

**Effect of maternal post-partum depression on child cognitive
development in boys and girls: A systematic review**

Master's Capstone Project

Nadine Ebeid

February 10, 2018

St. Luke's Graduate School of Public Health

St. Luke's International University

Abstract

Researchers have explored the relationship between maternal post-partum depression and cognitive development of the offspring, but the results remain inconclusive regarding the presence of a difference in effect based on the child's gender. This study aims to assess the cumulative evidence from the current body of literature on the association between maternal post-partum depression and child cognitive development in boys and girls separately. A search for articles was performed through PubMed, The Cochrane Library, PsycInfo, and Embase, and was supplemented by manual search of the reference lists. Articles exploring the epidemiological association between maternal post-partum depression and cognitive development separately in boys and girls were included. Eight articles were considered eligible for this review; half of them focused on child cognitive development at the preschool age of 3-6 years, 2 articles for the age of 18 months, and 2 articles targeting older children (ages 11 and 16 years). Collective results show lower cognitive development especially among boys of post-partum depressed mothers, and particularly when associated with low social class. This finding appears consistent across all age groups. Further research that target representative populations from developing countries may be important considering the observed role of social class and overall higher rates of maternal depression in those regions.

Keywords: PPD, maternal depression, postpartum depression, postnatal depression, cognitive development, cognitive abilities, IQ, Intelligence.

Introduction

A child's cognitive development during early childhood, which includes building skills such as pre-reading, language, vocabulary, and numeracy, begins from the moment a child is born. A child who has an impaired or delayed development of these skills is at risk of poor performance at school (White House Archives). Moreover, it has been noted that cognitive development at early ages has a significant effect on the individual's health-seeking behaviors and consequently the individual's health (Park *et al.* 2011).

Childhood developmental milestones and cognitive skills

Children progress through distinct periods of development as they age. In infancy, one of the first developmental milestones is marked by the ability to distinguish the five different senses during the first month of life. During the following two months, the child starts to recognize colors, differentiate between them, and gain control of muscles. At this stage, the child also develops the ability to express some emotions such as distress, delight and certain social skills such as smiling at people. From four to six months, the child can localize sounds, starts babbling, and distinguishes the mother. Starting from the seventh month, the motor development is distinctive, the child starts crawling and social skills are more developed; he/she may protest separation from the mother (Committee on the Science of Children Birth to Age 8, 2015; Staff, 2015). Later and with time, the child learns how to control all motor activities, how to express different emotions, starts obeying commands, learns how to speak effectively, and cognitive skills become well-developed.

The presence of a difference in the development of boys and girls remains debatable; Zambrana *et al.* (2012) concluded that boys develop language comprehension (LC) at a faster rate than girls between 18 and 36 months, but girls still remain superior in their level of

LC at 36 months of age. Barbu *et al.* (2011) suggests that girls develop social skills and structured forms of play at younger ages than boys. According to the American Academy of Pediatrics (AAP) girls are able to pay attention for longer periods of time and boys do better at visual tasks.

Cognitive skills are the core skills that the brain uses to think, learn, read, remember, reason, and pay attention. The cognitive development in early childhood is affected by genetic, biological, social, and psychological factors which may all be influenced by other factors such as poverty, cultural norms, and childrearing environments (Grantham-McGregor *et al.* 2007; Walker *et al.* 2011). The Adverse Childhood Experiences (ACE) study has shown that adverse childhood events including physical/ emotional/sexual abuse or neglect, substance abuse by the parents, violence against the mother and parental separation or divorce have an effect on the child health and social life. Those adverse childhood experiences may lead to delayed cognitive, social and emotional development, risky health behaviors, and the individual may be more prone to diseases, disabilities and social problems and even early death (Felitti *et al.* 1998)

Maternal influence on child's early development

Mothers play an important role in shaping the child's cognitive development during the early milestones (Howard *et al.* 2011). Thus, the mother's physical and mental health are thought to be important for the child's cognitive development and well-being. The World Health Organization estimates that worldwide, about 10% of pregnant women and 13% of women who have just given birth experience a mental disorder, primarily depression. In developing countries, this is even higher in the range of about 15.6% during pregnancy and 19.8% after child birth, and there appears to be an increasing trend in rates (WHO, 2015). In severe cases, the mothers' suffering may be very extreme leading her to commit suicide (WHO, 2015; CDC, 2017). The rates are

higher in the less developed countries owing to poverty, migration, extreme stress, and exposure to violence.

Symptoms may start as post-partum blues that usually resolves spontaneously, but in 5% of cases they may transition into post-partum depression that requires medical treatment. Women suffering from post-partum depression might develop hallucinations or even suicidal ideation (Pearlstein *et al.* 2009).

Maternal depressive symptoms are negatively associated with early child development and quality of parenting across different cultures and socioeconomic groups (Wachs *et al.* 2009). Mothers largely influence infants' social environment and mediate their experiences with the external world; thus, maternal responsiveness and sensitivity are recognized to be major factors that shape cognitive and socioemotional competence in children (Walker *et al.* 2007). This problem is present in high-income as well as in middle- and low-income countries; in Bangladesh, maternal depressive symptoms were associated with infant stunting, perhaps owing to unresponsive caregiving (Black *et al.* 2009).

Purpose of this systematic review

The consequences of maternal post-partum depression on child development do not stop at infancy, but can extend into school age and the effects may be different by the child's gender. Significant adverse effects of post-partum depression on the intelligence quotient (IQ) of the offspring at the age of 16, particularly among boys, were observed (Hay *et al.* 2008). Few other studies have evaluated the effects of maternal depression on the cognitive development in boys and girls separately. The lines of evidence available that address gender as a factor influencing the effects of maternal depression on child development have shown some inconsistency. Sharp *et al.* (1995) found that the mean score of the general cognitive function measure was one

standard deviation lower in boys of post-partum depressed mothers than in the boys of well mothers. Murray (1992) found that post-partum depression had no effect on infant cognitive development, but did show an influence on boys and socioeconomically deprived children in terms of vulnerability.

Taken together, while the evidence does seem to point towards a real association between maternal post-partum depression and childhood cognitive development in general (Liu *et al.* 2017), less is known about its potential heterogeneity in effect by gender, and a synthesis of the collective evidence has not yet been performed. Thus, we conducted a systematic review with the objective to comprehensively assess the current available evidence examining the effect of maternal post-partum depression on child cognitive development by gender of the child.

Methods

Literature search strategy

A systematic review of current epidemiological studies was performed according to the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) guidelines. We retrieved articles from various databases including PubMed, The Cochrane Library, PsycInfo, and Embase from inception of the database until the present; the last search was performed on October 16, 2017. The following search terms were used for the identification of articles:

“post-partum depression” or “postpartum depression” or “post-natal depression” or
“postnatal depression” or “maternal AND depression” or “mother AND depression”.
AND

“cognitive ability” or “intelligence quotient” or “child AND cognition AND Intelligence”
or “child AND cognitive AND Impairment” or “child AND cognitive AND ability”

All keywords were searched using the free text term and MeSH terms. In addition, a manual screening of the reference list of the most relevant articles was performed to potentially identify additional studies.

Inclusion and exclusion criteria

The inclusion and exclusion criteria were specified in advance in the study protocol. Articles with maternal post-partum depression as the primary exposure and child cognitive development as the primary outcome were included. For child age, no limitations were applied as we sought to understand the effect of maternal depression on cognitive development in different age groups. All types of epidemiological study designs were considered.

The search was limited to studies published in English due to the inability to translate articles published in foreign languages. Primary exposures such as anxiety or other psychiatric conditions, and articles with unclear or unstated ethical approval were excluded. Studies that did not mention the effects of maternal depression on boys and girls separately were also excluded.

Study selection and data extraction

Studies were selected using a three step process. First, a primary screening by title and abstract of the retrieved articles was conducted. Second, the full texts of the studies selected in the first step screening were read and those that met the inclusion criteria were identified. Third, a final selection step was carried out by reviewing the references of the selected articles to identify relevant articles that were not captured by the systematic screening. Only published articles were included due to the inaccessibility to unpublished articles.

Quality of the selected studies was assessed using the “Newcastle-Ottawa Quality Assessment Form for Cohort Studies” (Wells *et al.* 2011). This form consists of eight items that evaluate the selection of the cohort, comparability, and assessment of the outcome of interest. This form was selected for the evaluation of the articles as the final selected studies were all longitudinal cohort studies. The quality of the study was used to evaluate the potential influence of study heterogeneity, and was not used as a criterion for exclusion.

For each of the included studies, the following information were extracted: the presence of maternal post-partum depression, mean age of the mother during the post-partum period, mother’s education, mother’s IQ, marital status and home environment, social class, child birth weight at time of delivery, child sex, child mean age at time of the study, child’s mean cognitive scores and if the child was breastfed.

Synthesis of collective evidence

Due to the variation in measurement tools and other sources of heterogeneity across studies, a meta-analysis was not performed. Instead, included studies were evaluated qualitatively by grouping the studies by age categories of the child. A focus was placed on the pre-school/school age as this group had the most number of studies available for assessment. Additionally, the consistency of evidence was evaluated in the context of various sources of heterogeneity including the effect of maternal IQ, and the social class or maternal education.

Results

The searched terms retrieved 247 articles from PubMed, 472 from Embase, 177 from the Cochrane Library and 1499 from PsycInfo. One additional relevant study was found through manual search (Azak 2012). Ninety-four potentially relevant articles were identified by primary

screening of the title and abstract. Among these, 8 articles met the pre-defined criteria for inclusion (Figure 1).

As shown in Table 1, included studies were conducted in 4 European countries: 5 studies from the United Kingdom (Murray 1992, Murray *et al.* 1996, Hay 2001, Murray *et al.* 2010 and Sharp *et al.* 1995), 1 study from the Netherlands (Kersten-Alvarez *et al.* 2012), 1 study from France (Waerden *et al.* 2016) and 1 study from Norway (Azak *et al.* 2012). All of these studies used longitudinal cohort designs among which maternal depressive symptoms were assessed during the last trimester and first year post-partum and at least 6 months prior to the assessment of the child cognitive development. The duration of follow-up of the cohorts varied and ranged from 2 years to 16 years.

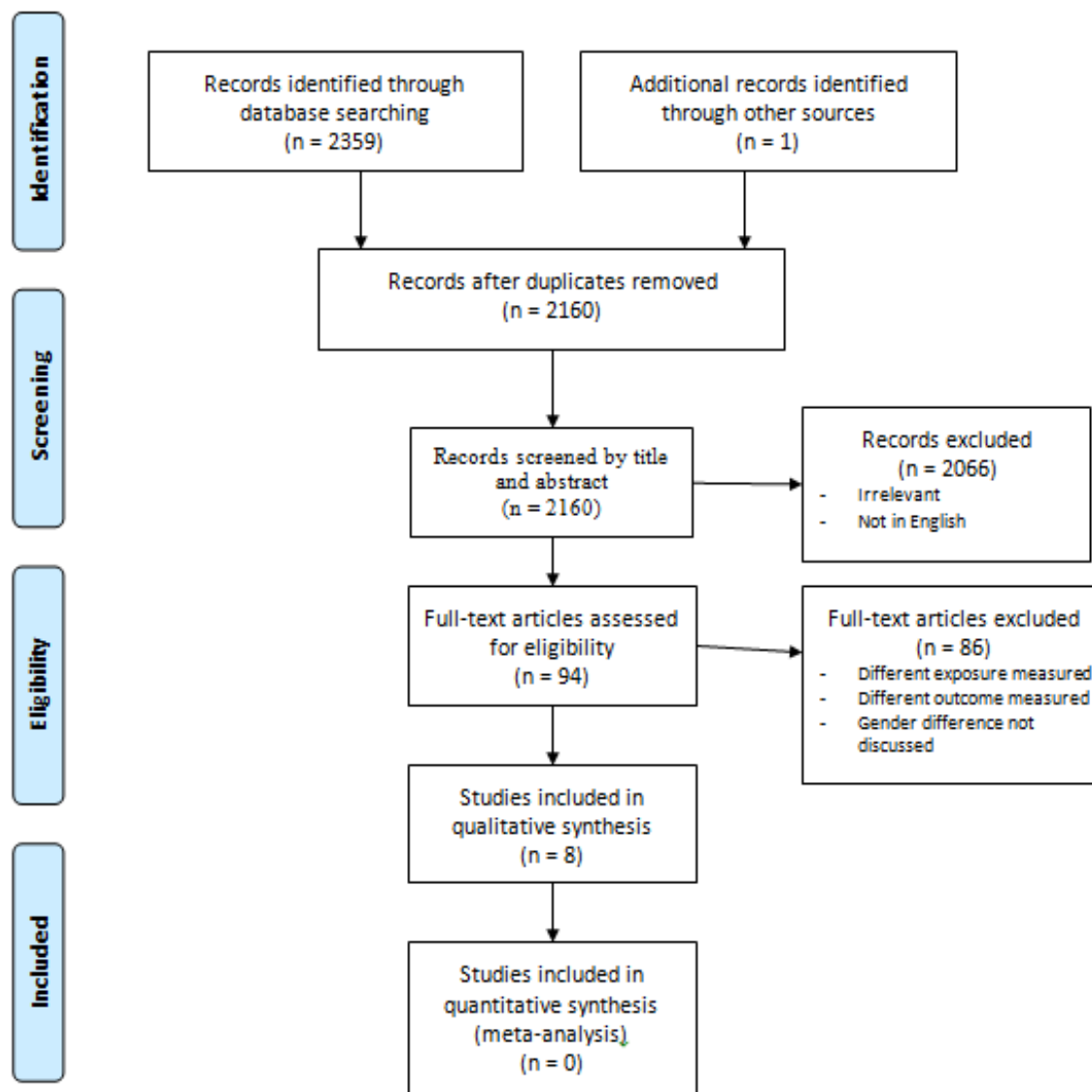


Figure 1: Flow diagram of study identification and selection

Table 1: Summary and characteristics of included studies

Author and year	Country	Number of participants	Assessment of maternal depression	Assessment of child cognitive development	Child age at the time of assessment
Waerden <i>et al.</i> (2016)	France	1039	CES-D and EPDS	WPPSI-III (VIQ/PIQ/FSIQ)	5- 6 years
Azak (2012)	Norway	50	CES-D and DSM IV	MSEL	6- 12- 18 months
Kersten-Alvarez <i>et al.</i> (2012)	The Netherlands	142	DSM IV and Becks depression inventory	PPVT-R (Verbal intelligence)	5-6 years
Murray <i>et al.</i> (2010)	U.K	89	EPDS	GSCE score	16 years
Hay <i>et al.</i> (2001)	S. London U.K	132	CIS and ICD9	WISC-III (VIQ/PIQ/FSIQ)	11 years
Murray <i>et al.</i> (1996)	Cambridge, U.K	94	EPDS and SPI	McCarthy scale	5-6 years
Sharp <i>et al.</i> (1995)	S.E London, U.K	172	CIS and ICD9	McCarthy scale	3 years and 10 months
Murray (1992)	Cambridge, U.K	113	EPDS and SPI	BSMD and Reynell scales	18 months

Abbreviations: BSMD, Bailey Scales for Mental Development; CES-D, Center for Epidemiological Studies-Depression; CIS, Clinical Interview Schedule; DSM IV, Diagnostic and Statistical Manual for Mental Disorders 4th edition; EPDS, Edinburgh Postnatal Depression Scale; FSIQ, Full Scale IQ; GCSE, General Certificate of Secondary Education; ICD-9, International Classification of diseases-9th edition; MSEL, Mullen's Scales of Early Learning; PPVT-R, The Peabody Picture Vocabulary Test-Revised Edition; PIQ, Performance IQ; SPI, the Standard Psychiatric Interview; VIQ, Verbal I; WISC-III, Wechsler Intelligence Scale for children-3rd edition; WPPSI-III, Wechsler Preschool and Primary Scale of Intelligence, 3rd edition.

Measures of cognitive development in children

For child cognitive development, the outcome was based on the estimated mean and standard deviation of the cognitive and IQ scores and differences were compared across groups. Scales for measuring the cognitive development varied according to the children's age. For infants, *Mullen Scales of Early Learning* (MSEL) and *Bailey Scale for Mental Development* (BSMD) were the

main tools used to calculate the cognitive development scores. *Wechsler Preschool and Primary Scale of Intelligence, 3rd edition* (WPPSI-III), *McCarthy Scales for Children Abilities* and *The Peabody Picture Vocabulary Test* (PPVT-R) were used for children aged 5 to 8 years old. One study measured intelligence at the age of 11 years using *Wechsler Intelligence Scale for Children, 3rd edition* (WISC III) and lastly, at the age of 16 years, *General Certificate of Secondary Education* (GCSE) scores were compared between students.

Measures for the detection of post-partum depression

For the detection of post-partum depression, the *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition* (DVM-IV) criteria, *International Statistical Classification of Diseases and Related Health Problems* (ICD9), *Clinical Interview Schedule* (CIS), the *Standard Psychiatric Interview* (SPI), the *Center for Epidemiological Studies-Depression* (CES-D), and the *Edinburgh Postnatal Depression Scale* (EPDS) were used. Most of the selected studies used two scales to diagnose post-partum depression. The mean score and standard deviation obtained from these scales were calculated and used to separate depressed and non-depressed mothers into two different groups.

Effect in pre-school and elementary school aged children

Table 2 shows select characteristics of the four included studies that addressed the child cognitive development considering the gender differences at the pre-school and elementary school age (Sharp *et al.* 1995; Murray *et al.* 1996; Kersten-Alvarez *et al.* 2012 and Waerden *et al.* 2016).

Table 2: Characteristics of studies included for the pre-school/school age groups

		Waerden <i>et al.</i> (2016)	Kersten-Alvarez <i>et al.</i> (2012)		Murray <i>et al.</i> (1996)	Sharp <i>et al.</i> (1995)
Maternal Education	Not post-partum-depressed	Education level A (more than 12 years)	Scale: 0-5	3.3	47% education level A	All levels of education
	Not Post-Partum depressed			3.8		
Social Class / Demographics		All social classes	Rural and urban areas		65% upper to middle social class	Low socioeconomic environment
Measurement of child cognitive development		WPPSI-III (VIQ/PIQ/FSIQ)	PPVT-R (Verbal Intelligence)		McCarthy Scale (Verbal ability/ GCI)	McCarthy Scale (Verbal ability/ GCI)

Abbreviations: GCI, General Cognition Index; Education level A: more than 12 years of school education; FSIQ, Full Scale IQ; PIQ, Performance IQ; PPVT-R, the Peabody Picture and Vocabulary Test-Revised Edition; VIQ, Verbal IQ; WPPSI-III, Wechsler Preschool and Primary Scale of Intelligence 3rd edition.

Sharp *et al.* (1995) and Murray *et al.* (1996) used the McCarthy scale to measure the child cognitive development at the age of 5-6 years. The scale measures the intellectual abilities including: verbal ability, perceptual ability, quantitative ability, memory, and motor ability, also providing a score for *General Cognitive Index* (GCI). It is one of the first tools developed for this purpose and has been shown to be valid and highly reliable which makes it competitive with the WPPSI test used by Waerden *et al.* (2016). WPPSI measures the verbal IQ (VIQ), performance IQ (PIQ), full scale IQ (FSIQ), processing speed (PSQ), and General Language Composite (GLC) (Bryant *et al.* 1978; Phillips *et al.* 1978; Community-University Partnership for the Study of Children, Youth, and Families 2011)

Table 3: McCarthy General Cognition Index in pre-school and elementary school age children by gender (and mothers' social class for Murray 1996) for Murray (1996) and Sharp (1995) (Means and Standard Deviation)

		Murray <i>et al.</i> 1996		Sharp <i>et al.</i> 1995
		Social class		
		I,II,III (non-manual)	III (manual), IV, V	
Control group	Boys	116.7 (14.7) ^a	109.9 (11.2)	103.9 (13.4)
	Girls	113.6 (8.9)	106.8 (3.5)	98.0 (13.4)
Children of post-partum depressed mothers	Boys	112.0 (10.9)	104.7 (14.9)	85.2 (18.2)
	Girls	116.0 (12.6)	104.7 (8.3)	100.7 (12.5)

^aMean and standard deviation of cognitive development scores

Table 3 presents the results of two studies that used same measures of cognitive development in children of similar age. Murray *et al.* (1996) concluded that maternal depression alone is not associated with the cognitive development at the age of 5. Maternal post-partum depression has an effect only when associated with low social class. Post-partum depression and low social class may contribute to low cognitive scores, particularly in boys of depressed mothers which make them more vulnerable. The findings of this study are consistent with the findings of Sharp *et al.* (1995) - conducted in a socioeconomically deprived area in Southeast London- which showed that there is a significant cognitive impairment among boys of post-partum depressed mothers.

Both studies had very small sample sizes that did not appear to represent the whole population. Sharp *et al.* (1995) was representing an economically deprived area of Southeast London, and Murray *et al.* (1996) represented an area of better living conditions around the catchment of a hospital in Cambridge. Yet, both studies had similar results showing that boys of post-partum depressed mothers of low social class may be more vulnerable and have lower cognitive scores. In contrast, Hay *et al.* (1995) found, in a North London sample, that there is no

difference in the effect of maternal depression on the child development based on gender; however this study did not show the cognitive scores of boys and girls separately, hence, it was not included in the analysis. Furthermore, North London has better socioeconomic status than South London, which supports the hypothesis that social class may play a role in low cognitive development. The difference of effect across genders may be attributed to the influence of social class more than the maternal depression itself.

Waerden *et al.* (2016) found that post-partum depression has an effect on child cognitive development. This effect is more evident with persistent depression; the longer the depression persists, the poorer the child cognitive outcomes. Boys and not girls of persistent post-partum depressed mothers have low PIQ and FSIQ, but not VIQ. VIQ scores were within the normal range. Furthermore, no association between socioeconomic status and child cognitive development was found. The normal VIQ in boys in the Waerden *et al.* (2016) study is consistent with the finding of Kersten-Alvarez *et al.* (2012) which pointed out that boys have a normal VIQ; however, girls have lower verbal intelligence according to the PPVT-R test when exposed to maternal post-partum depression.

All studies excluded children born with low birth weight and adjusted for breast-feeding. Maternal IQ was a covariate in all included studies except the Waerden *et al.* (2016) study. Yet, after adjusting for it in all studies where it is included, the final association between maternal post-partum depression and cognitive development did not alter the interpretation.

Effect in infants and children up to two years of age

Table 4: The cognitive development scores in boys and girls at age of 18 months.

			Murray (1992)	Azak (2012)
		Sample Size	On Reynell Scales MSS	On MSEL Scales Estimate (SE)
Control group	Boys	20	-0.15	-0.21 (0.05)
	Girls	18	0.25	
Children of post-partum depressed mothers	Boys	16	-0.14	1.12 (0.42)
	Girls	19	0.63	

Abbreviations: MSS, Mean Standard Score

To assess the effect of post-partum depression on children during the first two years of life, Azak (2012) used the MSEL scale (Table 4). Nearly all depressed mothers in this sample were from high socioeconomic class, with more than 50% of the mothers well-educated with at least a master’s degree and were under treatment during follow-up for their post-partum depression. The majority of the depressed mothers (80%) reported being mentally ill during pregnancy. Additionally, they noted low parenting styles. MSEL was negatively correlated with maternal education, showing that mothers with higher education may experience less stresses in life and their children may have better cognitive trajectories. It is possible that the mental illness of the mothers during pregnancy could have affected the results. Girls showed faster rates of increasing MSEL scores (estimate: 0.12, S.E:0.42) over time compared to boys. This finding is consistent with other studies showing that female infants reach milestones earlier than boys (Diamond 1995, Kotovosky *et al.*1998 and Ozçaliskan *et al.* 2010). Thus the relationship between the

maternal post-partum depression and cognitive development according to gender could be confounded by this natural course of development in this age group.

Murray (1992) observed that low scores on the scales of mental development in this sample was associated with post-partum depression only in the context of low socioeconomic class and that boys are more affected than girls. A meta-analysis in this age group that did not stratify by gender (Liu *et al.* 2017) concluded the presence of an association between maternal post-partum depression and children development.

Effect in older children

Two studies were available for this age group (Table 5). Hay *et al.* (2001) measured the cognitive development at the age of 11 years by using the WISC-III scale. This study showed that post-partum depression may have an effect on the educational needs in children. Boys were more affected than girls in which the gender difference was more pronounced based on PIQ.

Murray *et al.* (2010) measured the cognitive development by assessing the GSCE scores of children of post-partum depressed mothers and a community sample of non-depressed mothers. They concluded that the boys' cognitive development is more affected by the maternal postpartum depression, as a continuation of the post-partum effect on earlier cognitive development.

Table 5: Summary of results of the studies included for the older age groups.

		Hay et al. (2001)		Murray et al. (2010)	
		Not depressed mothers (Mean Score)	Post-partum depressed mothers (Mean Score)	Not depressed mothers (Mean and SD of GCSE score)	Post-partum depressed mothers (Mean and SD of GCSE score)
Boys	FSIQ	103.2	83.8	45.8 (10.38)	38.48 (18.21)
	VIQ	102.6	88.0		
	PIQ	103.1	82.2		
Girls	FSIQ	97.6	93.8	44.00 (13.81)	45.31 (16.74)
	VIQ	98.3	92.8		
	PIQ	97.4	97.0		

Abbreviations: FSIQ, Full Scale IQ; GCSE, General Certificate of secondary education; PIQ, Performance IQ; VIQ, Verbal IQ.

Discussion

Our review of the eight studies that focused on the effects of post-partum depression on cognitive development of boys and girls separately revealed that the maternal well-being is extremely important during the first year after delivery. Infants of post-partum depressed mothers showed a delayed cognitive development compared to infants of non-depressed mothers. This association was more evident in boys from families of low social class. This observation may be explained by a tendency for greater attachment of the mother to the daughter in early life; post-partum depressed mothers may treat girls and boys differently. At an older age when the child reaches the preschool/elementary school period, the effect of post-partum depression is only observed among those living in low social classes and underprivileged societies. Maternal and paternal intelligence did not influence the cognitive development of the child at that age. Reaching the age of 11 and 16 years, the effect of post-partum depression continues to play a role on child cognition particularly in boys. Alternatively, personality traits and self-discipline

may apply more to girls and may account for the relatively poor prediction of their academic achievement from cognitive ability (Else-Quest *et al.* 2006, Duckworth *et al.* 2006). Based on the synthesis of the published literature to date, the evidence appears to suggest a significant role for social class and maternal mental state in influencing cognitive development of the child.

By examining the ability of the individual to adapt to adverse conditions, Sun *et al.* (2012) observed that in primary school children, girls have more psychosocial resilience than boys, which is consistent with the results of our study. However, psychosocial resilience could change in different genders over time and based on the environment where the individual lives. Bonanno *et al.* (2007) and Masood *et al.* (2016) concluded that in adults, women have less likelihood of resilience in stressful events, and Boardman *et al.* (2008) examined the heritability of psychological resilience among US adults aged 25 to 74 years showing that men have more psychological resilience.

Sources of study heterogeneity

Our study reviewed all the available evidence derived from epidemiological studies addressing the influence of maternal post-partum depression on the cognitive development of boys and girls at a range of ages. To our knowledge, this is the first review to summarize the evidence specifically by gender. However, this review should be interpreted in the context of certain limitations. For examining the association in infants, only two studies were available that examined the relationship by gender, and they were conducted in populations of specific social class and across different countries. This is a source of heterogeneity that may limit the generalizability of the findings, yet the results showed consistency. The sample size of both

studies was relatively small, which might have contributed to random variation and chance findings. However, consistency in results across studies argues in favor of a true association.

For the preschool and elementary school age population, different measurements were used to assess the mother's depression and the cognitive development. All scales are recognized to have high validity and reliability, except for the PPVT-R test which has lower reliability than the McCarthy scale and the WPPSI-III. Wechsler scales (WPPSI, WISC-III and WAIS) have a more rigid construct validity compared to the McCarthy scale, yet, according to Hedlund (1977) both McCarthy and Wechsler scales correlate well with each other except for measurements on motor ability, a characteristics not examined in our study. Moreover, Kersten-Alvarez *et al.* (2012), which used the PPVT-R test was scored as being a lower quality study based on the "Newcastle-Ottawa Quality Assessment Form for Cohort Studies". Despite this, the result of this study showed consistency with findings from the other studies. Different measurement scales could be a source of information bias, but we would expect the bias to be a non-differential in nature. Despite of the presence of this non-differential bias, the associations were detected and appeared consistent across studies.

There was variation in the combination of confounders addressed in each study including breastfeeding, low birth weight, social class, mother education, mother IQ, father IQ, parental relationship status and nutritional status. All studies appropriately excluded children born with low birth weight. There is an established association between low birth weight and delayed infant development in early life (Lee *et al.* 1993; Hack *et al.* 1995; Tong *et al.* 2006).

The main covariate that most studies focused on was social class. Studies conducted exclusively in high social class populations did not observe an association between maternal depression and the child's cognitive development. In contrast, those performed in populations of lower social

class observed associations. The quality scores of both studies representing high and low social classes generally indicated they were of high quality which makes it unlikely that the results can be explained completely by a major bias. This consistency of the association was present among all populations, which supports the presence of an association by gender.

It is also important to acknowledge that all studies were not performed over the same time period. Sharp *et al.* (1995) was in the nineties and Waerden *et al.* (2016) targeted a more recent population. This difference is accompanied by differences in the general surrounding environment and living conditions. Also, treatment options for maternal depression have improved over time. Despite these potential sources of heterogeneity, overall, the results appeared to still show marked consistency.

Generalizability of the findings

Sample sizes in all studies – except Waerdan *et al.* (2016) - were relatively small and may not be representative of the broader population. The identified role of social class in influencing the relationship between maternal post-partum depression and child's cognitive development differently in boys and girls suggests that the causal mechanisms are likely complex and that different mechanisms may be at play depending on the subpopulation. Populations for five of the eight studies appear to be homogenous, that is, from the same ethnicity, in the same city and having the same cultural background. Studies were limited to populations from European countries, and no articles mentioning gender differences were available from the USA or developing countries. If studies were conducted in other populations, results might not be the same. For example, in African countries, nutrition plays an important role in child development; the rates of infectious diseases are higher and socio-cultures bonds are tighter. Furthermore,

gender inequality is prevalent in many developing societies, leading to more care for boys than girls which might in turn leads to better cognitive outcomes for boys.

Interventions

In order to address this problem, we have to focus on treating and preventing the maternal post-partum depression. Several researchers have attempted to explore this area and provide suggestions for prevention or early treatment. Beck (1996) suggested that the mother and the infant are a dyad, since difficult infant temperament might be a cause for the maternal post-partum depression; and the best way to move forward is to focus on both of them. Symon *et al.* (2005) concluded that sleep interventions can help change the parental behavior and may improve the infant's sleep. This might help in reducing the maternal post-partum depression.

Another intervention is the Interpersonal Therapy (IPT), which is a short term psychotherapy, originally designed for major depressive disorders and later adapted to treat women in the post-partum period (Spinelli *et al.* 2003). Also, the ROSE program (Reach-Out, Stay strong, Essentials for new mothers) which is a manualized IPT-based group intervention to help pregnant women on public assistance improve and build closer relationships and support networks (Zlotnick *et al.* 2016).

Regular prenatal care is very important to detect antepartum and post-partum depression and treat them as early as possible. Reducing the prevalence of post-partum depression may have a significant public health impact leading to better maternal and child health.

Conclusion

Between 1995 and 2016, eight independent cohort studies were conducted, and addressed the gender differences in the association between maternal post-partum depression and cognitive development in children. Overall, the cumulative evidence to date suggests that boys' cognitive development are more affected than girls' cognitive development when exposed to the post-partum depression in low social class areas. Among populations of high social class, the effect of the post-partum depression on cognitive development does not appear to be difference in boys and girls.

Given these results, there is a need for future studies to pursue gender-specific evaluation of this association in other regions of the world, especially in middle and low income countries where levels of maternal depression are higher.

References

- American Academy of Pediatrics, Daughters. Retrieved February 04, 2018, from
<https://www.healthychildren.org/English/family-life/family-dynamics/Pages/Daughters.aspx>
- American Academy of Pediatrics, Sons. Retrieved February 04, 2018, from
<https://www.healthychildren.org/English/family-life/family-dynamics/Pages/Sons.aspx>
- Azak, S. (2012). *Maternal depression and sex differences shape the infants' trajectories of cognitive development*. *Infant Behavior & Development*, 35(4), 803-814.
doi:10.1016/j.infbeh.2012.07.017 [doi]
- Barbu, S., Cabanes, G., & Le Maner-Idrissi, G. (2011). *Boys and Girls on the Playground: Sex Differences in Social Development Are Not Stable across Early Childhood*. *PLoS ONE*, 6(1), e16407. <http://doi.org/10.1371/journal.pone.0016407>
- Beck, C. T. (1996). *A meta-analysis of predictors of postpartum depression*. *Nursing Research*, 45(5), 297-303.
- Black, M. M., Baqui, A. H., Zaman, K., El Arifeen, S., & Black, R. E. (2009). *Maternal depressive symptoms and infant growth in rural bangladesh*. *The American Journal of Clinical Nutrition*, 89(3), 951S-957S. doi:10.3945/ajcn.2008.26692E [doi]
- Boardman, J. D., Blalock, C. L., & Button, T. M. M. (2008). *Sex Differences in the Heritability of Resilience*. *Twin Research and Human Genetics : The Official Journal of the International Society for Twin Studies*, 11(1), 12–27. <http://doi.org/10.1375/twin.11.1.12>

Bonanno, G. A., Galea, S., Bucciarelli, A., & Vlahov, D. (2007). *What predicts psychological resilience after disaster? the role of demographics, resources, and life stress*. *Journal of Consulting and Clinical Psychology*, 75(5), 671-682. doi:10.1037/0022-006X.75.5.671

Bryant, C. K. and Roffe, M. W. (1978), *A reliability study of the McCarthy Scales of Children's Abilities*. *J. Clin. Psychol.*, 34: 401–406. doi:10.1002/1097-4679(197804)34:2<401::AID-JCLP2270340230>3.0.CO;2-V

Committee on the Science of Children Birth to Age 8: *Deepening and Broadening the Foundation for Success, Board on Children, Youth, and Families, Institute of Medicine, & National Research Council*. (2015). doi:NBK310532 [bookaccession]

Community-University Partnership for the Study of Children, Youth, and Families (2011). *Review of the Wechsler Preschool and Primary Scale of Intelligence – Third Edition [Canadian] (WPPSI-III-CDN)*. Edmonton, Alberta, Canada.

Diamond, A. (1985). *Development of the ability to use recall to guide action, as indicated by infants' performance on A-B̄*. *Child Development*, 56(4), 868-883. doi:10.2307/1130099

Duckworth, A. L., & Seligman, M. E. P. (2006). *Self-discipline gives girls the edge: Gender in self-discipline, grades, and achievement test scores*. *Journal of Educational Psychology*, 98(1), 198-208. <http://dx.doi.org/10.1037/0022-0663.98.1.198>

Else-Quest, N. M., Hyde, J. S., Goldsmith, H. H., & Van Hulle, C. A. (2006). *Gender differences in temperament: A meta-analysis*. *Psychological Bulletin*, 132(1), 33-72.

Felitti, V. J., M.D., FACP, Anda, R. F., M.D., MS, Nordenberg, D., M.D., Williamson, D. F., M.S., et al. *Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults*. *American Journal of Preventive Medicine*, 14(4), 245-258. doi:10.1016/S0749-3797(98)00017-8

Grantham-McGregor, S., Cheung, Y. B., Cueto, S., Glewwe, P., Richter, L., Strupp, B., et al. (2007). *Developmental potential in the first 5 years for children in developing countries*. *Lancet* (London, England), 369(9555), 60-70. doi:S0140-6736(07)60032-4 [pii]

Hack, M., Klein, N. K., & Taylor, H. G. (1995). *Long-term developmental outcomes of low birth weight infants*. *The Future of Children*, 5(1), 176-196.

Hay, D. F., & Kumar, R. (1995). *Interpreting the effects of mothers' postnatal depression on children's intelligence: A critique and re-analysis*. *Child Psychiatry and Human Development*, 25(3), 165-181.

Hay, D. F., Pawlby, S., Sharp, D., Asten, P., Mills, A., & Kumar, R. (2001). *Intellectual problems shown by 11-year-old children whose mothers had postnatal depression*. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 42(7), 871-889.

Hay, D. F., Pawlby, S., Waters, C. S., & Sharp, D. (2008). *Antepartum and postpartum exposure to maternal depression: Different effects on different adolescent outcomes*. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 49(10), 1079-1088. doi:10.1111/j.1469-7610.2008.01959.x [doi]

Hedlund, M. (1977). *A comparison of WISC-R and McCarthy scales of children's abilities*

(master's thesis). Marquette University, Cambridge, Massachusetts.

Howard, K., Martin, A., Berlin, L. J., & Brooks-Gunn, J. (2011). *Early mother-child separation, parenting, and child well-being in early head start families*. *Attachment & Human*

Development, 13(1), 5-26. doi:10.1080/14616734.2010.488119 [doi]

Kersten-Alvarez, L. E., Hosman, C. M., Riksen-Walraven, J. M., van Doesum, K. T., Smeekens, S., & Hoefnagels, C. (2012). *Early school outcomes for children of postpartum depressed*

mothers: Comparison with a community sample. *Child Psychiatry and Human*

Development, 43(2), 201-218. doi:10.1007/s10578-011-0257-y [doi]

Kotovskiy, L., & Baillargeon, R. (1998). *The development of calibration-based reasoning about collision events in young infants*. *Cognition*, 67(3), 311-351. doi:S0010027798000365 [pii]

Lee, H., & Barratt, M. S. (1993). *Cognitive development of preterm low birth weight children at 5 to 8 years old*. *Journal of Developmental and Behavioral Pediatrics : JDBP*, 14(4), 242-249.

Liu, Y., Kaaya, S., Chai, J., McCoy, D. C., Surkan, P. J., Black, M. M., et al. (2017). *Maternal depressive symptoms and early childhood cognitive development: A meta-analysis*.

Psychological Medicine, 47(4), 680-689. doi:10.1017/S003329171600283X [doi]

Masood, A., Masud, Y., & Mazahir, S. (2016). *Gender differences in resilience and*

psychological distress of patients with burns. *Burns: Journal of the International Society for*

Burn Injuries, 42(2), 300-306. doi:10.1016/j.burns.2015.10.006 [doi]

Maternal depression and child development.(2004). *Paediatrics & Child Health*, 9(8), 575-598.

Maternal mental health. Retrieved January 17, 2018, from

http://www.who.int/mental_health/maternal-child/maternal_mental_health/en/

Murray, L. (1992). *The impact of postnatal depression on infant development*. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 33(3), 543-561.

Murray, L., Hipwell, A., Hooper, R., Stein, A., & Cooper, P. (1996). *The cognitive development of 5-year-old children of postnatally depressed mothers*. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 37(8), 927-935.

Murray, L., Arteche, A., Fearon, P., Halligan, S., Croudace, T., & Cooper, P. (2010). *The effects of maternal postnatal depression and child sex on academic performance at age 16 years: A developmental approach*. *Journal of Child Psychology and Psychiatry*, 51(10), 1150-1159. doi:10.1111/j.1469-7610.2010.02259.x

Ozcaliskan, S., & Goldin-Meadow, S. (2010). *Sex differences in language first appear in gesture*. *Developmental Science*, 13(5), 752-760. doi:10.1111/j.1467-7687.2009.00933.x [doi]

Park, J. M., Fertig, A. R., & Allison, P. D. (2011). *Physical and mental health, cognitive development, and health care use by housing status of low-income young children in 20 american cities: A prospective cohort study*. *American Journal of Public Health*, 101 Suppl 1, S255-61. doi:10.2105/AJPH.2010.300098 [doi]

Pearlstein, T., Howard, M., Salisbury, A., & Zlotnick, C. (2009). *Postpartum depression.*

American Journal of Obstetrics and Gynecology, 200(4), 357-364.

doi:10.1016/j.ajog.2008.11.033 [doi]

Phillips, B. L., Pasewark, R. A., & Tindall, R. C. (1978). *Relationship among McCarthy Scales*

of Children's Abilities, WPPSI, and Columbia Mental Maturity Scale. *Psychology in the*

Schools, 15(3), 352-356. [http://dx.doi.org/10.1002/1520-6807\(197807\)15:3<352::AID-](http://dx.doi.org/10.1002/1520-6807(197807)15:3<352::AID-)

[PITS2310150307>3.0.CO;2-O](http://dx.doi.org/10.1002/1520-6807(197807)15:3<352::AID-PITS2310150307>3.0.CO;2-O)

Reproductive Health. (2017, December 13). Retrieved January 17, 2018, from

<https://www.cdc.gov/reproductivehealth/depression/index.htm>

Sharp, D., Hay, D. F., Pawlby, S., Schmucker, G., Allen, H., & Kumar, R. (1995). *The impact of*

postnatal depression on boys' intellectual development. *Journal of Child Psychology and*

Psychiatry, and Allied Disciplines, 36(8), 1315-1336.

Spinelli, M. G., & Endicott, J. (2003). *Controlled clinical trial of interpersonal psychotherapy*

versus parenting education program for depressed pregnant women. *The American Journal*

of Psychiatry, 160(3), 555-562. doi:10.1176/appi.ajp.160.3.555 [doi]

Staff, P. T. (2011, September 25). *Know Your Child Better By Learning The Ages & Stages Of*

Child Development. Retrieved January 17, 2018, from

https://childdevelopmentinfo.com/ages-stages/#.W1_eZLyWZdg

- Sun, J., & Stewart, D. (2007). *Age and gender effects on resilience in children and adolescents*. *International Journal of Mental Health Promotion*, 9(4), 16-25.
doi:10.1080/14623730.2007.9721845
- Symon, B. G., Marley, J. E., Martin, A. J., & Norman, E. R. (2005). *Effect of a consultation teaching behaviour modification on sleep performance in infants: A randomised controlled trial*. *The Medical Journal of Australia*, 182(5), 215-218. doi:sym10800_fm [pii]
- Tong, S., Baghurst, P., & McMichael, A. (2006). *Birthweight and cognitive development during childhood*. *Journal of Paediatrics and Child Health*, 42(3), 98-103. doi:JPC805 [pii]
- Van der Waerden, J., Bernard, J. Y., De Agostini, M., Saurel-Cubizolles, M. J., Peyre, H., Heude, B., et al. (2017). *Persistent maternal depressive symptoms trajectories influence children's IQ: The EDEN mother-child cohort*. *Depression and Anxiety*, 34(2), 105-117.
doi:10.1002/da.22552 [doi]
- Wachs, T. D., Black, M. M., & Engle, P. L. (2009). *Maternal depression: A global threat to Children's health, development, and behavior and to human rights*. *Child Development Perspectives*, 3(1), 51-59. doi:10.1111/j.1750-8606.2008.00077.x
- Walker, S. P., Wachs, T. D., Gardner, J. M., Lozoff, B., Wasserman, G. A., Pollitt, E., et al. (2007). *Child development: Risk factors for adverse outcomes in developing countries*. *Lancet (London, England)*, 369(9556), 145-157. doi:S0140-6736(07)60076-2 [pii]
- Walker, S. P., Wachs, T. D., Grantham-McGregor, S., Black, M. M., Nelson, C. A., Huffman, S. L., et al. (2011). *Inequality in early childhood: Risk and protective factors for early child*

development. *Lancet* (London, England), 378(9799), 1325-1338. doi:10.1016/S0140-6736(11)60555-2 [doi]

White House Archive. Retrieved January 17, 2018, from <https://georgewbush.whitehouse.archives.gov/infocus/earlychildhood/sect2.html>

Wells G, Shea B, O'Connell J, Robertson J, et al. *The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analysis*. 2011. Available from http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp.

Zambrana, I. M., Ystrom, E., & Pons, F. (2012). *Impact of gender, maternal education, and birth order on the development of language comprehension: A longitudinal study from 18 to 36 months of age*. *Journal of Developmental and Behavioral Pediatrics* : JDBP, 33(2), 146-155. doi:10.1097/DBP.0b013e31823d4f83 [doi]

Zlotnick, C., Tzilos, G., Miller, I., Seifer, R., & Stout, R. (2016). *Randomized controlled trial to prevent postpartum depression in mothers on public assistance*. *Journal of Affective Disorders*, 189, 263–268. <http://doi.org/10.1016/j.jad.2015.09.059>