INVESTIGATING THE IMPACT OF MATERNAL-INFANT BONDING IMPAIRMENT DUE TO POSTPARTUM DEPRESSION ON CHILD IQ AND ADHD OUTCOMES

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ABSTRACT

Postpartum depression (PPD) is a psychiatric disorder following childbirth that is associated with health complications, such as chronic depression, changes in sleep patterns and appetite, and feelings of worthlessness, when left untreated. While PPD directly influences the mother, there are underlying consequences on child cognitive development, such as a link with lower child Intelligence Quotient (IQ) scores. This review aims to better understand the impact of PPD on maternal-infant bonding, and how this may influence child Intelligence Quotient (IQ) scores and attention-deficit hyperactivity disorder (ADHD) outcomes. A literature search on PubMed, OVID Medline, Cochrane Library, and Google Scholar was conducted using keywords relating to PPD, ADHD, and IQ. Current literature has suggested that PPD-induced impaired maternal-infant bonding is a risk factor for child ADHD outcomes and is associated with lower child IQ scores. However, there are limitations to consider, such as the validity of IQ scores, as the association between PPD and impaired maternal-infant bonding on child IQ scores is complex and multi-faceted. There are many potentiating risk factors and confounders that may influence the mother's experience of PPD and the developmental outcomes in the offspring.

INTRODUCTION

Maternal postpartum depression (PPD) is a psychiatric disorder consisting of depressive symptoms that persist for at least two weeks and interferes with the mother's ability to return to normal function following postpartum [1,3]. Symptoms of PPD consist of depressed moods, emotional withdrawal, changes in sleep patterns and appetite, feelings of worthlessness, psychomotor agitation, and other symptoms that may have a severe impact on the mother's mental state, quality of life (QoL), and relationships with others [1,4].

Maternal-infant bonding dynamic refers to the quality of emotional connection and interaction between the mother and her offspring [3]. When PPD is left untreated, it may lead to impaired bonding dynamics between the mother and her offspring, as PPD may hinder the mother's ability to engage and interact with her child by responding to infant cues [3]. Maternal PPD has been correlated with a decrease in responsiveness to infant cues and needs, and disengaged parenting outcomes that are thought to contribute to lower child Intelligence Quotient (IQ) scores and attention-deficit hyperactivity disorder (ADHD) outcomes [3]. It is also important to note that not all mothers with PPD show poor responsiveness or disengaged parenting behaviours that may lead to these outcomes [3].

Although PPD is a severe health concern for both the mother and her child, this paper will primarily focus on the complications of PPD on the offspring [1,2]. Currently, to this paper's knowledge, there are no reviews written in English with a specific focus on investigating the effects of impaired maternal-infant bonding due to maternal PPD on either child IQ scores or ADHD outcomes. Thus, this paper seeks to provide a review of recent literature to address the three following research inquiries: 1) What is the impact of PPD on maternal-infant bonding dynamics? 2) How does PPD-induced impaired maternal-infant bonding affect child IQ scores? and 3) Is there an association between PPD-induced impaired maternal-infant bonding and ADHD?

RESULTS

The Influence of PPD on Impaired Maternal-Infant Bonding

The relationship between postpartum depression (PPD) and impaired maternal-infant bonding is well-established in current literature [5]. Research suggests that PPD may negatively affect the bonding dynamic between the mother and her offspring due to a decrease in maternal responsiveness and engagement [5]. Gilden et al. involved sixty-four women with PPD, 61.1% of whom reported self-perceived impaired bonding with their offspring that could result in "undesirable" bonding experiences with their child [5]. In this study, "bonding" referred to the mother's feelings towards her child, with impaired bonding deemed to be undesirable, as it could impact the child's cognitive long-term development [5]. However, it is important to note that bonding was measured using the self-administered Postpartum Bonding Questionnaire (PBQ), thus the results may not entirely translate to the actual quality of maternal-infant bonding. Other studies have found similar findings, including an association between impaired maternal-infant bonding and child behavioural challenges during early childhood, as well as a risk for maltreatment later in life [6,7].

Mother and Baby Units to Improve Maternal-Infant Bonding:

Although impaired maternal-infant bonding can result in undesirable child developmental outcomes, an adequate treatment regime will usually improve bonding in mothers with PPD [5]. In the study by Gilden et al., a significant association between a decrease in depressive symptoms and improvement in maternal-infant bonding was identified among participants with PPD over an eight-week period following admission to a Mother and Baby Unit (MBU) [5]. MBUs are non-pharmacological interventions that involve guidance from nurses regarding ways mothers can engage with their offspring, connect with support groups, and learn from video-based instructions [5]. The aim of MBUs is to facilitate healthy mother-infant relationships and provide inpatient psychiatric support for mothers and their infants [8]. Moreover, a systematic review involving twenty-three studies investigated the outcomes for women admitted to MBUs [8]. The results indicated that higher levels of insecure attachment in infants were observed in mothers with PPD and other affective disorders which are characterized by severe disruptions in emotions; however, the quality of mother-infant interactions generally improved following MBU admission. Quality was based on the mother's engagement with her offspring and her response to infant cues [8]. In addition to MBUs and other non-pharmacological interventions, pharmacological treatment options, such as tricyclic antidepressants or selective serotonin reuptake inhibitors, are commonly prescribed medications to treat depressive symptoms of PPD and improve maternal-infant bonding [3]. Thus, adequate treatment plans are important to improve the well-being of the mother and her offspring and mitigate the effects of PPD on impaired maternal-infant bonding.

Relationship Between PPD and Child IQ Scores

Several studies have indicated a negative association between maternal PPD symptoms and child cognitive development [2,9-11]. PPD has been linked to impaired maternal-infant attachment and bonding that is thought to contribute to changes in cognitive developmental outcomes, particularly lower IQ scores in children [2,9]. Mothers diagnosed with PPD were found to exhibit a decrease in sensitivity to infant cues and response to fulfilling infant needs [10]. A study by Sharp et al. [11] found a relationship between a lack of maternal engagement and responsiveness due to PPD and lower IQ scores in children. Children of mothers with PPD demonstrate a greater likelihood of developing attentional deficiencies, difficulties with Piaget's object permanence tasks, and other cognitive-related tasks [11]. During the first year of maternal PPD, children demonstrated a decrease in performance on standardized tests of intellectual attainment at four years old; however, these lower IQ scores were not displayed in children of mothers who became depressed after the first year of PPD [11]. Although further research is required to understand the relationship between the onset of PPD symptoms on child IQ scores, these results suggest that maternal PPD has a greater effect on child IQ scores during infancy than later stages of child development.

Sex Differences in IQ Scores:

Another study found that three-year-old children of mothers with maternal PPD at six months postpartum had a notable difference in full IQ scores, but no major difference in performance IQ (PIQ) or verbal IQ (VIQ) [12]. Full IQ is composed of both PIQ and VIQ, which can be further broken down into subcategories, and measure an individual's visuospatial intellectual abilities and spoken language abilities, respectively [12]. Interestingly, the three-year-old male participants were disproportionately affected by maternal PPD than female children, as they exhibited the lowest full IQ scores in the study [12]. A meta-analysis by Sui et al. [13] found similar results; significant differences in cognitive test scores were identified in male children, whereas no significant differences were observed in female children's test scores. It is hypothesized that male children are more sensitive to the effects of PPD partly due to maturational disadvantages and differences [13]. However, some studies found conflicting research that indicated an insignificant difference in IQ scores among male and female children [11]. Based on the inconclusive findings, there is insufficient evidence to prove whether there is a difference between maternal PPD and the child's IQ in males compared to females. However, there is consistent research evidence that demonstrates that PPD is a predictor for lower child IQ scores.

Brain Activity:
It is hypothesized that the negative relationship between PPD and lower IQ scores could be explained by an infant's electrical brain activity and a lack of synchrony and reciprocity between an infant's actions and maternal response [13]. Research suggests that infants of mothers without PPD demonstrated a greater likelihood of exhibiting electrical activity within the left frontal cortex, whereas infants of mothers with PPD are more likely to exhibit electrical activity within the right frontal cortex [13]. These findings are significant as electrical activity in the left frontal cortex has been shown to establish positive emotions and "normal" behaviour, whereas electrical activity in the right frontal cortex is more responsible for negative emotions and feelings of distress [13,14]. As a result, greater activity expressed in the left frontal cortex in the infants of mothers with PPD is linked to higher rates of distress, negative emotions, and reactions that may have a negative impact on the infant's ability to react to novel stimuli and hinder learning abilities [14,15]. The change in electrical brain activity in the offspring may result in frequent distress that prompts cognitive or intellectual developmental delays [14,15]. However, more research on the brain activity in infants or children of mothers with PPD is needed to confirm this hypothesis.

Impaired Maternal-Infant Bonding and Child ADHD Outcomes

Attention-deficit hyperactivity disorder (ADHD) is a psychiatric condition that tends to involve inappropriate levels of inattentiveness and hyperactivity, difficulty concentrating, disorganization, and other symptoms that affect a child's ability to function [16]. Symptoms of ADHD can be broadly categorized into inattentive- and hyperactive symptoms [16]. Inattentive symptoms include difficulties sustaining attention, missing small details, avoiding tasks that require more cognitive effort, and forgetfulness [16]. Hyperactive symptoms include fidgeting, inability to engage in activities quietly, and difficulty waiting for their turn in group situations [16]. ADHD may also affect an individual's ability to function through procrastination, low-self-esteem, mood instability, and difficulty controlling emotions [16]. It is also important to acknowledge that ADHD may manifest differently among individuals, with variations in symptom prevalence, severity, and impact, reflecting a spectrum of experiences that can change over time [16,17].

According to study findings, PPD is a risk factor for child ADHD as PPD may result in symptoms of impaired maternal-infant bonding, including maternal inattentiveness, inability to cope with the care of the child, and a lack of nurturing behaviour [3,17]. However, the specific relationship between a lack of nurturing behaviour as a result of PPD on child ADHD outcomes is not entirely known [3,17]. A meta-analysis that investigated the general relationship between PPD and child ADHD found a statistically significant correlation between PPD and ADHD with a 95% confidence interval of 1.27 to 2.26 among nine cohort studies, which indicates that there is a 95% likelihood that children were 1.27 to 2.26 times more likely to have ADHD or exhibit inattentive or hyperactive ADHD symptoms if their mother was diagnosed with PPD compared to mothers without a PPD diagnosis [3].

Bowlby's Theory of Attachment:
Bowlby's theory of attachment highlights the significance of the dyadic relationship between the mother and her infant in shaping early attachment, which refers to the emotional bond that forms between the mother and her child during early years of life [18,19]. This early attachment influences cognitive and emotional development, as well as internal working models that shape future relationships [18]. Infants rely on their mothers for engagement, interaction, and emotional regulation, making the quality of early attachment an important factor in psychological well-being and social development [18,19]. Research suggests that variations in attachment styles may be associated with differences in impulse control, patience, self-regulation, and self-soothing abilities, which are traits linked to ADHD [18,19]. PPD has been connected to disruptions in maternal-infant engagement, which may influence these developmental processes [18,19].

Early Breastfeeding Cessation and Child ADHD Outcomes:
Breastfeeding is an important physiological and emotional bonding experience between mothers and their infants [18]. Mothers with PPD tend to engage in less healthy nurturing habits such as early breastfeeding cessation, which is a risk factor for child ADHD [18]. Current literature suggests that breastfeeding has protective properties against child ADHD, which could account for the increased likelihood of child ADHD outcomes when mothers are unable to consistently breastfeed for an adequate period [18]. Furthermore, a prospective study by Hamdan et al. found a reciprocal relationship between breastfeeding and a reduced risk of PPD [20]. The results of the study found that: 1) mothers who were breastfeeding after two months following postpartum had a lower risk for PPD in later months of postpartum, and 2) mothers with PPD were linked with a decreased period of breastfeeding [20]. Another study found a similar association between having higher depressive symptoms at two weeks following postpartum and early breastfeeding cessation around three-months postpartum [21]. It is hypothesized that a reciprocal relationship exists between PPD and reduced breastfeeding rates, as early breastfeeding cessation may exacerbate the risk and duration of PPD [19,21]. According to these studies, children of mothers with PPD are more likely to exhibit ADHD symptoms due to early breastfeeding cessation; however, the specific mechanisms and strength of this correlation are not well understood [19,21].

disabilities reported feeling very or extremely concerned about managing their child's behaviour, stress, anxiety, and emotions.[17]

Lastly, experts in the field are also worried that the rates of FASD may rise during the COVID-19 pandemic due to increased alcohol consumption. The Canadian Centre on Substance Use and Addiction revealed that 20% of Canadians have increased their alcohol consumption during the pandemic due to the lack of routine, boredom, stress, and loneliness. Furthermore, women have been found to consume more drinks than recommended per day according to Canada's Low Risk Alcohol Drinking Guidelines.[15] Additionally, intimate partner violence, a risk factor for FASD, as it may increase maternal alcohol consumption, has increased during the pandemic.19 Lockdown and stay-at-home measures have increased safety concerns among women who live with controlling or coercive partners, and it has been found that the number of calls to women's support services has significantly risen during this time.[18] With both the rise in alcohol consumption and intimate partner violence, there may be a potential increase in alcohol-exposed pregnancies.[18] Strategies that can help prevent FASD during the pandemic are inclusion of FASD education and prevention in public health messaging, provision of free contraceptives, and collaboration among healthcare providers for substance use and intimate partner violence to provide holistic care to women at risk of substance use during pregnancy.[18-19]

Hence, it is clear that the COVID-19 pandemic has impacted FASD in a number of facets, including the disruption of support services for children with FASD and their caregivers, the impact of social isolation on the mental health of children with FASD, and the potential increase in FASD prevalence in the near future.[12,15]

CURRENT RESEARCH GAPS & FUTURE DEVELOPMENTS

Given the short-and long-term implications on a child's cognitive development, alongside the complexities of FASD, over 90% of individuals diagnosed with this disorder are estimated to experience mental health challenges.[20] Despite the prevalence of such poor implications, little research has investigated the impact of interventions that address these persistent challenges for youth with FASD. In fact, a recent systematic review conducted in 2020 aimed at exploring the effectiveness of mental health and substance use interventions, revealed that only three out of 10,000 screened studies assessed their efficacy in FASD individuals.[20] The need for these future developments are imperative during this time, given the impacts of COVID-19 in exacerbating mental health challenges for these individuals.

Thus, future research is warranted to investigate the effectiveness of such interventions in FASD youth specifically. Apart from the poor mental health outcomes that many children with FASD experience, many other repercussions associated with the primary and secondary disabilities of FASD also exist. While their implications have been well-established, again, there is limited research on specific behavioural and cognitive strategies that may improve cognitive functioning. Developing a deeper understanding of the effectiveness of these strategies is critical to the implementation of intervention programs that can improve the physiological, psychosocial and physical health outcomes amongst youth with FASD.[21] Moreover, pharmacological interventions are often prescribed to manage the behavioural issues associated in children with FASD. However, if specific brain receptors that these medications act on are altered by prenatal alcohol exposure, then they may be ineffective.[6] Thus, future research should be aimed at developing a deeper understanding of the various changes that FASD can cause at a cellular level in order to facilitate more effective pharmacological interventions for youth with FASD.[22]

Given the rising concerns of caregivers, especially during the COVID-19 pandemic, it is pertinent that stronger support services are put in place. The 2015 Ontario provincial roundtable report on FASD found very little to no immediate crisis support or services outside of business hours.[23] Furthermore, participants of this roundtable report also called for more funding for services so that families and caregivers have increased access to supports that would assist them in coping with their mental health challenges as well. Finally, support currently exists in silos. As such, streamlining resources for children with FASD and their caregivers will be essential to reduce barriers in accessing information about these programs. For example, participants recommended establishing a one-stop 24/7 source where they could obtain the most updated information about FASD services, such as a national website or toll-free number.

By improving the current research gaps and enhancing support services, caregivers and children with FASD will be more cared for, thus leading to better outcomes with the child's cognitive and overall health development. Stakeholders, such as governmental jurisdictions, are beginning to see these gaps and take action for the future. For example, the Ontario government is investing $10.1 million in annual funding towards FASD programs and services and diagnostic services for people impacted by FASD.[24] This funding will go towards expanding FASD diagnostic services through new clinics and programs.

DISCUSSION

There are existing meta-analyses that examine the relationship between postpartum depression (PPD) and child attention-deficit hyperactivity disorder (ADHD) outcomes, as well as the relationship between PPD and lower child Intelligence Quotient (IQ) scores. However, research specifically exploring the impact of PPD-induced impaired maternal-infant bonding on these developmental outcomes remains limited. While PPD can influence child IQ and ADHD risk through multiple pathways, this paper focuses solely on one specific mechanism: the role of impaired maternal-infant bonding.

Studies have demonstrated an association between maternal PPD and decrease in maternal-infant attachment and bonding, which may affect reasoning and problem-solving abilities [2,9]. A lack of maternal engagement during early stages of child development has been linked to a decrease in performance on standardized tests of intellectual attainment, particularly in children of mothers who are diagnosed with PPD within the first year of postpartum [11]. There are conflicting findings on the influence of sex differences in IQ scores among children [11]. While some studies have found that male children appear to be disproportionately affected by impaired maternal-infant bonding, exhibiting lower full IQ scores than female children, others suggest that the difference is not statistically significant [11-13]. Thus, further research is needed to determine if PPD may influence the IQ scores of male and female children differently. Although the studies evaluated in this paper demonstrated that PPD has a negative association with lower IQ scores and poorer performance on standardized tests, understanding the limitations of these tests and potential confounders are necessary for interpreting these findings accurately [2,9-11]. Such confounders may include the child's sex, birth order, socioeconomic status, and family adversity [11].

Although IQ tests are an important indicator of intelligence as they are designed to measure cognitive functioning abilities, such as comprehension, reasoning, and judgment, there are limitations associated with IQ tests [22,23]. Researchers find that IQ tests may fail to accurately measure more cognitively complex or nuanced aspects of mental functioning, which may influence the predictive validity of IQ scores [22]. Additionally, there are external factors, like motivational influences and affective states, that may drive variations in performance on IQ tests [22]. Studies demonstrate that individuals who are more motivated, open to new learning experiences, and willing to search and process information, may perform better on IQ tests than if they were unmotivated to do so [22,23]. Affective states refer to the emotional state and expression of a person and can also influence IQ test performance [22]. Negative affective states, such as test anxiety and stress, are associated with lower IQ test performances [22]. Thus, when evaluating the IQ of a child, it is important to evaluate the validity of these tests, and how this may influence our understanding of the relationship between maternal PPD and offspring cognitive development.

Furthermore, although it is unclear if a causal relationship exists between PPD-related impaired maternal-infant bonding and ADHD outcomes, a correlation has been identified by several studies [16,18,19]. PPD increases the likelihood for a child to exhibit insecure attachment styles and receive a lack of maternal attentiveness, which are associated with symptoms of ADHD, such as having impulses, non-self-regulation, and impatience [18,19]. PPD has also been associated with early breastfeeding cessation that may negatively affect the bonding experience between the mother and infant [18]. Literature suggests that breastfeeding has protective properties against ADHD and has found an association between early breastfeeding cessation and an increased risk of ADHD in the offspring [18]. While associations have been identified between PPD and early breastfeeding cessation, as well as between early breastfeeding cessation and increased child ADHD, more research is needed on how the interconnected relationship between all three considerations (PPD, early breastfeeding cessation, and child ADHD outcomes) might affect the lives of mothers and their children [18,19].

CONCLUSION

The findings of this review suggest that impaired maternal-infant bonding due to maternal postpartum depression (PPD) is associated with lower Intelligence Quotient (IQ) scores and attention-deficit hyperactivity disorder (ADHD) in children. Adequate treatment plans are necessary to improve maternal-infant bonding, as well as the general health and well-being of mothers with PPD and their offspring. While a correlational relationship exists between PPD-induced impaired maternal-infant bonding and lower child IQ scores, as well as increased risk of child ADHD, evidence supporting a causal relationship is limited. Thus, to better understand the relationship of impaired maternal-infant bonding and maternal PPD on child IQ and ADHD outcomes, further research is required to explore the underlying mechanisms, assess the long-term impacts, and develop targeted interventions that support maternal mental health and promote healthy developmental trajectories for children.

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