | .31** | .14 | .37** | .35** | | .05 |
| Mental health | .33** | .36** | -.05 | -.22** | -.36** | .34** | .21* | .13 | .07 | .21* | .15 | .05 | |

*Notes:* Head Circ.; head circumference. Tx; Treatment. SF risk; Socio-familial risk. Benzos; Benzodiazepines. $p$ <.05*, $p$ <.01**.

Only those variables which showed a significant ($p$ <.05), correlation of $r$ >.3 with child unreadiness, were retained for further analysis. However, in checking for multicollinearity, the variables of group status and NAS treatment were found to highly correlate ($r$ = .86), and so violated the assumptions of multiple regression analysis. Therefore, the NAS treatment variable was omitted in further analysis.

The final step in the regression analysis was to determine the independent contributions of methadone-exposure (group status), socio-familial risk factors and poly-substance use to school readiness outcomes at age 4.5 years. This analysis was conducted to investigate whether methadone-exposure in utero is associated with school readiness outcomes at age 4.5 years, independent of socio-familial risk factors and other drug exposure, or if these other covariates analysed explained more variance in school readiness outcome than methadone-exposure.

First, group status was entered into the model as a covariate of school readiness outcome at age 4.5 years. Table 13 (p. 76) shows that in Model 1, group explained a significant amount of variance in child unreadiness at age 4.5 years ($\beta$ = -.51, $p$ <.0001). In Model 2, group remained a significant covariate of school readiness ($p$ = .001), after entering the socio-familial risk index as a covariate of school readiness outcomes; however the amount of variance explained by group status was reduced from $\beta$ = -.51 to $\beta$ = -.30. Socio-familial risk factors explained one third of the variance of school readiness outcomes in Model 2 of the regression ($p$ = .001).

Table 13

*School Readiness Outcomes After Adjusting for Confounding and Selection Factors*

| Variable | *B* | *SE B* | *β* | *p* |
|---|---|---|---|---|
| Model 1 – Unadjusted | | | | |
| Group Status | -1.80 | .27 | -.51 | <.0001 |
| | $F$ (1, 132) = 46.23, $p$ < .0001, $R^2$ = .26, Adjusted $R^2$ = .25 | | | |
| Model 2 – Adjusted for socio-familial risk | | | | |
| Group status | -1.07 | .33 | -.30 | .001 |
| Socio-familial risk | .41 | .12 | .33 | .001 |
| | $F$ (2, 131) = 67.43, $p$ < .0001, $R^2$ = .33, Adjusted $R^2$ = .31 | | | |
| Model 3 – Adjusted for other confounding factors | | | | |
| Group Status | -.03 | .38 | -.01 | .95 |
| Socio-familial risk | .26 | .11 | .21 | .03 |
| Tobacco | .07 | .02 | .37 | <.0001 |
| Illicit benzodiazepines | .95 | .41 | .18 | .02 |
| Maternal Mental Health | .53 | .30 | .14 | .06 |
| | $F$ (5, 128) = 18.66, $p$ < .0001, $R^2$ =.42, Adjusted $R^2$ = .40 | | | |

In the third, and final regression model, the number of domains of school readiness in which a child exhibited vulnerability was regressed on: (a) group status (methadone-exposed or comparison) (b) socio-familial risk, (c) average maternal use of cigarettes during pregnancy, (d) maternal use of illicit benzodiazepines during pregnancy (use/non-use) and (e) maternal mental health. Model 3 showed that after controlling for confounding and selection processes, methadone exposure was not significantly associated with school readiness outcomes ($p$ = .95). Factors found to be significantly associated with school readiness were (a) average maternal cigarette use during pregnancy ($p$ <.0001), (b) maternal illicit benzodiazepine use during pregnancy ($p$ = .02), and (c) socio-familial risk factors ($p$ = .03).

This finding suggests that methadone exposure during pregnancy is not solely responsible for children displaying low levels of school readiness at age 4.5 years, but socio-familial risk factors and other substance use during pregnancy is more associated with higher levels of unreadiness.

# 4 DISCUSSION

This study was designed to determine whether school readiness outcomes at age 4.5 years were significantly different between children born to mothers maintained on methadone during pregnancy, and non-exposed children, thus providing an initial glance of the school readiness of this at-risk population. It also aimed to uncover socio-familial covariates of school readiness, to observe what maternal or environmental factors may account for some of the between-group differences noted on measures of school readiness.

In New Zealand and internationally, illicit drug use during pregnancy remains a significant issue, not only for the health and well-being of the drug-users, but also for the children they raise (Adamson et al., 2012; Ministry of Health, 2007). Previous research investigating the developmental outcomes of children born to women maintained on methadone during pregnancy suggests that these children are at higher risk of adverse outcomes during infancy, compared to non-drug exposed children. Studies have yet to thoroughly investigate the outcome of these children at preschool age and beyond. Another issue concerning research on the effects of prenatal drug exposure on developmental outcome is the lack of control for confounding and selection factors typically associated with drug-abusing families.

This study has a number of strengths, including its prospective, longitudinal design, strong recruitment and retention rates, and the use of a wide-range of measures, with the ability to include all domains of school readiness in the data analysis. An added strength of this study included the size of the samples, with results obtained for 67 children exposed prenatally to methadone, and 81 comparison children, all from the Canterbury region. The key findings from this study are reviewed below.

### *4.1 Health and Physical Development Outcome*

In line with other studies researching the developmental outcomes of infants and children exposed prenatally to methadone, the children in this study that were born to mothers maintained on methadone during pregnancy were physically significantly shorter in length, weighed less, and had a significantly smaller head circumference than control infants at term. This supports the evidence that children prenatally exposed to methadone have restricted foetal growth, when born full-term (Kandall et al., 1976; Lifschitz et al., 1985). The study by Wilson et al. (1979) found that at preschool age, heroin-exposed children also have a lower mean weight, and a smaller mean head circumference than comparison groups.

Collectively, this evidence supports the proposal that a trend for growth impairment is apparent for children exposed prenatally to opiates.

Approximately one third of children born to mothers maintained on methadone during pregnancy were not considered school ready according to their physical health, compared to one quarter of comparison children. The high proportion of methadone-exposed children with a health and physical development vulnerability causes the need for concern about the physical welfare of these children, and their health status for the future. The proportion of control children considered not ready for school by health and physical development was significantly less than the methadone-exposed group.

The results gained using measures of health and physical development at age 4.5 years also showed that there were a significantly higher proportion of methadone-exposed children than comparison children showing unreadiness in this domain. Specifically in terms of general health, more methadone-exposed than comparison children were classified as having significant health problem, which would cause them to seek health care services more than once a month. This indicates that methadone-exposed children may be more likely to suffer chronic health issues that may cause them to miss time in school. Although the majority of studies researching infants exposed prenatally to methadone have not recorded the health status of the children, one study did note a higher incidence of infections such as glue-ear, and more eye disorders in the methadone-exposed infants (Rosen & Johnson, 1982). This suggests a trend for poor health and physical development of methadone-exposed children compared to control children, however further evidence is needed to support this suggestion.

In terms of toilet training issues, this study revealed that a higher proportion of methadone-exposed children were unable to stay dry during the day, compared to the control group. While this difference was not statistically significant, the proportion of children about to start school in the methadone-exposed group that were not toilet-trained was 12.1%, with methadone-exposed children having almost four times the odds of not being toilet trained at age 4.5 years than comparison children. Such issues may present a problem for schools, as children start school at an age when they are expected to be able to go to the toilet on their own.

In agreement with the majority of the literature on the motor outcomes of methadone-exposed infants, this study found that the methadone-exposed group performed more poorly than the control group on a measure of visual-motor integration. Specifically, in this study, 54% of methadone-exposed children were classified as having a visual-motor delay, compared to 17.5% of comparison children. Methadone-exposed children had almost seven times the odds of having a visual-motor delay than comparison children. During their school years, those children that have poor motor development are likely to show academic difficulties (Roberts et al., 2011), as certain tasks, such as handwriting, require well-developed visual-motor integration. Later in life, those individuals that show poor visual-motor integration during preschool, may struggle to improve this area of their development, and may come across several more visual-motor integration difficulties in adult life, such as the ability to drive a car.

### *4.2 Social-Emotional Outcome*

The school readiness domain of social and emotional skills is an area that is relatively understudied in the research of methadone-exposed children. Only two studies have measured social-emotional skills in methadone-exposed children of various age groups (de Cubas &

Field, 1993; Hunt et al., 2008), but no study has yet measured the social and emotional skills of methadone-exposed children in terms of school readiness. This study measured social and emotional skills of methadone-exposed and control children at age 4.5 years using the SDQ.

Over half of the children in the methadone-exposed group were not school ready in the domain of social-emotional skills, compared to only 15% of the control children, a difference that was statistically significant. Methadone-exposed children had over six times the odds of comparison children of being unready in terms of their social-emotional skills. Collectively, these findings suggest a large percentage of methadone-exposed children will present with a greater number of social-emotional and behavioural adjustment problems at age 4.5 years.

Results were obtained for the SDQ subtests relating to emotional difficulties, inattention/hyperactivity, conduct problems and peer difficulties, as well as obtaining a total difficulties score. The results of this study showed that methadone-exposed children were significantly more likely to have problems in each subtest of the SDQ, as reported by their primary caregiver. Specifically, the total difficulties score for methadone-exposed children was significantly higher than for comparison children. This indicates a higher number of total social-emotional problems within the methadone-exposed children. The mean score for inattention/hyperactivity showed the largest between-group difference of the individual SDQ subtests, with methadone-exposed children's caregivers rating their children significantly more inattentive and hyperactive than comparison caregivers. More methadone-exposed compared to control children were also rated by their caregivers as having conduct problems. In addition, methadone-exposed children were rated by their caregivers as having more emotional difficulties and more peer difficulties than comparison children.

Previous studies have also reported a significant difference in the social-emotional adjustment between methadone-exposed children at age 3 years (Hunt et al., 2008) and at school-age (de Cubas & Field, 1993) compared to control children. The trend shown by Hunt et al., de Cubas and Field, and the current study, for methadone-exposed children to have more socio-emotional difficulties than comparison children at a variety of ages from infancy to adolescence, suggests that these difficulties remain an issue for methadone-exposed children throughout their lives.

A study of the school readiness of heroin-exposed children also noted poor social and emotional skills in the exposed compared to non-exposed children, further supporting the notion that prenatal opiate-exposure affects social-emotional adjustment. Parent and researcher ratings of child behaviour indicated that heroin-exposed children were more impulsive, temperamental, aggressive, and more hyperactive than comparison children at preschool age (Wilson, McCreary, Kean, & Baxter, 1979).

The results from the SDQ indicate that at age 4.5 years, methadone-exposed children may be difficult to interact with as parents, teachers and friends (Blair, 2002). As adults, poor social and emotional adjustment could cause problems to develop within various relationships, and could lead to more run-ins with the law, as misconduct could become a more serious issue. As a larger result, society would benefit from the identification of children with social-emotional problems at a young age, to try and prevent the coercion of these issues, and help the individuals gain important social skills, and the ability to self-regulate emotions.

### *4.3 Approaches to Learning Outcome*

Approaches to learning is an important domain of school readiness, and is yet to be studied in a population of methadone-exposed children. This research assessed the approaches to learning of methadone-exposed preschool children compared to control children, using the PKRS-II. Results from the PKRS-II revealed that almost half of the children in the methadone-exposed group were not school ready in the domain of approaches to learning. This was a significantly higher proportion of unready children compared to the control group, in which only 13% were considered not ready for school. Methadone-exposed children had almost five times the odds of being unready for school according to their approaches to learning results.

The PKRS-II provided results for the verbal, perceptual and auditory processing of the two study groups, as well as a total readiness score. The results obtained showed that methadone-exposed children scored significantly lower than the control children on the verbal processing, perceptual processing, auditory processing subscales, and obtained a lower total readiness score. As far as the author is aware, no research among the methadone-exposed or wider opiate-exposed population has yet been published. Therefore, the results of this study provide an initial theoretical stand-point, proposing that the domain of approaches to learning is impaired among methadone-exposed children. As an early measure of executive functioning (Roberts et al., 2011), approaches to learning is an important area of school readiness for further research. Executive functioning becomes extremely important at school and beyond. Working memory, attentional ability, self-control, and the ability to create and execute plans, are all skills essential for succeeding in education and are governed by executive function development (Blair, 2002). Children that show strong executive function development, are more curious, attentive, and eager to learn, will manage school curriculum tasks more easily children with poor executive functioning (Copple, 1997). The significant difference between methadone-exposed and control children in terms of approaches to learning, highlights the importance of early intervention, focused on executive function, for methadone-exposed children, as they are falling behind non-exposed children before school-age. One intervention available to assist children aged 4 to 12 years with the development of executive functioning, is the "Tools of the Mind" programme, developed by Adele Diamond (Diamond & Lee, 2011).

### *4.4 Language and Communication Outcome*

Language and communication was found to be the most vulnerable of the domains of school readiness for children born to mothers maintained on methadone, with only 37.9 % of these children classified as school ready in this domain. Specifically, a significantly higher proportion of children in the methadone-exposed group had a receptive language delay, with this group having seven times the odds of a receptive language delay compared to the comparison group. The methadone-exposed children also had significantly increased odds of having an expressive language delay compared to the comparison children. In addition, methadone-exposed children had almost nine times the odds of having a total language delay compared to comparison children, which was significant.

No studies have yet measured the language or communication skills of methadone-exposed children in terms of school readiness. One study that measured the language ability of younger (3 year old) children, found that there was a significant difference between methadone-exposed children and control children on subtests of both receptive and expressive language (Hunt et al., 2008). Studies researching the developmental outcomes of children prenatally exposed to other opiates have not yet researched the school readiness of these children, in terms of language and communication development, therefore the results of this study could be of theoretical importance to the wider opiate-exposed population. As far as the author is aware, the current study is the first to measure language and communication skills of methadone-exposed children in an assessment of school readiness. The results suggest this school readiness domain is severely compromised among methadone-exposed children, and that language could pose a potential problem for these children as they progress through school.

While there is no supporting evidence for a language and communication vulnerability among methadone-exposed children to date, the results of this study suggest that the school readiness domain of language and communication for methadone-exposed children is the most significantly impaired domain, with large mean differences between methadone-exposed and control children on receptive and expressive language subtests, and on total language. A language intervention at the earliest age possible could lessen the proposed language gap between methadone-exposed and non-exposed children. This may assist methadone-exposed children in areas of schooling that are governed by language and communication, such as understanding subject matter at school, and with peer interactions (Roberts et al., 2011).

### *4.5 Cognition and General Knowledge Outcome*

Relative to other neurodevelopmental domains, the cognitive outcomes of methadone-exposed infants and children have been highly researched. Previous research in this area has focused on global measures of intelligence as a measure of child cognitive outcome after prenatal methadone exposure. In line with previous research, this study found a significant difference between the methadone-exposed group and the control group using IQ as a measure of cognition and general knowledge. Methadone-exposed children had an average IQ score of 96.16 on the WPPSI-R. Although this mean was only slightly below the normative mean of 100, this score was significantly different to the mean of the comparison group in this study (110.83). Methadone-exposed children had significantly higher odds of unreadiness in the cognition and general knowledge domain compared to comparison children.

The results from the cognition and general knowledge analysis supports previous research suggesting that while children born to mothers maintained on methadone during pregnancy may exhibit global cognitive ability within the normal range, these children often lag behind their non-exposed peers (de Cubas & Field, 1993; H. L Johnson et al., 1984; Lifschitz et al., 1985; Strauss et al., 1976; Wilson et al., 1981). Early cognitive differences noted in infancy appear to become more prominent over time. For example, several of the longitudinal studies reviewed found no significant differences between methadone-exposed and control groups between 3 and 12 months of age, but differences emerged around the age of 18 months (Hans, 1989; Hunt et al., 2008; Rosen & Johnson, 1982), suggesting more severe deficits may be uncovered later in development as more cognitive skills come on line. Of the few studies that have not shown significant differences between methadone-exposed and control groups, large attrition rates by their final follow-up assessments, or initial low sample sizes have often been a factor, therefore their results may not be generalised (de Cubas & Field, 1993; Hans, 1989; H. L Johnson et al., 1984; Lifschitz et al., 1985; Strauss et al., 1976; Wilson et al., 1981).

The findings of the current study are also in line with studies examining the school readiness outcomes of children prenatally exposed to other opiates. These studies have also reported differences between exposed and non-exposed children on measures of cognition and general knowledge. For example, Wilson et al. (1979) also noted that while heroin-exposed children scored within the normal range on measures of cognition, their scores were lower overall compared to the control group. As was also found in the current study, Pulsifer et al. (2004) found that opiate- and other drug-exposed children performed below the normative mean on a measure of IQ. Compared to control children however, their performance was not significantly different. The insignificance of this difference may be due to the small sample size of the comparison group in the Pulsifer et al. study. The results of Wilson et al. and Pulsifer et al. are similar to the results of the current study, suggesting that in the domain of cognition and general knowledge, opiate-exposed children tend to fall behind non-exposed children in their performance.

Cognition and general knowledge form the basis of our understanding of the world (Copple, 1997). Well developed cognition and general knowledge provide us with the ability to carry out daily tasks as adults, such as balancing finances, cooking meals, and taking care of our children. Cognition and general knowledge are partly dependent on what a child has learnt during their preschool years, with the ability to understand numbers, differentiate between shapes and colours, and have a basic knowledge of time and seasons, important as the foundations for further development (Roberts et al., 2011). These basic skills are likely to play a critical role in children’s transition to school, when children begin to learn basic mathematics, write comprehensible stories, and need to know the important general information for survival, such as the need of food for growth and strength, and the relationship between warm clothes and cold weather (Copple, 1997). A child with good general knowledge and sound cognitive ability will succeed in school, but those that show vulnerability in this area are likely to struggle (G. J. Duncan et al., 2007).

The large proportion (46.3%) of methadone-exposed children identified in this study that were not school ready according to cognition and general knowledge, indicates that children born to mothers maintained on methadone during pregnancy may need support at an early age to build up their general knowledge, to provide a good base that is ready for the hoard of new knowledge that they will encounter when they transition to school.

### *4.6 Overall School Readiness Outcome*

This far, results of the study suggest that children in the methadone-exposed group have higher odds of unreadiness than comparison children across all five school readiness domains, suggesting that these children are significantly less likely to be school ready than their same-age, non-exposed peers. After adjustment for socio-familial risk, using the socio-familial risk index, these differences attenuated. However, there remained significant differences between the two groups for the domains of social-emotional skills, and language and communication, with methadone-exposed children having significantly higher odds for unreadiness after adjustment for socio-familial risk in these domains.

These results suggest that even after controlling for socio-familial factors, children exposed prenatally to methadone are still more likely to experience difficulties in social-emotional skills, or language and communication skills than their non-exposed peers. Although the odds for rates of health and physical development unreadiness were no longer significantly higher for methadone-exposed children after adjustment, there was a trend for higher rates of problems in this area for children in the methadone-exposed group. Similarly, odds for unreadiness in the domains of approaches to learning, and cognition and general knowledge, while no longer significantly higher for the methadone-exposed group, were trending towards significance.

The decrease in odds of unreadiness in these three domains after adjustment for socio-familial risk could be due to several factors. First, children who live in environments characterised by low SES may be subject to more health disorders due to poorer living conditions. This may be colder housing, poor nutrition, and other factors which may contribute to ill-health, such as poor hygiene. The decrease in odds for unreadiness in the domains of approaches to learning, and cognition and general knowledge after adjustment could be due to explanatory factors in the socio-familial risk index such as lower maternal education and maternal age. Mothers who are less educated and who had children at an early age may spend less time interacting with, and creating a stimulating learning environment for their child. This includes reading books, and teaching their child new information as they converse with them. Families of low income may also not have the resources or time available to spend teaching their children, or to play educational games with them. All of these factors add up to create a stimulating environment in which a child learns as they grow. Children in the methadone-exposed group living among families characterised by lower maternal education and family SES may not have as many opportunities to learn through their environment as children living in a lower risk environment (K. Johnson et al., 2003). It therefore important to note that children born to women maintained on methadone during pregnancy are more likely to be living among families of higher socio-familial risk than children in the comparison group. This is because a high risk lifestyle is strongly correlated with opiate-use (H. L. Johnson et al., 1990; K. Johnson et al., 2003; Moe, 2002; Vucinovic et al., 2008).

The current study also found that children in the methadone-exposed group have significantly more domains in which they are not school ready, compared to the control children. Specifically, 21.7% of these children showed readiness vulnerability in four plus domains compared to only 8% of the control children. This high level of comorbidity in the methadone-exposed group relative to the control group could be due to the fact that five school readiness domains are inherently related, and so problems in one school readiness domain are likely to cause problems within another (Papalia & Feldman, 2011).

### *4.7 Socio-Familial Risk Factors*

A multiple regression analysis was conducted to determine the extent to which group differences across school readiness outcomes at age 4.5 years might be explained by a range of cofounding and selection factors of the methadone-exposed group. This result suggested that a child born to a mother maintained on methadone during pregnancy that was living in a higher-risk environment was less likely to be school ready, than a non-exposed child from a low-risk environment. This finding is in line with current research that has shown that socio-familial factors such as poly-drug use during pregnancy and maternal SES and education, predict poor neurodevelopmental outcome for children prenatally exposed to teratogenic drugs (Chasnoff et al., 1988; Lester & Lagasse, 2010; Vucinovic et al., 2008).

### *4.8 Limitations of the Current Study*

There are several limitations inherent in research examining the developmental outcomes of drug-exposed children, particularly in the literature on opiate-exposed children. Limitations of the current study are discussed below, in relation to those in the existing literature on methadone-exposed infants and children.

*Retention and Recruitment.* Whilst this study has shown a relatively excellent retention rate compared to other studies researching methadone-exposed infants and children (Hunt et al., 2008; H. L Johnson et al., 1984; Rosen & Johnson, 1982; Strauss et al., 1976), it is possible that the families in the current study that were unable to be re-recruited at age two or 4.5 years, represent families with the most at-risk children. It is likely that those families that were not able to be recruited for further follow-up assessment in the current study are the most disadvantaged families in terms of social-familial and environmental risk (K. Johnson et al., 2003; Vucinovic et al., 2008). It is possible that if successfully retained, inclusion of those children in this analysis may have contributed to even poorer outcomes for the methadone-exposed group.

Nevertheless, the initial high recruitment rate of mothers in the methadone-exposed population in this study increases the confidence of the generalisability of the results to the wider methadone-exposed population of Christchurch and New Zealand. This is true particularly for the generalisability to the Canterbury region, since it is reported that Christchurch has a higher number of opiate-dependent individuals than other regions of New Zealand (Adamson et al., 2012).

*Poly-Drug Use.* An issue that causes difficulty when researching and interpreting results of research among the methadone-dependent population is the factor of poly-drug use. Many people that use illicit drugs are often poly-drug users, and the difficulty of attempting to single out the effects of the prenatal exposure of a particular drug on later child neurodevelopmental outcome has been acknowledged (Lifschitz et al., 1985; Rosen & Johnson, 1982; Wilson et al., 1981). As was noted in the results of this thesis, maternal illicit benzodiazepine use, and maternal cigarette smoking during pregnancy, were both significant covariates of poor school readiness outcome at age 4.5 years, and explained more variance in school readiness than group (methadone vs. comparison). The use of regression as a tool to try and disentangle socio-familial factors contributing to school readiness allowed the common cofounder of poly-drug use as seen in other such studies to be examined in this study. Conclusions can now be drawn from these results, including the finding that children born to methadone maintained mothers that are poly-drug users, are less likely to be school ready at age 4.5 years, due to the cumulative socio-familial risk factors they are exposed to. Interestingly, maternal cigarette smoking and illicit benzodiazepine use were the strongest contributing factors to poor school readiness outcome. Other maternal illicit drug use such as the use of other illicit opiates, stimulants and cannabis during pregnancy, were not significant covariates of unreadiness at age 4.5 years. Benzodiazepine use during pregnancy has not been singled out as associated with later child neurodevelopmental outcomes in studies of this population at preschool age previously. The use of benzodiazepines and tobacco in pregnancy are of particular concern for child school readiness development, as they predict the most poor school readiness outcome at age 4.5 years, and are therefore of interest for future research. Due to the high number of methadone maintained mothers who are poly-drug users, it is important to monitor their children further into the future, to assess potential neurotoxic effects that prenatal poly-drug exposure may cause to emerge in later childhood.

*Measures.* The majority of the school readiness measures used in this study were standardised tests that have been psychometrically assessed, assuring they are reliable and valid. However, the SDQ is a parent-report measure, which obtains the parent’s or primary caregiver’s perspective on their child’s social and emotional strengths and difficulties. It is possible that parent reports hold a desirability bias, as parents may under-report problems they perceive to exist in their children's social and emotional behaviour. If parents or caregivers of the comparison children did not report the true characteristics of their children's socio-emotional behaviour, this may account for some of the group difference in reported problems between the methadone-exposed and comparison groups. It is also possible that parents in the methadone-exposed group may have over-reported problems of inattention/hyperactivity and misconduct among their children. Over-reporting of child difficulties may occur more within mothers maintained on methadone, as these women are more likely to lead an unorganised life-style, characterised by low income, and more mental health problems, possibly causing them to feel overwhelmed as parents (Vucinovic et al., 2008). This could be one reason for the high rate of problems in social and emotional skills reported in the methadone-exposed group.

*Data Collection.* Data collection for this study was completed by a clinical psychologist, the author, and other research assistants, all of whom were blind to the group status of the child. The interviewer was not able to be blind to group status, as questions regarding drug use were included in the maternal interview at the child's 4.5 year assessment. On particular occasions, such as home visits, it was impossible to remain blind to the group status of the child. It is possible that the effect of observer bias influenced some of the scoring or administration for children that were suspected as either methadone-exposed or comparison children. However all measures were taken to remain professional, and to administer tasks consistently between children.

To make data collection as consistent as possible, the tasks administered to each child were split between the clinical psychologist, the author, and the other research assistants. Therefore, the clinical psychologist administered only certain specific tasks to the study children, and the research assistants administered the remaining tasks. Therefore each task was administered by the same person, so each child experienced a similar administration process throughout their assessment. In some cases, in which a child was too shy or uncooperative, both the clinical psychologist and the author would administer tasks together, to make the child feel more comfortable, as will be discussed in the next section.

*Challenges of Researching Young Children.* Researching young children is not always a straight-forward procedure, as several factors can affect the performance of the child. The assessments were almost always scheduled to be held in the morning, in which the children would be in their most alert state, and could provide their best effort on all assessment tasks. Assessments were also almost always scheduled to take place at the Canterbury Child Development Research House, to ensure that the test environment was controlled, and each child was exposed to a similar assessment experience. In some cases, when it was not convenient for the family, a child had to be assessed in the afternoon, or at their home. These factors may have influenced the child's performance on certain tasks, as there are often more distractions at their own home, and in the afternoon, children are often less alert.

In some cases a child was too shy to respond to the researchers when approached with assessment tasks. In other cases, children were not non-compliant, or were too inattentive or hyperactive to complete the assessment tasks. In these cases it is difficult to ascertain whether these children simply did not know the answer to the task at hand, or whether the problem was behavioural. However, the majority of children assessed in the study were able to produce clear results on all assessment measures, and showed various levels of high concentration and slight wariness throughout the assessment, as would be expected of a child of their age.

### 4.9 Implications of Findings

The study undertaken by the Canterbury Child Development Research Group is making significant contributions to research among the understudied population of methadone-exposed children. To date, due to high rates of attrition, no studies have followed an adequate number of children born to methadone maintained women past the infancy period. However, these studies have been helpful in highlighting that their development in several domains is compromised compared to typically developing control children.

The research group has presently followed this cohort of children from term age to age 4.5 years, with excellent rates of retention. This thesis presents results concerning the school readiness outcomes of methadone-exposed preschool children, a novel, and previously understudied research area for this population. Therefore, to the best of the author's knowledge, this study is the only study of its kind, and has the potential to make a significant impact on intervention practises for this at-risk population. It is clear that compared to their non-exposed peers, methadone-exposed children at age 4.5 years have difficulties across the five domains of school readiness. However, these children are not receiving the special attention they require at this influential age. It has been reported that school readiness predicts later academic achievement (G. J. Duncan et al., 2007). Therefore it is important that children with prenatal methadone exposure receive targeted intervention at the youngest age possible, to allow time for wider development of their school readiness skills, to prepare them for later academic success. These interventions should combine special assistance for working with families with a history of drug use, and specialists of working with children, to address the intricate problems relating to the welfare of children of drug-dependent parents.

In summary this study has brought to light the numerous adverse developmental problems faced by methadone-exposed children, placing them at risk for an unfavourable developmental trajectory. Early and targeted intervention for these at-risk children will improve their school readiness outcomes at age 4.5 years.

### *4.10 Suggestions for Future Research*

In spite of the limitations noted above, this study is making ground as one of the first prospective longitudinal studies to follow children born to mothers maintained on methadone during pregnancy to preschool age. Furthermore, existing studies have researched this group of children, but most do not continue follow-up assessments past infancy. These studies have also not extensively assessed all the domains of child development, and none have yet researched the school readiness of methadone-exposed children. Therefore this research is adding considerably to what is currently known about the developmental trajectory of children born to mothers maintained on methadone during pregnancy.

Further assessment of methadone-exposed children at age 4.5 could be undertaken, analysing school readiness domains with the use of different measures, to expand on what was found in this research. For example, a task measuring gross motor development could be used, as opposed to a fine visual motor task, as was used in this thesis to measure the motor component of health and physical development. This would test whether methadone-exposed children have global motor problems in addition to the known delays in visual-motor functioning. A gross motor coordination problem may have more implications for general development than a fine, visual motor integration delay. For instance, while visual motor integration is essential for school readiness for tasks such as handwriting and art (Roberts et al., 2011), gross motor skills are important for sports and can govern the child's general movement (Bukatko, 2008).

There are also several opportunities for future research to include different measures to analyse the development of methadone-exposed children's approaches to learning. The PKRS-II was used to measure approaches to learning in this thesis, which measured working memory in several forms, such as digit- and sentence-recall. These aspects of executive functioning are important measures of approaches to learning (Roberts et al., 2011), and there are several other components of executive functioning such as attention, and goal-orientated planning, which could take a stronger measurement focus in future research. These skills become increasingly important as a child progresses through school, when more attentional ability is expected of them, and when more difficult maths or problem solving tasks require a more highly developed working memory.

Measuring the social and emotional skills of methadone-exposed children through observation, as well as through parent report, is another option for further research. Wilson et al. (1979) assessed the social-emotional and behavioural adjustment of heroin-exposed children compared to non-exposed children through parent ratings, as well as observation by a researcher, who was blind to child group status. This study showed that significantly more heroin-exposed than comparison children were rated by their parents and the observer as hyperactive, impulsive, temperamental and aggressive. No studies have yet measured the social-emotional and behavioural adjustment of methadone-exposed children by observer, as well as parent ratings. Combining parent report with observer ratings would provide a more reliable measure of the social and emotional skills of methadone-exposed children at age 4.5 years, by eliminating the parent's social desirability bias.

If this study was to be replicated, a more heavy focus could be placed on the extent to which poly-drug exposure determines school readiness outcomes at age 4.5 years among methadone-exposed children. Comparing the outcome of children exposed to tobacco and benzodiazepines in combination with methadone to those children exposed to methadone only, may provide more insight into the effects of poly-drug exposure on this population, and how school readiness is affected. A benzodiazepine-exposed group with no methadone exposure could also be studied. Separating the drug-exposed group into smaller sub-groups may help to determine specific drug effects on school readiness outcome at age 4.5 years. Such research will help answer the question about the effects of methadone maintenance during pregnancy on the exposed child's school readiness skill development. It will achieve this by observing whether prenatal exposure to other licit and illicit drugs in combination with methadone leads to more adverse outcomes for child school readiness at age 4.5 years, compared to prenatal exposure to methadone alone.

It is also important for children born to mothers maintained on methadone during pregnancy to be studied to school-age, to research whether school readiness outcome at age 4.5 years predicts academic achievement at school. It would also be important to know whether children that received intervention for their school readiness vulnerabilities achieved more academic success than children that did not receive school readiness intervention. This would further our knowledge on the influence of the methadone-exposed child's socio-familial context. If intervention can improve the academic outcome of methadone-exposed children at school age, this may, in turn, help them to lead more successful adulthoods, characterised by lower rates of socio-familial risk than they were exposed to in childhood. Currently, there is no special service treatment for methadone-exposed children after the neonatal period. Underlining the importance of, and developing and tracking special intervention services is the next step in researching this vulnerable population.

### *4.11 Conclusions*

Researching children born to mothers maintained on methadone during pregnancy is important to aid the understanding of the nature and extent of the developmental problems they face. Knowing the areas in which methadone-exposed children show vulnerability is essential in order to provide appropriate intervention, to assure they are school ready by age 4.5 years. The aims of this study were to describe school readiness in a group of methadone-exposed children at age 4.5 years, in comparison to a non-exposed control group, and to determine socio-familial covariates of school readiness. Findings of this study indicated that children born to mothers maintained on methadone during pregnancy are less likely to be school ready across all five domains of school readiness, compared to their non-methadone exposed peers. Methadone-exposed children also had higher odds of unreadiness in each of the school readiness domains assessed, and high rates of multiple domain impairments were common.

Even after adjustment for socio-familial risk, methadone-exposed children were still more likely to show vulnerability, or unreadiness in the domains of social and emotional skills, and language and communication. Domains of school readiness that were not statistically significant after adjustment for socio-familial risk were health and physical development, approaches to learning, and cognition and general knowledge, however increased odds for unreadiness for methadone-exposed children were still present in these domains compared to comparison children.

Control for confounding and selection factors revealed that maternal smoking in pregnancy, maternal illicit benzodiazepine use in pregnancy, and socio-familial risk, are significant covariates of unreadiness at age 4.5 years, and explained more variance of school readiness outcome than maternal methadone maintenance during pregnancy. However, as noted by several studies, the home environment of children of drug using parents is often characterised by high levels of stress, including low income, poor nutrition, poly-drug use, less stimulating environments, and single parenthood (K. Johnson et al., 2003; Lester & Lagasse, 2010; Vucinovic et al., 2008). The strong relationship between maternal methadone maintenance and high socio-familial risk increases the importance of monitoring this group of developmentally at-risk children, as they face multiple risks for poor school readiness outcome.

This research underlines the multiple domains of school readiness development in which methadone-exposed children are impaired. The difference identified between methadone-exposed children and their non-exposed peers on school readiness measures emphasises the need for helpful, targeted intervention services to work alongside these children and their drug-dependent parents. Early assistance to prevent the trend of multiple domain comorbidity and improve school readiness at age 4.5 years will attenuate the likelihood of later academic failure and provide a more positive developmental trajectory for methadone-exposed children.

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# 6 LIST OF APPENDICES

APPENDIX A: CAREGIVER INTERVIEW; CHILD HEALTH AND DEVELOPMENT

## SECTION B: THE CHILD

B.2 Toilet Training

| a) Does s/he | Never | Some Days | Most Days | Always |
|---|---|---|---|---|
| Stay dry during the day | 1 | 2 | 3 | 4 |
| Stay dry at night | 1 | 2 | 3 | 4 |
| Stay clean during the day | 1 | 2 | 3 | 4 |
| Stay clean at night | 1 | 2 | 3 | 4 |

b) Does s/he ask to go to the toilet when s/he needs to?

| | |
|---|---|
| Never | 1 |
| Sometimes | 2 |
| Usually | 3 |
| Always | 4 |

c) Does s/he go to the toilet by her/himself?

| | |
|---|---|
| Never | 1 |
| Sometimes | 2 |
| Usually | 3 |
| Always | 4 |

# APPENDIX A: CAREGIVER INTERVIEW; CHILD HEALTH AND DEVELOPMENT, Continued

## SECTION C: Child Health

### C. 1 **Medication**

| | Yes | No |
|---|---|---|
| Is your child currently on any form of prescribed medication? | 1 | 2 |

If yes, please give details:

___________________________________________________________________________

### C.2 General Health Conditions

Has your child ever been diagnosed with, or been suspected of having, any of the following conditions?

| | No | Suspected | Yes |
|---|---|---|---|
| Vision Problems | 0 | 1 | 2 |
| Hearing loss | 0 | 1 | 2 |
| Ear infections | 0 | 1 | 2 |
| Asthma/wheezy bronchitis | 0 | 1 | 2 |
| Eczema/skin rash | 0 | 1 | 2 |
| Hayfever | 0 | 1 | 2 |

APPENDIX A: CAREGIVER INTERVIEW; CHILD HEALTH AND DEVELOPMENT, Continued

**Vision**

C3 a) If parent reports vision problems, ask: what kind of visual difficulties does your child have? (If no problem, code 0)

| | |
|---|---|
| No problem | 0 |
| Short sighted | 1 |
| Longsighted | 2 |
| Other | 3 |
| Not known | 3 |

If 'Other' visual problem please specify……………………………………………….

………………………………………………………………………………………….

b) Does your child wear glasses or lenses to correct their vision?

| | |
|---|---|
| No | 0 |
| Glasses | 1 |
| Lenses/Contacts | 2 |
| Other (please specify): ……………………………………….. | 4 |

APPENDIX A: CAREGIVER INTERVIEW; CHILD HEALTH AND DEVELOPMENT, Continued

C4 **Hearing**

If parent reports hearing loss, ask:

(If no problem, code 0)

a) Is this hearing loss:

| | |
|---|---|
| No problem | 0 |
| Sensorineural | 1 |
| Conductive | 2 |
| Mixed | 3 |
| Any other hearing problem (please specify): ………………… ………………………………………………………………… ………………………………………………………………… | 4 |
| Not known | 5 |

b) How well can s/he hear?

| | |
|---|---|
| No hearing problem | 0 |
| Has some hearing loss, but does NOT need a hearing aid | 1 |
| Hears well or with little difficulty WITH a hearing aid | 2 |
| Has severe hearing difficulty even with a hearing aid | 3 |

APPENDIX A: CAREGIVER INTERVIEW; CHILD HEALTH AND DEVELOPMENT, Continued

C.5 Since our last interview has your child visited (or been visited by) any of the following services?

| | Number of visits |
|---|---|
| Plunket Nurse | |
| Public Health Nurse. Specify: | |
| Audiologist/Hearing Assessment Clinic. Specify: | |
| Optometrist/Ophthalmologist. Specify: | |
| Psychologist. Specify: | |
| Physiotherapist. Specify: | |
| Occupational Therapist. Specify: | |
| Barnardos or other child care support agency. Specify: | |
| Hospital Social Worker. Specify: | |
| Other support agency. Specify: | |

APPENDIX B: THE STRENGTHS AND DIFFICULTIES QUESTIONNAIRE, (Goodman, 1997)

## Strengths and Difficulties Questionnaire

For each item, please mark the box for Not True, Somewhat True or Certainly True. It would help us if you answered all items as best you can even if you are not absolutely certain or the item seems daft! Please give your answers on the basis of the child's behaviour over the last six months or this school year.

Child's Name ............................................................................................ Male/Female

Date of Birth..........................................................

| | Not True | Somewhat True | Certainly True |
|---|---|---|---|
| Considerate of other people's feelings | ☐ | ☐ | ☐ |
| Restless, overactive, cannot stay still for long | ☐ | ☐ | ☐ |
| Often complains of headaches, stomach-aches or sickness | ☐ | ☐ | ☐ |
| Shares readily with other children (treats, toys, pencils etc.) | ☐ | ☐ | ☐ |
| Often has temper tantrums or hot tempers | ☐ | ☐ | ☐ |
| Rather solitary, tends to play alone | ☐ | ☐ | ☐ |
| Generally obedient, usually does what adults request | ☐ | ☐ | ☐ |
| Many worries, often seems worried | ☐ | ☐ | ☐ |
| Helpful if someone is hurt, upset or feeling ill | ☐ | ☐ | ☐ |
| Constantly fidgeting or squirming | ☐ | ☐ | ☐ |
| Has at least one good friend | ☐ | ☐ | ☐ |
| Often fights with other children or bullies them | ☐ | ☐ | ☐ |
| Often unhappy, down-hearted or tearful | ☐ | ☐ | ☐ |
| Generally liked by other children | ☐ | ☐ | ☐ |
| Easily distracted, concentration wanders | ☐ | ☐ | ☐ |
| Nervous or clingy in new situations, easily loses confidence | ☐ | ☐ | ☐ |
| Kind to younger children | ☐ | ☐ | ☐ |
| Often lies or cheats | ☐ | ☐ | ☐ |
| Picked on or bullied by other children | ☐ | ☐ | ☐ |
| Often volunteers to help others (parents, teachers, other children) | ☐ | ☐ | ☐ |
| Thinks things out before acting | ☐ | ☐ | ☐ |
| Steals from home, school or elsewhere | ☐ | ☐ | ☐ |
| Gets on better with adults than with other children | ☐ | ☐ | ☐ |
| Many fears, easily scared | ☐ | ☐ | ☐ |
| Sees tasks through to the end, good attention span | ☐ | ☐ | ☐ |

Signature ........................................................................... Date ...........................................................................

Parent/Teacher/Other (please specify:)

**Thank you very much for your help**

# APPENDIX C: MATERNAL INTERVIEW AT TERM

SECTION A. RESPONDENT'S BACKGROUND

A.1 What is your expected date of delivery?

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| D | D | M | M | Y | Y | Col 18 |

**Mother**

A.2 How old were you on your last birthday?

| | | |
|---|---|---|
| Years | | |

A.3 Which of the following ethnic groups do you belong to or identify with?

| | Yes | No |
|---|---|---|
| NZ Maori | 1 | 2 |
| NZ European | 1 | 2 |
| Other European (English, Dutch, Scottish, Australian, etc) | 1 | 2 |
| Samoan | 1 | 2 |
| Tongan | 1 | 2 |
| Niuean | 1 | 2 |
| Asian | 1 | 2 |
| Other Specify: ________________________________________ | 1 | 2 |

# APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

A.4 Which of the following best describes your educational qualifications? (circle one)

| | |
|---|---|
| Left school between 13-16 years | 1 |
| Further secondary education | 2 |
| Secretarial or trade qualifications | 3 |
| Professional qualifications without a degree | 4 |
| University degree | 5 |
| Other qualifications, specify: ________________________ | 6 |

**Partner Relations**

A.5 Are you currently living with a partner?

| | |
|---|---|
| Yes, legally married | 1 |
| Yes, cohabiting | 2 |
| Has partner, not cohabiting | 3 |
| No partner | 4 |

A.6 If yes, is he the father of your new baby?

| | |
|---|---|
| Yes | 1 |
| No | 2 |
| No partner | 9 |

IF NO PARTNER ENTER 9s IN A.7 – A.10 AND ASK B.1

# APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

A.7 How old is your partner? Years | | |

A.8 Which of the following ethnic groups does your partner belong to or identify?

| | Yes | No | NA |
|---|---|---|---|
| NZ Māori | 1 | 2 | 9 |
| NZ European | 1 | 2 | 9 |
| Other European (English, Dutch, Australian, etc) | 1 | 2 | 9 |
| Samoan | 1 | 2 | 9 |
| Tongan | 1 | 2 | 9 |
| Niuean | 1 | 2 | 9 |
| Asian | 1 | 2 | 9 |
| Other, specify: ________________________________________ | 1 | 2 | 9 |

A.9 Which of the following best describes your partner's school/educational qualifications?

| | |
|---|---|
| Left school between 13-16 years, no qualifications | 1 |
| School Certificate (>2 subjects) | 2 |
| Further secondary education, eg UE, HSC or Bursary | 3 |
| Secretarial or trade qualifications | 4 |
| Professional qualifications without a degree | 5 |
| University degree | 6 |
| Other qualifications, describe: _______________________ | 7 |
| Don't know | 8 |
| NA (no partner) | 9 |

# APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

A.10 How long have you been in this relationship?

| | | |
|---|---|---|
| Months | | |

SECTION B. PARENTHOOD

B.1 a) Is this your first pregnancy?

| | |
|---|---|
| Yes | 1 |
| No | 2 |

b) If yes, how many times have you been pregnant before?

| | |
|---|---|
| Number | |

IF RESPONDENT HAS HAD OTHER PREGNANCIES, GIVE DETAILS BELOW. IF NO PREVIOUS PREGNANCY ENTER 9's IN RELEVANT ITEMS

**Family Finances**

C.4 Are you working (in paid employment) at the moment?

(If on maternity leave please note employment details)

| | |
|---|---|
| Yes | 1 |
| No | 2 |

C.5 If yes, specify:

a) Occupation: ______________________________________________

b) Industry: ________________________________________________

APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

c) How many hours per week do you work?
If no work enter 00.

Hours

d) How much do you receive each week after tax? (If not working enter 0's)

Amount

C.6 Are you in receipt of any of the following Social Welfare benefits?

| | Yes | No |
|---|---|---|
| Domestic Purposes Benefit | 1 | 2 |
| Unemployment Benefit / Community Wage | 1 | 2 |
| Sickness/Invalid's Benefit | 1 | 2 |
| Other Social Welfare Benefit. Specify: | 1 | 2 |

C.7 How much do you receive in benefit payments per week?

Amount

C.8 Do you receive any Family Assistance payments (that are not already included above)?

Amount/week

C.9 Do you receive income from any other source, eg donations from parents, investment income, etc

Amount/week

APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

C.10 Is your partner working (in paid employment) at the moment?

| | |
|---|---|
| Yes | 1 |
| No | 2 |
| NA | 9 |

C.11 If yes, specify:

a) Occupation: _______________________________________________

b) Industry: _________________________________________________

c) How many hours per week does s/he work? Hours [ ][ ]

d) How much does s/he receive each week after tax? (If not working enter 0's)

Amount [ ][ ][ ][ ]

| C.12 Is your partner in receipt of any of the following Social Welfare benefits? | Yes | No | NA |
|---|---|---|---|
| Domestic Purposes Benefit | 1 | 2 | 9 |
| Unemployment Benefit / Community Wage | 1 | 2 | 9 |
| Sickness/Invalid's Benefit | 1 | 2 | 9 |
| Other Social Welfare Benefit. Specify: | 1 | 2 | 9 |

APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

C.13 How much does your partner receive in benefit payments per week?

Amount

C.14 Does your partner receive any Family Assistance payments (that are not already included above)?

Amount/week

C.15 Does s/he receive income from any other source, eg donations from parents, investment income, etc

Amount/week

**SECTION D. PREGNANCY**

D.1 How many weeks pregnant are you at the moment?

GA

D.2 Were you trying to get pregnant?

| | |
|---|---|
| Yes | 1 |
| Unsure | 2 |
| No | 3 |

APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

D.3 What was your reaction when you first heard you were pregnant?

| | |
|---|---|
| Delighted/very happy | 1 |
| Happy | 2 |
| Indifferent | 3 |
| Upset | 4 |
| Very upset | 5 |

D.4 What was your partner's reaction when you told him you were pregnant?

| | |
|---|---|
| Delighted/very happy | 1 |
| Happy | 2 |
| Indifferent | 3 |
| Upset | 4 |
| Very upset | 5 |
| No partner | 9 |

D.5 When did you first consult a doctor concerning your pregnancy?

| | | |
|---|---|---|
| Record weeks of pregnancy | | |

# APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

D.6 So far during your pregnancy, have you experienced any of the following problems or illnesses?

c) Psychiatric or emotional problems treated by a doctor eg depression

Specify: ________________________________

| | | |
|---|---|---|
| 0-3 months | Yes | 1 |
| | No | 2 |
| 4-6 months | Yes | 1 |
| | No | 2 |
| 7-9 months | Yes | 1 |
| | No | 2 |
| | NA | 9 |

**SECTION E. DRUG USE DURING PREGNANCY**

E.1 Did you smoke cigarettes before or during your pregnancy?

| | No. of cigs per day | |
|---|---|---|
| Before pregnancy | | |
| 1st 3 months | | |
| 2nd 3 months | | |
| 3rd 3 months | | |

# APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

E.2 Did you smoke dope/cannabis before or during your pregnancy?

| | No. of joints per week | |
|---|---|---|
| Before pregnancy | | |
| 1st 3 months | | |
| 2nd 3 months | | |
| 3rd 3 months | | |

E.3 Did you drink alcohol before or during your pregnancy?

| | No. of drinks per week | |
|---|---|---|
| Before pregnancy | | |
| 1st 3 months | | |
| 2nd 3 months | | |
| 3rd 3 months | | |

APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

E.4

Did you use benzodiazepines before or during your pregnancy?

| | No. of times per week | |
|---|---|---|
| Before pregnancy | | |
| 1st 3 months | | |
| 2nd 3 months | | |
| 3rd 3 months | | |

E.5 Did you use heroin or other opioids (excluding methadone) before or during your pregnancy?

| | No. of drinks per week | |
|---|---|---|
| Before pregnancy | | |
| 1st 3 months | | |
| 2nd 3 months | | |
| 3rd 3 months | | |

# APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

E.6 Did you use stimulants (eg amphetamines, speed, cocaine) before or during your pregnancy?

| | | |
|---|---|---|
| Before pregnancy | | |
| 1st 3 months | | |
| 2nd 3 months | | |
| 3rd 3 months | | |

SECTION F. MATERNAL WELLBEING

(Edinburgh Postnatal Depression Scale, Cox et al., 1987)

| F.1 Right NOW | Not at all | Somewhat | Moderately | Very much |
|---|---|---|---|---|
| I feel calm | 1 | 2 | 3 | 4 |
| I am tense | 1 | 2 | 3 | 4 |
| I feel upset | 1 | 2 | 3 | 4 |
| I am relaxed | 1 | 2 | 3 | 4 |
| I feel confident | 1 | 2 | 3 | 4 |
| I am worried | 1 | 2 | 3 | 4 |

APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

F.2 During my PREGNANCY:

| | Often | Sometimes | Hardly Ever | Never |
|---|---|---|---|---|
| I was able to laugh and see the funny side of things | 1 | 2 | 3 | 4 |
| I looked forward with enjoyment to things | 1 | 2 | 3 | 4 |
| I blamed myself unnecessarily when things went wrong | 1 | 2 | 3 | 4 |
| I felt anxious or worried for no good reason | 1 | 2 | 3 | 4 |
| I felt scared or panicky for no very good reason | 1 | 2 | 3 | 4 |
| Things got on top of me | 1 | 2 | 3 | 4 |
| I was so unhappy that I had difficulty sleeping | 1 | 2 | 3 | 4 |
| I felt sad or miserable | 1 | 2 | 3 | 4 |
| I got so unhappy that I cried | 1 | 2 | 3 | 4 |
| I thought about harming myself | 1 | 2 | 3 | 4 |

# APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

F.3 In the PAST TWO WEEKS:

| | Often | Sometimes | Hardly Ever | Never |
|---|---|---|---|---|
| I have been able to laugh and see the funny side of things | 1 | 2 | 3 | 4 |
| I have looked forward with enjoyment to things | 1 | 2 | 3 | 4 |
| I have blamed myself unnecessarily when things went wrong | 1 | 2 | 3 | 4 |
| I have been anxious or worried for no good reason | 1 | 2 | 3 | 4 |
| I have felt scared or panicky for no very good reason | 1 | 2 | 3 | 4 |
| Things have been getting on top of me | 1 | 2 | 3 | 4 |
| I have been so unhappy that I have had difficulty sleeping | 1 | 2 | 3 | 4 |
| I have felt sad or miserable | 1 | 2 | 3 | 4 |
| I have been so unhappy that I have been crying | 1 | 2 | 3 | 4 |
| The thought of harming myself has occurred to me. | 1 | 2 | 3 | 4 |

# APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

SECTION G. DRUG DEPENDENCE

(DSM-IV questions from the Composite International Diagnostic Interview)

**Cigarettes**

G.1 Over the last 6 months have you smoked a cigarette or cigarettes? If yes, how many cigarettes would you smoke per day?

| | |
|---|---|
| Non-smoker | 1 |
| <1 per day | 2 |
| 1-4 per day | 3 |
| 5-9 per day | 4 |
| 10-20 per day | 5 |
| 21+ per day | 6 |

**Alcohol**

G.3 Over the past month how often would you have drunk alcohol?

| | |
|---|---|
| Never | 1 |
| Very occasionally (once or twice) | 2 |
| At least weekly | 3 |
| Almost every day | 4 |

***Marijuana***

F.1 Have you ever used or tried smoking cannabis (marijuana, grass, dope etc)?

| | |
|---|---|
| Yes | 1 |
| No | 2 |

# APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

F.2 At the present time how often do you use cannabis?

| | |
|---|---|
| Nearly every day | 1 |
| At least once a week | 2 |
| At least once a month | 3 |
| Less than once a month | 4 |
| Has only used once or twice | 5 |
| Not used cannabis | 9 |

| F.4 Have you ever used or tried any of the following | Yes | No |
|---|---|---|
| Solvents - glue, petrol, etc | 1 | 2 |
| Sedatives – downers | 1 | 2 |
| Stimulants – uppers | 1 | 2 |
| Heroin/homebake | 1 | 2 |
| Morphine/MSTs | 1 | 2 |
| Cocaine | 1 | 2 |
| LSD, PCP, ecstasy | 1 | 2 |
| Other prescription medicine to get you high | 1 | 2 |
| Any other substance. Specify: | 1 | 2 |

IF RESPONDENT HAS USED ANY SUBSTANCE IN F.4 ASK F.5 OTHERWISE ENDORSE THIS ITEM WITH 9

## APPENDIX C: MATERNAL INTERVIEW AT TERM, Continued

F.5 At the present time (ie over the last month) how often do you use this drug (these drugs)

| | |
|---|---|
| Nearly every day | 1 |
| At least once a week | 2 |
| At least once a month | 3 |
| Less than once a month | 4 |
| Has only used once or twice | 5 |
| Not used drugs | 9 |

APPENDIX D: CONSENT FORMS

Canterbury Child Development
Research Group
Department of Psychology
College of Science

UNIVERSITY OF CANTERBURY
*Te Whare Wānanga o Waitaha*
CHRISTCHURCH NEW ZEALAND

November 2007

**CODE NUMBER**

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**4.5-YEAR FOLLOW-UP STUDY**
**CONSENT FORM**

- I have been invited to participate with my child in a study that is comparing the development of children who were and were not born to mothers on methadone maintenance during their pregnancy. I have read and understood the Information sheet dated November, 2007.

- I have had enough time to consider whether we will take part in the study, and to discuss my decision with the researcher or a person of my choice.

- I know who to contact if I have any questions about the study.

- I understand that our participation in this research is **confidential** and that no material which could identify me will be used in any study reports, or made available to anyone else without my approval in writing.

- I understand my child will be videotaped during the procedure and that this information will only be used for further observation by the named investigators and the material will be secured and kept strictly confidential.

- I also understand that my child and I can withdraw from the study at any time.

- I understand the compensation provisions for the study.

APPENDIX D: CONSENT FORMS, Continued

- I agree to members of the research team having access to medical information about my child for cross checking the number and dates of any major or minor illnesses that I have recorded on the study forms. **YES/NO**

- I wish to receive a summary of the results of this study. **YES/NO**

I consent to take part in this study.

Parent/s Name: _______________________________________

**Signature of Parent/s**: __________________________________ **Date**: ______________________

I consent to my child taking part in this study.

Child's name________________________________ Parent/s Name:
________________________________

**Signature of Parent/s**: __________________________________ **Date**: ______________________

In my opinion, consent was given freely and the participant understands what is involved in this study.

Researcher's Name:____________________________________

**Signature of Researcher**: _______________________________ **Date**: ______________________

APPENDIX D: CONSENT FORMS, Continued

**Child's GP (Family Doctor) Contact Details**:

Child's GP

Name:…………………………………………………………………………………………………….

Medical Centre/Practice:……………………………………………………………………………….

Address and phone (If known)

……………………………………………………………………………………………………………………………………………………

Previous GP's and Name of Medical Centres (if changed over past 4 years)

Name:…………………………………………………………………………………………………….

Name…………………………………………………………………………………………………….

APPENDIX D: CONSENT FORMS, Continued

N. Z. NEONATAL NEUROLOGICAL RESEARCH GROUP
TE ROPU RANGAHAU IO TOPU O AOTEAROA

***Woman's Health Division, Department of Paediatrics, Christchurch, NZ***

**Canterbury Child Development Group, University of Canterbury, NZ**
**Psychological Medicine, Christchurch School of Medicine, NZ**

**Video Use Consent Statement (4½ years)**

We are videotaping this session to help us record how your child responds to the activities, which we will do today. Most tapes are coded and scored by the Child Development Research Team and will never be seen by anyone else.

However occasionally, it is useful to be able to use short video clips for training or for presentations, with students and/or other professional workers. This may take place in Christchurch, elsewhere in New Zealand or abroad.

If you would be happy for us to use the tape of your child for this purpose, please indicate below. Your name and that of your child would always remain confidential and the videos would be presented in an anonymous way.

I **give / do not give** permission for the tape to be used for talks and presentations.

(Delete as appropriate)

**Signed:**________________________________________

**Name:**________________________________________

**(Please print clearly)**

**Date:**__________________