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A Systematic Review and Meta-analysis of Parental Depression, Antidepressant Usage, Antisocial Personality Disorder, and Stress and Anxiety as Risk Factors for Attention-Deficit/ Hyperactivity Disorder (ADHD) in Children

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Abstract

Poorparental mental health and stress have been associated with children's mental disorders, including attention-deficit/hyperactivity disorder (ADHD), through social, genetic, and neurobiological pathways. To determine the strength of the associations between parental mental health and child ADHD, we conducted a set of meta-analyses to examine the association of parent mental health indicators (e.g., parental depression, antidepressant usage, antisocial personality disorder, and stress and anxiety) with subsequent ADHD outcomes in children. Eligible ADHD outcomes included diagnosis or symptoms. Fifty-eight articles published from 1980 to 2019 were included. We calculated pooled effect sizes, accounting for each study's conditional variance, separately for test statistics based on ADHD as a dichotomous (e.g., diagnosis or clinical cutoffs) or continuous measurement (e.g., symptoms of ADHD subtypes of inattentiveness and hyperactivity/impulsivity). Parental stress and parental depression were significantly associated

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with increased risk for ADHD overall and both symptoms and diagnosis. Specifically, maternal stress and anxiety, maternal prenatal stress, maternal depression, maternal post-partum depression, and paternal depression were positively associated with ADHD. In addition, parental depression was associated with symptoms of ADHD inattentive and hyperactive/impulsive subtypes. Parental antisocial personality disorder was also positively associated with ADHD overall and specifically ADHD diagnosis. Prenatal antidepressant usage was associated with ADHD when measured dichotomously only. These findings raise the possibility that prevention strategies promoting parental mental health and addressing parental stress could have the potential for positive long-term impacts on child health, well-being, and behavioral outcomes.

Keywords

Attention-deficit/hyperactivity disorder (ADHD); Parent mental health; Meta-analysis

Introduction

Treatment and prevention of mental disorders among parents is critical to public health given their prevalence and impact not only on parental health and well-being but also on child development (Herman-Stahl et al., 2007; National Academies of Sciences, Engineering, and Medicine (NASEM), 2016, 2019; National Research Council (NRC), 2009; NRC & Institute of Medicine (IOM), 2009; Wolicki et al., 2021). From 2008 to 2014, among US adults parenting a child under the age of 18 years old, 22.8% of women and 12.4% of men experienced any mental disorder in the last year (Stambaugh et al., 2017). Moreover, nationally representative data of children 0–17 years old indicate 7% have a primary caregiver/parent with poor mental health (Wolicki et al, 2021). Parental mental disorders and stress have been associated with a variety of adverse child health and development outcomes (NASEM, 2016, 2019; Liu et al., 2016; World Health Organization and Calouste Gulbenkian Foundation (WHO & CGF), 2014). Specifically, a body of research links poor parental mental health with children's mental disorders, such as attention-deficit/hyperactivity disorder (ADHD) and other disruptive behavior disorders (Alpern & Lyonsruth, 1993; Grizenko et al., 2012; Herndon & Iacono, 2005; NASEM, 2019; NRC & IOM, 2009; Ray et al., 2009).

ADHD is a prevalent, neurobehavioral disorder characterized by symptoms of inattention, impulsivity, and hyperactivity and is associated with significant long-term social, academic, economic, and vocational impacts (American Psychiatric Association, 2013; Danielson et al., 2018; Faraone et al., 2021; Fleming et al., 2017; Guo et al., 2018; Harpin, 2005; Ray et al., 2009; Zhao et al., 2019). The identification of potentially modifiable ADHD risk factors for children such as parental mental health indicators might inform efforts to prevent the onset of, reduce the severity of, and mitigate the persistence of ADHD.

Genetic and Biological Mechanisms of ADHD Risk Associated with Parental Mental Health

The causal mechanisms of ADHD risk associated with parental mental disorders are likely related to the combined effects of genetic, biological, and environmental factors and their interactions (Faraone et al., 2021). Findings from twin and family studies of ADHD report

strong heritability of ADHD with estimates of 60–80% (Faraone & Larsson, 2019; Freitag & Retz, 2010). Furthermore, mental disorders such as major depressive disorders and ADHD may have a coheritability of a common genetic polymorphism, indicating a shared genetic risk among these mental disorders (Lee et al., 2013). Parental stress and stressors are distinct from mental disorders but can be similarly related to parental mental health. Research on prenatal and even preconception exposures suggests that maternal stressors and mental disorders can alter in utero brain development through both neurodevelopmental structural or system changes, such as fetal neuronal cellular migration, and epigenetic methylation (Abbott et al., 2018; Glover, 2011; Keenan et al., 2018; Lupien et al., 2016; Manzari et al., 2018; Mill & Petronis, 2008). Neurological and genetic differences in turn have been associated with differences in child stress responses and behavioral disorders (Braithwaite et al., 2015; Hanson et al., 2015; Luby et al., 2017; McLaughlin et al., 2014; Oberlander et al., 2008).

Environmental Mechanisms of ADHD Risk Associated with Parental Mental Health

Parents also shape and support children's developmental outcomes through distinct environmental pathways such as parenting behaviors and family climate (NASEM, 2016). Negative parenting interactions (e.g., harsh discipline, intrusiveness, or lacking sensitivity or warmth) and hostile parenting have been associated with risk for child ADHD (Claussen et al., 2022; Romano et al., 2006). Mental disorders can impair a parent's ability to provide a nurturing, responsive, and consistent caregiving environment for their child (Clavarino et al., 2010; Sohr-Preston & Scaramella, 2006). For example, among parents with depression, negative parent–child interactions (e.g., lower warmth, higher hostility) have been associated with ADHD in children (Breaux & Harvey, 2019; Jacobvitz et al., 2004; Romano et al., 2006). Postnatal maternal anxiety has been associated with feeling less positive about childcare activities and investing less time playing and teaching their child (Clavarino et al., 2010). Among children previously diagnosed with ADHD, paternal antisocial personality disorder symptomatology and not paternal ADHD was associated with conduct problems in the children through negative parenting behaviors (e.g., poor monitoring, overactivity, inconsistent discipline; LeMoine, et al., 2018).

Minor parental stress can be normative (Crnic & Low, 2002) and result in healthy or even beneficial responses (Rudland et al., 2020); however, high levels of parental stress and stressors can impair parental mental health and parenting (Fredland et. al., 2018; Kahng et al, 2008). Pathways are also likely bidirectional, as ADHD symptoms among children may result in higher levels of parental stress (Breaux & Harvey, 2019). Stress, negative parental affect, and inconsistent or hostile parenting behaviors may play a role in bidirectional negative coercive family interactions that are impacted by child temperamental negativity (Patterson, 1982). These interacting factors may serve to maintain and exacerbate both the parental mental disorders and the ADHD symptomatology.

Gene by Environment Mechanisms of ADHD Risk Associated with Parental Mental Health

The interaction of genetic (e.g., parent and child shared neuroregulatory deficits) and environmental (e.g., negative parent–child interactions, family conflict) mechanisms could explain relations between parent mental health and ADHD risk (Retz et al., 2008;

Sciberras et al., 2011). The emerging field of ADHD epigenetics suggests that genetic and environmental contributions to generational effects are complex (Mill & Petronis, 2008; Nigg, 2018). Gene-environment effects indicate evidence of at-risk genotypes interacting with social and environmental adversity to increase ADHD risk (Hamza et al., 2017; Retz et al., 2008) as well as gene-environment epigenetic mediated interactions of ADHD risk, such as maternal stress (Rice et al., 2010) and family conflict or violence (Retz et al., 2008).

In summary, parental mental health may convey a genetic, biological, or environmental risk for ADHD. Greater understanding of parental mental health risk factors and their potential effects on childhood ADHD diagnosis and symptomatology could help with the development and prioritization of prevention efforts to mitigate negative effects on child well-being. We used meta-analytic methods (Borenstein et al., 2011) to examine the data on potentially modifiable parental mental health risk factors that may increase ADHD susceptibility and can help to identify broad targets for future research and intervention, within and across risk factors.

Methods

This study is part of a larger set of meta-analyses conducted to synthesize results from studies examining potentially modifiable risk factors (e.g., perinatal complications, Bitsko et al., 2022; parenting and family environment, Claussen et al., 2022) for childhood ADHD. A complete description of the full search strategies, inclusion and exculsion criteria, and data abstraction are described in detail elsewhere in this supplement (Bitsko et al., 2022). Briefly, the ADHD search terms encompassed ADHD diagnoses (e.g. ADHD, attention-deficit disorder, hyperkinetic disorder, minimal brain dysfunction) and ADHD core symptomatology (e.g. inattenti*, hyperact*, and impulse disorder). The specific search terms used to identify parental mental health risk factor studies were “parental OR maternal OR prenatal OR perinatal OR distress OR stress OR mental disorder OR mental health OR anxiety OR depress* OR buproprion OR antidepressant.” All articles published in English prior to February 2014 were considered for study inclusion. Relevant publications discovered through iterative reference mining of retrieved articles were subsequently added, resulting in 77 eligible studies, of which 38 were initially included.

In addition, we conducted a literature search in January 2021 using the same search terms and criteria to account for any new studies published from 2014 through January 2021. Inclusion criteria were restricted to previously included risk factors and analyses. Twenty additional articles met inclusion criteria. After abstract-level and full-text review (see Fig. 1), a final group of 58 articles was eligible for analysis, representing 60 studies that examined the relationship between parental mental health risk factors and child ADHD outcomes. Measures of parent mental health varied across studies and are described briefly in Table 1.

Effect sizes within each study were eligible for inclusion in the meta-analyses only if the risk factor was present prior to child ADHD diagnosis or documented symptomatology. Concurrent assessment of parental stress and child ADHD symptoms were excluded. In addition, studies retrospectively inquiring about peripartum depression were included. In addition, studies of parental antisocial personality disorder diagnosis were included

regardless of timing of assessment because the diagnostic criteria for antisocial personality disorder require evidence of the disorder prior to the age of 15 years old. Studies of parental mental health indicators with sufficient prospective data for inclusion in the final meta-analyses were parental depression (30), prenatal antidepressant usage (9), parental stress and anxiety (27), and parental antisocial personality disorder (5). To ensure independence of estimates, we chose the largest study sample size and included only one effect size in an analysis from a study (e.g., the Avon Longitudinal Study of Parents and Children) when multiple articles were identified from the same longitudinal study population. See Fig. 1 for a flow chart detailing the number of articles identified, excluded at each stage, and final number of studies included. Coding forms are available from the first author.

Results are presented separately for each risk factor-ADHD pairing for which there were at least three relevant effect sizes, and by whether the measures of association were dichotomous or continuous. First, we conducted pooled analyses to produce an overall indicator (e.g., all included measures of ADHD categorizations including diagnosis, inattentive and hyperactive/impulsive symptoms) representing the relationship between a risk factor and any ADHD outcome, aggregating across ADHD outcomes as needed and ensuring independent study samples. The ADHD diagnosis category included dichotomous test statistic measurement of DSM diagnosis by clinician evaluation or interview, clinical diagnostic tool, ICD-9/10 code, ADHD prescription filled, or diagnosis via medical record report.

Subsequent analyses were also conducted for each subset of risk factors for which there were three relevant effect sizes. For example, parental depression and ADHD overall was further subdivided into separate analyses of maternal depression, paternal depression, and maternal post-partum depression. Similarly, a sufficient number of parental depression effect sizes were available to analyze associations separately for ADHD overall, ADHD diagnosis, inattentive symptoms, and hyperactive/impulsive symptoms. For studies that reported on the same ADHD outcome separately for males and females, the effect sizes were averaged. Third trimester prenatal stress was selected for inclusion in the analysis when effect sizes only by trimester were available for an included study ($k = 4$ effect sizes). Third trimester stress was selected based on previous research linking later term gestational stress to child emotional and neurobehavioral disorders (Rice et al., 2010; O'Connor et al., 2002; Li et al., 2010) potentially through disruptions in fetal synaptic migration and differentiation (Rice et al., 2007).

We calculated effect sizes and 95% confidence intervals (CIs) for dichotomous and continuous test statistics separately. Odds ratios (ORs) were calculated for dichotomous statistics, and correlation coefficients (CC) were calculated for continuous statistics. We also calculated the variance of effect sizes across individual studies using Cochran's Q (DerSimonian & Laird, 1986). We present results from random-effects models, which include a weighting term to account for the between-study variation in effect size (Sutton et al., 2000) and therefore produce a more conservative estimate of effect size than a fixed-effect model (Berlin et al., 1989).

Results

Table 2 summarizes the results, which represent a total sample size of 2,208,231 participants from 18 countries; study year of publication ranged from 1980 to 2019. Supplemental Figs. 1–22 contain the forest plots with effect sizes and confidence intervals for individual studies and the summary effect size for each risk factor.

Parental depression studies were the most numerous, with 30 eligible studies of earlier parental depression and later ADHD. Parental depression was associated with significantly increased risk for ADHD overall (inclusive of ADHD diagnosis and symptom outcomes), for both dichotomous and continuous test statistics. Parental depression was also significantly associated with ADHD symptoms (not shown in Table 2) measured dichotomously (OR = 1.34, 95% CI:1.05, 1.71; Supplementary Fig. 9), more specific indicators of inattentive symptoms (CC = 0.10; 95% CI: 0.05, 0.15; Supplementary Fig. 7), and hyperactive/impulsive symptoms (CC = 0.12; 95% CI: 0.05, 0.19; Supplementary Fig. 8). The significant parental depression and ADHD overall continuous analysis was the only analysis with significant heterogeneity across studies ($Q(10) = 43.32$, $p < 0.01$).

Maternal depression at any time prior to ADHD measurement, maternal post-partum depression more specifically, and paternal depression were associated with increased risk for child ADHD (Table 2). Maternal depression was also significantly associated with hyperactive/impulsive symptoms when reported dichotomously (OR = 1.51, 95% CI: 1.04, 2.18; Supplementary Fig. 10, not shown in Table 2).

Prenatal antidepressant usage, with 9 total studies, was associated with ADHD overall analyzed dichotomously ($k = 6$); however, we found no significant associations between prenatal antidepressant usage and later ADHD reported from continuous test statistics ($k = 4$).

Parental stress and anxiety, with 27 eligible studies, similarly allowed for multiple analyses. Parental stress and anxiety were associated with increased risk for ADHD overall (measured dichotomously and continuously), and for ADHD diagnosis more specifically. Maternal stress and anxiety and maternal prenatal stress were also significantly associated with increased childhood ADHD risk. The parental stress and anxiety and ADHD overall continuous analysis was the only analysis with significant heterogeneity across studies ($Q(7) = 27.82$, $p < 0.0001$).

Parental antisocial personality disorder ($k = 5$) was positively associated with ADHD overall and more specifically ADHD diagnosis. Maternal and paternal antisocial personality disorders were not significantly associated with overall childhood ADHD risk. The odds ratios for maternal-specific ($k = 4$) and paternal-specific ($k = 4$) analyses were similar to that of antisocial personality disorder overall but neither subgroup reached statistical significance on their own.

Discussion

This meta-analysis highlights the potential role of parental mental health indicators as risk factors for ADHD diagnosis and symptoms. In addition to links of prenatal exposures to stress and depression to fetal and early childhood brain changes associated with risk for psychopathology (Glover, 2011; MacKinnon et al., 2018), the findings from this meta-analysis also indicate potential evidence of postnatal effects of parental stress and mental disorders (e.g., maternal post-partum depression and parental antisocial personality disorder) with later ADHD risk. The multiple associations across parental mental disorders and child ADHD risk are in line with previous research suggesting that ADHD risk is associated with the combined effects of many genetic and environmental risk factors (Faraone et al., 2021). The associations of both prenatal and postnatal exposures (e.g., maternal prenatal stress and maternal post-partum depression) and ADHD risk suggest that multiple opportunities might exist to prevent or mitigate ADHD symptomatology and promote the mental health of the entire family.

Parental Mental Health Associations with Child ADHD

Parental depression overall, inclusive of both prenatal and postnatal exposures, was associated with more than twice the likelihood of an ADHD diagnosis. Results from the current meta-analysis were consistent across parental depression risk factors indicating an increased risk for ADHD diagnosis and symptoms among children. The results from this meta-analysis are consistent with the body of research linking parental depression, both prenatally and postnatally, to poor child outcomes and, more specifically, child ADHD (Romano et al., 2006; Weissman et al., 1984; Sciberras et al., 2011; O'Connor et al., 2002; Wolford et al., 2017). We found a significant relationship between paternal depression and ADHD risk; however, previous research is mixed on the independent influence of paternal depression on childhood externalizing disorders (Cheung & Theule, 2019; Pietikäinen et al., 2019). For example, Letourneau et al. (2019) reported that paternal depression was only associated with child behavior problems when the mother also experienced perinatal depression.

In the current meta-analysis, significant variability across depression studies was only evidenced in the analysis of parental depression and ADHD symptoms continuous analysis; correlation coefficients ranged from 0.05 (Hayatbakhsh et al., 2011) to 0.35 (Breaux & Harvey, 2019). Differences in effect sizes across these two studies could be related to a variety of factors including time of measurement between risk and exposure, population differences, and child age at measurement. Despite this variability across studies, there was a consistent, significant relationship between parental depression and child ADHD among all six depression risk factor analyses. Future research could explore differences in timing of effects and co-occurring mental disorders in their contributions to the strength of relationships between parental depression and child ADHD risk.

Previous individual studies on prenatal exposure to antidepressants and ADHD risk have demonstrated mixed results (Figueroa, 2010; Pedersen et al., 2013; Sujan et al., 2017). The mixed findings for ADHD risk and antidepressant usage found here are similar to recent studies and reviews in this area (Man et al., 2017; Sujan et al., 2017, 2019). Sujan et

al. (2019) concluded that human research is insufficient to support a causal link between prenatal antidepressant usage and ADHD risk; the effects are small and may be due instead to unmeasured factors that differentiate the unexposed and exposed children. Findings from two studies suggest that untreated parental psychopathology could be associated with child behavior or ADHD risk rather than the prenatal antidepressant exposure (Pederson et al., 2013; Yang et al., 2018). Other factors related to antidepressant use, including the timing and specific type of antidepressant might also influence the outcomes in this meta-analysis (Boukhris et al., 2017; Figueroa, 2010); however, only 9 articles were included and did not allow for sub-analyses. The overall findings from the current meta-analysis suggest more research may help determine how specific factors related to antidepressant treatment may impact child ADHD symptomatology and risk.

Findings from this meta-analysis study indicated that all except one of the included parental stress and anxiety risk factors were positively associated with ADHD diagnosis or symptoms. Only the relationship between paternal stress and ADHD was non-significant; additional research with fathers may help further clarify these findings. Across this risk factor category, stress and anxiety were measured in a variety of ways including self-report of distress, anxiety, and exposure to specific stressors; however, this variability in measurement is consistent with the measurement of perinatal anxiety in the field (Meades & Ayers, 2011). Despite this variability in measurement, effect sizes for stress and anxiety risk factor analyses only varied statistically within the parental stress and anxiety ADHD overall continuous risk factor analysis. In this analysis, correlation coefficients ranged from 0.00 (Bolea-Alamañac et al., 2018) to 0.26 (Breaux & Harvey, 2019). Similar to the differences in measurement previously described, the two studies varied in their measurement of stress and anxiety using the anxiety symptomatology scale of a validated psychopathology screener (Bolea-Alamañac et al., 2018) and a validated measure of stressful life events (Breaux & Harvey, 2019).

Parental antisocial personality disorder (ASPD) was significantly associated with ADHD overall and ADHD diagnosis in this meta-analysis; however, the lower end of the confidence intervals ranged from 1.02 to 1.07. Neither maternal ASPD nor paternal ASPD alone was significantly associated with ADHD outcomes although the odds ratios for parental, maternal, and paternal ASPD were similar in magnitude to parental ASPD. Notably, different studies comprised the parental, maternal, and paternal antisocial personality disorder analyses, which might provide clarity for the appearance of inconsistency between those sets of results. Three studies (Chronis et al., 2003; Galéra et al., 2011; Herndon & Iacono, 2005) were common to all three analyses. However, Earls et al. (1988) was only eligible for inclusion in the parental antisocial personality disorder analysis (which reported a significant result), not the maternal or paternal analyses. Morrison (1980) was only eligible in the maternal and paternal analyses, but not the analyses for parental antisocial personality disorder. ASPD has been estimated to affect 0.6% of US adults (Lenzenweger et al., 2007); the relatively lower prevalence of this disorder in comparison to depression and anxiety is reflected in the fewer available studies. Large, population-level studies inclusive of parental ASPD would allow for the examination of the distinct effects of paternal and maternal ASPD on childhood ADHD risk.

Implications for Prevention and Intervention

The implications of this meta-analysis merit further consideration given the high prevalence of parental stress and mental disorders, co-occurrence across disorders, and child ADHD among parents with mental disorders (Burns et al., 2015; Caspi & Moffitt, 2018; Homan et al., 2019; Kessler et al., 1994). Parents with mental disorders may simultaneously experience other risk factors and stressors that are also associated with ADHD, such as poverty and substance use disorders (Cree et al., 2018; Maher et al., 2022; WHO & CGF, 2014). These additional stressors within the family context may further contribute to a child's risk for ADHD through a chaotic family climate and negative, coercive parent–child interactions. Untreated parental psychopathology may contribute to antidepressant impacts on ADHD risk (Sujan et al., 2019), and maternal stressors and mental disorders can contribute to prenatal neurobiological influences on ADHD risk (Abbott et al., 2018; Glover, 2011; Keenan et al., 2018; Lupien et al., 2016; Manzari et al., 2018; Mill & Petronis, 2008). Thus, the findings from this meta-analysis suggest parental mental health mechanisms of risk may be associated with common or shared modifiable (e.g., negative parenting interactions, adversity) etiologies rather than specific risk factors (Caspi & Moffitt, 2018) and both prenatal and postnatal opportunities for prevention and intervention. These shared family and contextual risk factors offer insights for public health prevention and intervention targets across parental mental health indicators.

Transdiagnostic prevention strategies focused on common risk factors or implementation of intervention approaches with effectiveness across several types of mental disorders such as cognitive behavior therapy or parent behavioral training may therefore be indicated to reduce overall psychopathology risk (Caspi & Moffitt, 2018). Taken together, the results of the current study and past research suggest the importance of using a broadly disseminated public health approach to addressing parental mental health within the family context and through services families may already be accessing (NRC, 2009). Family-centered intervention strategies that can promote parental mental health, address stress, promote children's resiliency, and build parenting skills have the potential to prevent the onset or persistence of childhood mental disorders such as ADHD (NASEM, 2019). For example, this type of easily disseminated, prevention approach that includes cognitive skill training for the at-risk child or adolescent along with strategies that promote parenting skills such as communication and responsive relationship building has demonstrated evidence for longer term child and family impacts among families with a parent with a mood disorder (Beardslee et al., 2007, 2010).

In addition, integrated, two-generation behavioral approaches within pediatric primary care, such as treating the family (rather than only the child) as the unit of care, may provide an opportunity to screen, identify early, and make referrals for both child and parental mental health needs (Brundage & Shearer, 2019; Homan et al., 2019; NASEM, 2016, 2019). For example, the American Academy of Pediatrics (AAP) has recommended taking a mother-infant dyadic approach, within well child visits, to screening, referral, and treatment of postpartum depression and its impacts on the infant (Earls et al., 2019). Integrated family care strategies also have the potential for significant return on investments (Brundage & Shearer, 2019). Nine state Medicaid programs have invested in this type of prevention

approach by paying for home-based services for children at risk for mental disorders due to factors such as parental mental disorders, *prior* to the child showing evidence of a mental disorder (Brundage & Shearer, 2019). The AAP recommends behavior therapy, such as evidence-based parent training in behavior management, as the first line treatment for young children with ADHD (Wolraich et al., 2019); however, parental mental disorders have been associated with poor adherence to and response to parent training (Forehand & Kotchick, 2002; Reyno & McGrath, 2006). Therefore, the integration of parenting programs within primary care during the perinatal period can provide an opportunity to reach more families and mitigate mental health risk across the family unit by building parenting skills in combination with addressing the parental mental disorder and or stressor (NASEM, 2016, 2019).

Strengths and Limitations

The current study has several strengths. First, our meta-analysis only included studies in which the risk factor preceded the ADHD outcome to best inform prevention efforts. Prior research has identified the need to better understand parental mental health indicators, such as prenatal exposure to stress, to inform mental health screening practices and early intervention efforts (Manzari et al., 2018). Second, the current study included data from many large, nationally representative datasets resulting in an overall sample size of more than two million participants across 18 countries. The size and diversity of these studies suggests broad generalizability of our findings. Although diagnosed ADHD is more prevalent in boys than girls (Danielson et al., 2018), the majority of the studies included in this meta-analysis had nearly equal male/female sample sizes, allowing for ADHD outcomes that included effects on these two genders. Finally, analyses examined both diagnosed ADHD and symptoms of ADHD separately allowing us to identify independent effects for both diagnosed ADHD and ADHD symptomatology.

This meta-analysis also has some limitations. In line with the documented parenting research bias toward mothers (NASEM, 2016), more published studies on maternal mental health risk factors than paternal risk factors were identified. Focused research efforts around paternal mental health and child mental disorders could further our understanding of the impacts on paternal mental health factors on ADHD risk. Second, although we only included studies in which parental mental health indicators were measured before the child ADHD outcomes, we cannot rule out the possibility that ADHD symptoms were present prior to the parental mental health factor, but not assessed. Third, given the intent to include a wide range of risk factors in the overall meta-analysis (including other manuscripts in this supplement), it was beyond the scope of this study to investigate the influence of study design (e.g., clinical or population-based samples) or population characteristics (e.g., child gender and household socioeconomic status) on effect sizes. Future research could examine these findings by additional child, family, and study characteristics to offer insights for targeted intervention efforts. Fourth, we were not able to examine the effects of all mental disorders (e.g., parental ADHD and schizophrenia) because too few studies met our inclusion criteria. Fifth, when prenatal stress was not measured generally as any point during pregnancy, as in 4 of our 16 prenatal stress studies, we prioritized the third trimester stress effect size for inclusion in our analyses based on previous research (Rice et al., 2010; O'Connor et al., 2002; Li et

al., 2010). Therefore, additional research could examine the independent effects of maternal stress during earlier periods. Sixth, the influence of treatment effects on parental mental health indicators and ADHD outcomes could not be examined due to insufficient study data. Future longitudinal studies could explore these relations among groups receiving treatment and those not receiving treatment. Our study was also subject to limitations inherent in the meta-analysis design; the measurement of mental health indicators varied across studies and represents a range of measurement approaches from validated screeners to clinician diagnoses. In addition, the included studies may, in some cases, represent a single point in time of the impact of the parental mental disorder on child ADHD, and the effects of a chronic or episodic mental disorder course could be underestimated. Furthermore, meta-analytic methods analyze outcomes across multiple studies, which can have diversity in methodological approaches, providing an overall synthesis of relationship effects. Meta-analyses may not allow for more specific translation of the results into the individual aspects of parent mental health or which preventive interventions are likely to have the most benefit. Future research could examine the cumulative or episodic effects of parental mental disorders on child ADHD and specific interventions that are associated with the greatest efficacy for these factors. Finally, 11 of the 58 articles included in this meta-analysis either controlled for mental disorders inclusive of ADHD or excluded parents with ADHD or any mental disorder. Future research could examine parental ADHD as a moderator of the effect of other parental mental disorders on child ADHD symptoms and diagnosis to inform prevention and intervention efforts.

The findings from this meta-analysis highlight the associations between both prenatal and postnatal parental mental health and child ADHD risk. These prenatal and postnatal associations point to multiple potential opportunities for the promotion of overall child well-being and the reduction of ADHD symptomatology, suggesting the opportunity for early childhood prevention efforts around parental mental health to improve the overall functioning and well-being of children with or at risk for ADHD. Further research on strategies that can promote parental mental health and address stress, prenatally and postnatally, could inform our understanding of the long-term impacts of poor parental mental health on child health, well-being, and behavioral outcomes (NASEM, 2016, 2019).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

*Article included in the meta-analysis study.

Abbott PW, Gumusoglu SB, Bittle J, Beversdorf DQ, & Stevens HE (2018). Prenatal stress and genetic risk: How prenatal stress interacts with genetics to alter risk for psychiatric illness. Psychoneuroendocrinology, 90, 9–21. 10.1016/j.psyneuen.2018.01.019 [PubMed: 29407514]

*Alpern L, & Lyonsruth K (1993). Preschool children at social risk: Chronicity and timing of maternal depressive symptoms and child behavior problems at school and at home. Development and Psychopathology, 5, 371–387. 10.1017/S0954579400004478

American Psychiatric Association. (2013). Diagnostic and Statistical Manual of Mental Disorders (DSM-5). Arlington, VA: American Psychiatric Publishing.10.1176/appi.books.9780890425596

*Bauer NS, Gilbert AL, Carroll AE, & Downs SM (2013). Associations of early exposure to intimate partner violence and parental depression with subsequent mental health outcomes. JAMA Pediatrics, 167, 341–347. 10.1001/jamapediatrics.2013.780 [PubMed: 23381234]

Beardslee WR, Ayoub C, Avery MW, Watts CL, & O'Carroll KL (2010). Family connections: An approach for strengthening early care systems in facing depression and adversity. American Journal of Orthopsychiatry, 80, 482–495. 10.1111/j.1939-0025.2010.01051.x [PubMed: 20950289]

Beardslee W, Wright E, Gladstone T, & Forbes P (2007). Long-term effects from a randomized trial of two public health preventive interventions for parental depression. Journal of Family Psychology, 21, 703–713. 10.1037/0893-3200.21.4.703 [PubMed: 18179342]

Berlin JA, Laird NM, Sacks HS, & Chalmers TC (1989). A comparison of statistical methods for combining event rates from clinical trials. Statistics and Medicine, 8, 141–151. 10.1002/sim.4780080202

Bitsko RH, Holbrook JR, O'Masta B, Maher B, Cerles A, Saadeh K, et al. (2022). A systematic review and meta-analysis of prenatal, birth, and postnatal factors associated with attention-deficit/hyperactivity disorder in children. Prevention Science. 10.1007/s11121-02201359-3

Bolea-Alamañac B, Davies SJ, Evans J, Joinson C, Pearson R, Skapinakis P, & Emond A (2018). Do mothers who are anxious during pregnancy have inattentive children? Journal of Affective Disorders, 236, 120–126. 10.1016/j.jad.2018.04118 [PubMed: 29730511]

Bolea-Alamañac B, Davies SJC, Evans J, Joinson C, Pearson R, Skapinakis P, & Emond A (2019). Does maternal somatic anxiety in pregnancy predispose children to hyperactivity? European Child and Adolescent Psychiatry, 28, 1475–1486. 10.1007/s00787-019-01289-6 [PubMed: 30868247]

Borenstein M, Hedges LV, Higgins JPT, & Rothstein HR (2011). Introduction to meta-analysis. John Wiley & Sons. 10.1002/9780470743386

*Boukhris T, Sheehy O, & Bérard A (2017). Antidepressant use in pregnancy and the risk of attention deficit with or without hyperactivity disorder in children. Paediatric Perinatal Epidemiology, 31, 363–373. 10.1111/ppe.12378 [PubMed: 28640459]

Braithwaite E, Kundakovic M, Ramchandani P, Murphy S, & Champagne F (2015). Maternal prenatal depressive symptoms predict infant NR3C1 1F and BDNF IV DNA methylation. Journal of Epigenetics, 10, 408–417. 10.1080/15592294.2015.1039221 [PubMed: 25875334]

*Brammer WA, Galán CA, Mesri B, & Lee SS (2018). Parental ADHD and depression: Time-varying prediction of offspring externalizing psychopathology. Journal of Clinical Child and Adolescent Psychology, 47, S137–S149. 10.1080/15374416.2016.1183495 [PubMed: 27398972]

*Brandlistuen RE, Ystrom E, Eberhard-Gran M, Nulman I, Koren G, & Nordeng H (2015). Behavioural effects of fetal antidepressant exposure in a Norwegian cohort of discordant siblings. International Journal of Epidemiology, 44, 1397–1407. 10.1093/ije/dyv030 [PubMed: 25873178]

*Breaux RP, & Harvey EA (2019). A longitudinal study of the relation between family functioning and preschool ADHD symptoms. Journal of Clinical Child and Adolescent Psychology, 48, 749–764. 10.1080/15374416.2018.1437737 [PubMed: 29578799]

Brundage SC, & Shearer C (2019). Plan and provider opportunities to move toward integrated family health care. United Hospital Fund. Accessed from: https://uhfnyc.org/media/filer_public/c1/0b/c10bfb65-dbf9-4d2c-9f97-ecd2a3928a9e/plan_and_provider_opportunities_uhf.pdf

Burns ER, Farr SL, & Howards PP (2015). Stressful life events experienced by women in the year before their infants' births—United States, 2000–2010. MMWR. Morbidity and Mortality Weekly Report, 64, 247–251. [PubMed: 25763877]

Caspi A, & Moffitt TE (2018). All for one and one for all: Mental disorders in one dimension. American Journal of Psychiatry, 175, 831–844. 10.1176/appi.ajp.2018.17121383 [PubMed: 29621902]

*Chen MH, Pan TL, Wang PW, Hsu JW, Huang KL, Su TP, . . . Bai YM (2019). Prenatal exposure to acetaminophen and the risk of attention-deficit/hyperactivity disorder: a nationwide study in Taiwan. Journal of Clinical Psychiatry, 80(5). 10.4088/JCP.18m12612

Cheung K, & Theule J (2019). Paternal depression and child externalizing behaviors: A meta-analysis. Journal of Family Psychology, 33, 98. 10.1037/fam0000473 [PubMed: 30489128]

*Choenni V, Lambregtse-van den Berg MP, Verhulst FC, Tiemeier H, & Kok R (2019). The longitudinal relation between observed maternal parenting in the preschool period and the occurrence of child ADHD symptoms in middle childhood. Journal of Abnormal Child Psychology, 47, 755–764. 10.1007/s10802-018-0492-9 [PubMed: 30417251]

*Chronis AM, Lahey BB, Pelham WE Jr., Kipp HL, Baumann BL, & Lee SS (2003). Psychopathology and substance abuse in parents of young children with attention-deficit/hyperactivity disorder. Journal of the American Academy of Child and Adolescent Psychiatry, 42, 1424–1432. 10.1097/00004583-200312000-00009 [PubMed: 14627877]

Claussen AH, Kaminski JW, Holbrook JR, O'Masta B, Cerles A, Maher B, et al. (2022). All in the family? A systematic review and meta-analysis of parenting and family environment as risk factors for attention-deficit/hyperactivity disorder (ADHD) in children. Prevention Science. 10.1007/s11121-022-01358-4

*Clavarino AM, Mamun AA, O'Callaghan M, Aird R, Bor W, O'Callaghan F, et al. (2010). Maternal anxiety and attention problems in children at 5 and 14 years. Journal of Attention Disorders, 13, 658–667. 10.1177/1087054709347203 [PubMed: 19805622]

*Clements CC, Castro VM, Blumenthal SR, Rosenfield HR, Murphy SN, Fava M, & Perlis RH (2015). Prenatal antidepressant exposure is associated with risk for attention-deficit hyperactivity disorder but not autism spectrum disorder in a large health system. Molecular Psychiatry, 20, 727–734. 10.1038/mp.2014.90 [PubMed: 25155880]

Cree RA, Bitsko RH, Robinson LR, Holbrook JR, Danielson ML, Smith C, et al. (2018). Health care, family, and community factors associated with mental, behavioral, and developmental disorders and poverty among children aged 2–8 years - United States, 2016. MMWR Morb Mortal Wkly Rep, 67(50), 1377–1383. 10.15585/mmwr.mm6750a1 [PubMed: 30571671]

Crnic K, & Low C (2002). Everyday stresses and parenting. In Bornstein MH (Ed.), Handbook of Parenting Volume 5 Practical Issues in Parenting (pp. 243–268). Mahwah, New Jersey: Lawrence Erlbaum Associates. 10.2307/353007

Danielson ML, Bitsko RH, Ghandour RM, Holbrook JR, Kogan MD, & Blumberg SJ (2018). Prevalence of parent-reported ADHD diagnosis and associated treatment among US children and adolescents, 2016. Journal of Clinical Child Adolescent Psychology, 47, 199–212. 10.1080/15374416.2017.1417860 [PubMed: 29363986]

*Day NL, Richardson GA, Goldschmidt L, & Cornelius MD (2000). Effects of prenatal tobacco exposure on preschoolers' behavior. Journal of Developmental and Behavioral Pediatrics, 21, 180–188. [PubMed: 10883878]

DerSimonian R, & Laird N (1986). Meta-analysis in clinical trials. Controlled Clinical Trials, 7, 177–188. 10.1016/0197-2456(86)90046-2 [PubMed: 3802833]

*D'Souza S, Waldie KE, Peterson ER, Underwood L, & Morton SMB (2019). Antenatal and postnatal determinants of behavioural difficulties in early childhood: Evidence from growing up in New Zealand. Child Psychiatry and Human Development, 50, 45–60. 10.1007/s10578-018-0816-6 [PubMed: 29860616]

*Earls F, Reich W, Jung KG, & Cloninger CR (1988). Psychopathology in children of alcoholic and antisocial parents. Alcoholism Clinical and Experimental Research, 12, 481–487. 10.1111/j.1530-0277.1988.tb00230.x [PubMed: 3056068]

Earls MF, Yogman MW, Mattson G, & Rafferty J (2019). Incorporating recognition and management of perinatal depression into pediatric practice. Pediatrics, 143, e20183259. 10.1542/peds.2018-3259%JPediatrics [PubMed: 30559120]

Faraone SV, Banaschewski T, Coghill D, Zheng Y, Biederman J, Bellgrove MA, Newcorn JH, Gignac M, Al Saud NM, Manor I, Rohde LA, Yang L, Cortese S, Almagor D, Stein MA, Albatti TH, Aljoudi HF, Alqahtani MMJ, Asherson P …Wang Y (2021). The World Federation of ADHD International Consensus Statement: 208 evidence-based conclusions about the disorder. Neuroscience & Biobehavioral Reviews. Online ahead of print February 4, 2021. 10.1016/j.neubiorev.2021.01.022

Faraone SV, & Larsson H (2019). Genetics of attention deficit hyperactivity disorder. Molecular Psychiatry, 24, 562–575. 10.1038/s41380-018-0070-0 [PubMed: 29892054]

*Fergusson DM, & Lynskey MT (1993). The effects of maternal depression on child conduct disorder and attention deficit behaviours. Social Psychiatry and Psychiatric Epidemiology, 28, 116–123. 10.1007/BF00801741 [PubMed: 8378806]

*Figueroa R (2010). Use of antidepressants during pregnancy and risk of attention-deficit/hyperactivity disorder in the offspring. Journal of Developmental and Behavioral Pediatrics, 31, 641–648. 10.1097/DBP.0b013e3181e5ac93 [PubMed: 20613624]

Fleming M, Fitton CA, Steiner MF, McLay JS, Clark D, King A, et al. (2017). Educational and health outcomes of children treated for attention-deficit/hyperactivity disorder. JAMA Pediatrics, e170691–e170691. 10.1001/jamapediatrics.2017.0691 [PubMed: 28459927]

Forehand R, & Kotchick BA (2002). Behavioral parent training: Current challenges and potential solutions. Journal of Child Family Studies, 11, 377–384. 10.1023/A:1020913422609

Freitag CM, & Retz W (2010). Family and twin studies in attention-deficit hyperactivity disorder. Attention-Deficit Hyperactivity Disorder (ADHD) in Adults, 38–57. Karger Publishers. 10.1159/00025448

Fredland N, McFarlane J, Symes L, & Maddoux J (2018). Exploring the association of maternal adverse childhood experiences with maternal health and child behavior following intimate partner violence. Journal of Womens Health (larchmt), 27, 64–71. 10.1089/jwh.2016.5969

*Galéra C, Côté SM, Bouvard MP, Pingault JB, Melchior M, Michel G, et al. (2011). Early risk factors for hyperactivity-impulsivity and inattention trajectories from age 17 months to 8 years. Archives of General Psychiatry, 68, 1267–1275. 10.1001/archgenpsychiatry.2011.138 [PubMed: 22147844]

Glover V (2011). Annual research review: Prenatal stress and the origins of psychopathology: An evolutionary perspective. Journal of Child Psychology and Psychiatry, 52, 356–367. 10.1111/j.1469-7610.2011.02371.x [PubMed: 21250994]

*Grizenko N, Fortier ME, Zadorozny C, Thakur G, Schmitz N, Duval R, et al. (2012). Maternal stress during pregnancy, ADHD symptomatology in children and genotype: Gene-environment interaction. Journal of the Canadian Academy of Child and Adolescent Psychiatry, 21, 9–15. [PubMed: 22299010]

Guo L, Danielson M, Cogan L, Hines L, & Armour B (2018). Treatment patterns and costs among children aged 2 to 17 years with ADHD in New York State Medicaid in 2013. Journal of Attention Disorders, 25, 463–472. 10.1177/1087054718816176 [PubMed: 30547693]

Hamza M, Halayem S, Bourgou S, Daoud M, Charfi F, & Belhadj A (2017). Epigenetics and ADHD. Journal of Attention Disorders, 23, 655–664. 10.1177/1087054717696769 [PubMed: 28665177]

Hanson JL, Nacewicz BM, Sutterer MJ, Cayo AA, Schaefer SM, Rudolph KD, et al. (2015). Behavioral problems after early life stress: Contributions of the hippocampus and amygdala. Biological Psychiatry, 77(4), 314–323. 10.1016/j.biopsych.2014.04.20 [PubMed: 24993057]

Harpin VA (2005). The effect of ADHD on the life of an individual, their family, and community from preschool to adult life. Archives of Disease in Childhood, 90, i2–i7. 10.1136/adc.2004.059006 [PubMed: 15665153]

*Hayatbakhsh MR, Najman JM, Khatun M, Al Mamun A, Bor W, & Clavarino A (2011). A longitudinal study of child mental health and problem behaviours at 14 years of age following unplanned pregnancy. Psychiatry Research, 185, 200–204. 10.1016/j.psychres.2010.05.019 [PubMed: 20576294]

Herman-Stahl M, Ashley OS, Penne MA, Bauman KE, Weitzenkamp D, Aldridge M, et al. (2007). Serious psychological distress among parenting and nonparenting adults. American Journal of Public Health, 97, 2222–2229. 10.2105/AJPH.2005.081109 [PubMed: 17971564]

*Herndon RW, & Iacono WG (2005). Psychiatric disorder in the children of antisocial parents. Psychological Medicine, 35, 1815–1824. 10.1017/S0033291705005635 [PubMed: 16300694]

*Hirshfeld-Becker DR, Petty C, Micco JA, Henin A, Park J, Beilin A, et al. (2008). Disruptive behavior disorders in offspring of parents with major depression: Associations with parental behavior disorders. Journal of Affective Disorders, 111, 176–184. 10.1016/j.jad.2008.02.019 [PubMed: 18378320]

Homan KJ, Barbaresi WJ, Mellon MW, Weaver AL, Killian JM, Lucchetti AR, et al. (2019). Psychiatric disorders in mothers of children with attention-deficit/hyperactivity disorder: A population-based perspective. Journal of Child and Family Studies, 28, 1042–1051. 10.1007/s10826-019-01334-7

*Huang X, Zhang Q, Gu X, Hou Y, Wang M, Chen X, & Wu J (2019). LPHN3 gene variations and susceptibility to ADHD in Chinese Han population: A two-stage case-control association study and gene-environment interactions. European Child and Adolescent Psychiatry, 28, 861–873. 10.1007/s00787-018-1251-8 [PubMed: 30406846]

*Huizink AC, Dick DM, Sihvola E, Pulkkinen L, Rose RJ, & Kaprio J (2007). Chernobyl exposure as stressor during pregnancy and behaviour in adolescent offspring. Acta Psychiatrica Scandinavica, 116, 438–446. 10.1111/j.1600-0447.2007.01050.x [PubMed: 17997723]

*Jacobvitz D, Hazen N, Curran M, & Hitchens K (2004). Observations of early triadic family interactions: Boundary disturbances in the family predict symptoms of depression, anxiety, and attention-deficit/hyperactivity disorder in middle childhood. Development and Psychopathology, 16, 577–592. 10.1017/s0954579404004675 [PubMed: 15605626]

*Ji Y, Hong X, Wang G, Chatterjee N, Riley AW, Lee LC, & Wang X (2018). A prospective birth cohort study on early childhood lead levels and attention deficit hyperactivity disorder: New insight on sex differences. Journal of Pediatrics, 199, 124–131. e128. 10.1016/j.jpeds.2018.03.076 [PubMed: 29752174]

*Joelsson P, Chudal R, Uotila J, Suominen A, Sucksdorff D, Gyllenberg D, & Sourander A (2017). Parental psychopathology and offspring attention-deficit/hyperactivity disorder in a nationwide sample. Journal of Psychiatric Research, 94, 124–130. 10.1016/j.jpsychires.2017.07.004 [PubMed: 28710942]

Kahng SK, Oyserman D, Bybee D, & Mowbray C (2008). Mothers with serious mental illness: When symptoms decline does parenting improve? Journal of Family Psychology, 22, 162. 10.1037/0893-3200.22.1.162 [PubMed: 18266543]

Keenan K, Hipwell AE, Class QA, & Mbayiwa K (2018). Extending the developmental origins of disease model: Impact of preconception stress exposure on offspring neurodevelopment. Developmental Psychobiolology, 60, 753–764. 10.1002/dev.21773

Kessler RC, McGonagle KA, Zhao S, Nelson CB, Hughes M, Eshelman S, Hans-Ulrich W, & Kendler KS (1994). Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States: Results from the National Comorbidity Survey. Archives of General Psychiatry, 51, 8–19. 10.1001/archpsyc.1994.03950010008002 [PubMed: 8279933]

*Kim HW, Cho SC, Kim BN, Kim JW, Shin MS, & Kim Y (2009). Perinatal and familial risk factors are associated with full syndrome and subthreshold attention-deficit hyperactivity disorder in a Korean community sample. Psychiatry Investigation, 6, 278–285. 10.4306/pi.2009.6.4.278 [PubMed: 20140126]

*Laugesen K, Olsen MS, Telen Andersen AB, Froslev T, & Sorensen HT (2013). In utero exposure to antidepressant drugs and risk of attention deficit hyperactivity disorder: A nationwide Danish cohort study. British Medical Journal Open, 3, e003507. 10.1136/bmjopen-2013-003507

Lee SH, Ripke S, Neale BM, Faraone SV, Purcell SM, Perlis RH, Mowry BJ, Thapar A, Goddard ME, & Witte J. S. J. N. g. (2013). Genetic relationship between five psychiatric disorders estimated from genome-wide SNPs. 45(9), 984.

LeMoine KA, Romirowsky AM, Woods KE, & Chronis-Tuscano A (2018). Paternal antisocial behavior (but not paternal ADHD) is associated with negative parenting and child conduct problems. Journal of Attention Disorders, 22, 1187–1199. [PubMed: 26399711]

Lenzenweger MF, Lane MC, Loranger AW, & Kessler RC (2007). DSM-IV personality disorders in the National Comorbidity Survey replication. Biological Psychiatry, 62, 553–564. 10.1016/j.biopsych.2006.09.019 [PubMed: 17217923]

*Letourneau N, Leung B, Ntanda H, Dewey D, Deane AJ, & Giesbrecht GF (2019). Maternal and paternal perinatal depressive symptoms associate with 2- and 3-year-old children's behaviour: Findings from the APrON longitudinal study. BMC Pediatrics, 19, 435. 10.1186/s12887-019-1775-1 [PubMed: 31722682]

*Li J, Olsen J, Vestergaard M, & Obel C (2010). Attention-deficit/hyperactivity disorder in the offspring following prenatal maternal bereavement: A nationwide follow-up study in Denmark. European Child and Adolescent Psychiatry, 19, 747–753. 10.1007/s00787-010-0113-9 [PubMed: 20495989]

Liu CH, Yasui M, Giallo R, Tronick E, & Seidman LJ (2016). US Caregivers with mental health problems: Parenting experiences and children's functioning. Journal of Archives of Psychiatric Nursing, 30, 753–760. 10.1016/j.apnu.2016.07.006 [PubMed: 27888971]

Luby JL, Barch D, Whalen D, Tillman R, & Belden A (2017). Association between early life adversity and risk for poor emotional and physical Health in adolescence: A putative mechanistic neurodevelopmental pathway of early life adversity and poor emotional and physical health in adolescence. JAMA Pediatrics, 171, 1168–1175. 10.1001/jamapediatrics.2017.3009 [PubMed: 29084329]

Lupien SJ, Ouellet-Morin I, Herba CM, Juster R, & McEwen BS (2016). From vulnerabilityto neurotoxicity: a developmental approach to the effects of stress on the brain and behavioR. In Spengler D, & Binder E (Eds.), Epigenetics and Neuroendocrinology: Clinical Focus on Psychiatry, Volume 1 (pp. 3–48). Cham: Springer International Publishing. 10.1007/978-3-319-24493-8_1

MacKinnon N, Kingsbury M, Mahedy L, Evans J, & Colman I (2018). The association between prenatal stress and externalizing symptoms in childhood: Evidence from the Avon Longitudinal Study of Parents and Children. Biological Psychiatry, 83, 100–108. 10.1016/j.biopsych.2017.07.010 [PubMed: 28893381]

Maher B, Kaminski J, O'Masta B, Cerles A, Holbrook JR, Mahmooth Z, et al. (2022). A systematic meta-analysis of the relationship between exposure to parental substance use and attention-deficit/hyperactivity disorder. Prevention Science.

Man KKC, Chan EE, Ip P, Coghill D, Simonoff E, Chan PKL, et al. (2017). Prenatal antidepressant use and risk of attention-deficit/hyperactivity disorder in offspring: Population based cohort study. BMJ, 357. 10.1136/bmj.j2350

Manzari N, Matvienko-Sikar K, Baldoni F, O'Keeffe G, & Khashan A (2018). Prenatal maternal stress and risk of neurodevelopmental disorders in the offspring: a systematic review and meta-analysis protocol. HRB Open Research, 1(15). 10.12688/hrbopenres.12827.1

*Martini J, Knappe S, Beesdo-Baum K, Lieb R, & Wittchen HU (2010). Anxiety disorders before birth and self-perceived distress during pregnancy: Associations with maternal depression and obstetric, neonatal and early childhood outcomes. Early Human Development, 86, 305–310. 10.1016/j.earlhumdev.2010.04.004 [PubMed: 20547016]

McLaughlin KA, Sheridan MA, Winter W, Fox NA, Zeanah CH, & Nelson CA (2014). Widespread reductions in cortical thickness following severe early-life deprivation: A neurodevelopmental pathway to attention-deficit/hyperactivity disorder. Biological Psychiatry, 76, 629–638. 10.1016/j.biopsych.2013.08.016 [PubMed: 24090797]

Meades R, & Ayers S (2011). Anxiety measures validated in perinatal populations: A systematic review. Journal of Affective Disorders, 133, 1–15. 10.1016/j.jad.2010.10.009 [PubMed: 21078523]

*Meadows SO, McLanahan SS, & Brooks-Gunn J (2007). Parental depression and anxiety and early childhood behavior problems across family types. Journal of Marriage and Family, 69, 1162–1177. 10.1111/j.1741-3737.2007.00439.x

Mill J, & Petronis A (2008). Pre- and peri-natal environmental risks for attention-deficit hyperactivity disorder (ADHD): The potential role of epigenetic processes in mediating susceptibility. Journal of Child Psychology and Psychiatry, 49, 1020–1030. 10.1111/j.1469-7610.2008.01909.x [PubMed: 18492038]

*Morrell J, & Murray L (2003). Parenting and the development of conduct disorder and hyperactive symptoms in childhood: a prospective longitudinal study from 2 months to 8 years. Journal of Child Psycholology and Psychiatry, 44(4), 489–508.10.1111/1469-7610.t01-1-00139

*Morrison J (1980). Adult psychiatric disorders in parents of hyperactive children. American Journal of Psychiatry, 137(7), 825–827. 10.1176/ajp.137.7.825 [PubMed: 7386662]

*Murray E, Pearson R, Fernandes M, Santos IS, Barros FC, Victora CG, & Matijasevich A (2016). Are fetal growth impairment and preterm birth causally related to child attention problems and ADHD? Evidence from a comparison between high-income and middle-income cohorts. Journal of Epidemiology and Community Health, 70, 704–709. 10.1136/jech-2015-206222 [PubMed: 26767410]

National Academies of Sciences, Engineering, and Medicine. (2016). Parenting matters: Supporting parents of children ages 0–8. The National Academies Press. 10.17226/21868

National Academies of Sciences, Engineering, and Medicine (2019). Fostering healthy mental, emotional, and behavioral development in children and youth: a national agenda. Washington, DC: The National Academies Press. 10.17226/25201

National Research Council. (2009). Depression in parents, parenting, and children: Opportunities to improve identification, treatment, and prevention. National Academies Press. 10.17226/12565

National Research Council and Institute of Medicine. (2009). Preventing mental, emotional, and behavioral disorders among young people: Progress and possibilities. Washington, DC, The National Academic Press.

Nigg JT (2018). Toward an emerging paradigm for understanding attention-deficit/hyperactivity disorder and other neurodevelopmental, mental, and behavioral disorders: Environmental risks and epigenetic associations. JAMA Pediatrics, 172, 619–621. 10.1001/jamapediatrics.2018.0920 [PubMed: 29799950]

*Oberlander TF, Reebye P, Misri S, Papsdorf M, Kim J, & Grunau RE (2007). Externalizing and attentional behaviors in children of depressed mothers treated with a selective serotonin reuptake inhibitor antidepressant during pregnancy. Archives of Pediatrics and Adolescent Medicine, 161, 22–29. 10.1001/archpedi.161.1.22 [PubMed: 17199063]

Oberlander TF, Weinberg J, Papsdorf M, Grunau R, Misri S, & Devlin AM (2008). Prenatal exposure to maternal depression, neonatal methylation of human glucocorticoid receptor gene (NR3C1) and infant cortisol stress responses. Epigenetics, 3, 97–106. 10.4161/epi.3.2.6034 [PubMed: 18536531]

*O'Connor TG, Heron J, Golding J, Beveridge M, & Glover V (2002). Maternal antenatal anxiety and children's behavioural/emotional problems at 4 years: Report from the Avon Longitudinal Study of Parents and Children. The British Journal of Psychiatry, 180, 502–508. 10.1192/bjp.180.6.502 [PubMed: 12042228]

*Park S, Cho SC, Kim JW, Shin MS, Yoo HJ, Oh SM, & Kim BN (2014). Differential perinatal risk factors in children with attention-deficit/hyperactivity disorder by subtype. Psychiatry Research, 219, 609–616. 10.1016/j.psychres.2014.05.036 [PubMed: 24997783]

Patterson GR (1982). Coercive Family Process. Vol. 3. Castalia Publishing Company.

*Pedersen LH, Henriksen TB, Bech BH, Licht RW, Kjaer D, & Olsen J (2013). Prenatal antidepressant exposure and behavioral problems in early childhood–a cohort study. Acta Psychiatrica Scandanavica, 127, 126–135. 10.161/epi.3.2.6034

Pietikäinen JT, Kiviruusu O, Kylliäinen A, Pölkki P, Saarenpää-Heikkilä O, Paunio T, et al. (2019). Maternal and paternal depressive symptoms and children's emotional problems at the age of 2 and 5 years: A longitudinal study. Journal of Child Psychology and Psychiatry. 10.1111/jcpp.13126

*Ramchandani P, Stein A, Evans J, & O'Connor TG (2005). Paternal depression in the postnatal period and child development: A prospective population study. The Lancet, 365, 2201–2205. 10.1016/s0140-6736(05)66778-5

*Ray GT, Croen LA, & Habel LA (2009). Mothers of children diagnosed with attention-deficit/hyperactivity disorder: Health conditions and medical care utilization in periods before and after birth of the child. Medical Care, 47, 105–114. 10.1097/MLR.0b013e31817e18c0 [PubMed: 19106738]

Retz W, Freitag CM, Retz-Junginger P, Wenzler D, Schneider M, Kissling C, et al. (2008). A functional serotonin transporter promoter gene polymorphism increases ADHD symptoms in delinquents: Interaction with adverse childhood environment. Psychiatry Research, 158, 123–131. 10.1016/j.psychres.2007.05.004 [PubMed: 18155777]

Reyno SM, & McGrath PJ (2006). Predictors of parent training efficacy for child externalizing behavior problems–a meta-analytic review. Journal of Child Psychology, 47(1), 99–111. 10.1111/j.1469-7610.2005.01544.x

Rice F, Harold GT, Boivin J, van den Bree M, Hay DF, & Thapar A (2010). The links between prenatal stress and offspring development and psychopathology: Disentangling environmental and inherited influences. Psychological Medicine, 40, 335–345. 10.1017/S0033291709005911 [PubMed: 19476689]

*Rice F, Jones I, & Thapar A (2007). The impact of gestational stress and prenatal growth on emotional problems in offspring: A review. Acta Psychiatrica Scandinavica, 115, 171–183. 10.1111/j.1600-0447.2006.00895.x [PubMed: 17302617]

*Rodriguez A, & Bohlin G (2005). Are maternal smoking and stress during pregnancy related to ADHD symptoms in children? Journal of Child Psychology and Psychiatry, 46, 246–254. 10.1111/j.1469-7610.2004.00359.x [PubMed: 15755301]

*Romano E, Tremblay RE, Farhat A, & Côté S (2006). Development and prediction of hyperactive symptoms from 2 to 7 years in a population-based sample. Pediatrics, 117, 2101–2110. 10.1542/peds.2005-0651 [PubMed: 16740853]

Rudland JR, Golding C, & Wilkinson TJ (2020). The stress paradox: How stress can be good for learning. Teaching Strategies, 54, 40–45. 10.1111/medu.13830

*Sasaluxnanon C, & Kaewpornsawan T (2005). Risk factor of birth weight below 2,500 grams and attention deficit hyperactivity disorder in Thai children. Journal of the Medical Association of Thailand, 88, 1514–1518. 10.1007/s10802-011-9504-8 [PubMed: 16471095]

*Say GN, Karabekiroğlu K, Babadağı Z, & Yüce M (2016). Maternal stress and perinatal features in autism and attention deficit/hyperactivity disorder. Pediatrics International, 58, 265–269. 10.1111/ped.12822 [PubMed: 26338105]

*Sciberras E, Ukoumunne OC, & Efron D (2011). Predictors of parent-reported attention-deficit/hyperactivity disorder in children aged 6–7 years: A national longitudinal study. Journal of Abnormal Child Psychology, 39, 1025–1034. 10.1007/s10802-011-9504-8 [PubMed: 21468666]

*Simcock G, Cobham VE, Laplante DP, Elgbeili G, Gruber R, Kildea S, & King S (2019). A cross-lagged panel analysis of children's sleep, attention, and mood in a prenatally stressed cohort: The QF2011 Queensland flood study. Journal of Affect Disorders, 255, 96–104. 10.1016/j.jad.2019.05.041

Sohr-Preston SL, & Scaramella LV (2006). Implications of timing of maternal depressive symptoms for early cognitive and language development. Clinincal Child and Family Psychology Review, 9, 65–83. 10.1007/s10567-006-0004-2

Stambaugh LF, Forman-Hoffman V, Williams J, Pemberton MR, Ringeisen H, Hedden SL, & Bose J (2017). Prevalence of serious mental illness among parents in the United States: Results from the National Survey of Drug Use and Health, 2008–2014. Annals of Epidemiology, 27, 222–224. 10.1016/j.annepidem.2016.12.005 [PubMed: 28081894]

Sujan AC, Öberg AS, Quinn PD, & D'Onofrio BM (2019). Annual Research Review: Maternal antidepressant use during pregnancy and offspring neurodevelopmental problems - a critical review and recommendations for future research. Journal of Child Psychology and Psychiatry, 60(4), 356–376. 10.1111/jcpp.13004 [PubMed: 30515808]

Sujan AC, Rickert ME, Öberg A, et al. (2017). Associations of maternal antidepressant use during the first trimester of pregnancy with preterm birth, small for gestational age, autism spectrum disorder, and attention-deficit/hyperactivity disorder in offspring. JAMA, 317, 1553–1562. 10.1001/jama.2017.3413 [PubMed: 28418479]

Sutton AJ, Abrams KR, Jones DR, Sheldon TA, & Song F (2000). Methods for meta-analysis in medical research. New York: J. Wiley Chichester. Available at: https://www.researchgate.net/profile/Fujian-Song/publication/236905532_Methods_for_Meta-Analysis_in_Medical_Research/links/02e7e52deab41deeea000000/Methods-for-Meta-Analysis-in-Medical-Research.pdf

*Van Batenburg-Eddes T, Brion MJ, Henrichs J, Jaddoe VWV, Hofman A, Verhulst FC, et al. (2013). Parental depressive and anxiety symptoms during pregnancy and attention problems in children: A cross-cohort consistency study. Journal of Child Psychology and Psychiatry, and Allied Disciplines, 54, 591–600. 10.1111/jcpp.12023 [PubMed: 23215861]

*Van den Bergh BRH, & Marcoen A (2004). High antenatal maternal anxiety is related to ADHD symptoms, externalizing problems, and anxiety in 8- and 9-year-olds. Child Development, 75, 1085–1097. 10.1111/j.1467-8624.2004.00727.x [PubMed: 15260866]

*Walker MJ, Davis C, Al-Sahab B, & Tamim H (2013). Reported maternal postpartum depression and risk of childhood psychopathology. Maternal Child Health Journal, 17, 907–917. 10.1007/s10995-012-1071-2 [PubMed: 22744292]

Weissman MM, Prusoff BA, Gammon GD, Merikangas KR, Leckman JF, & Kidd KK (1984). Psychopathology in the children (ages 6–18) of depressed and normal parents. Journal of the American Academy of Child Psychiatry, 23(1), 78–84. [PubMed: 6693680]

*Weikum WM, Brain U, Chau CM, Grunau RE, Boyce WT, Diamond A, et al. (2013). Prenatal serotonin reuptake inhibitor (SRI) antidepressant exposure and serotonin transporter promoter genotype (SLC6A4) influence executive functions at 6 years of age. Frontiers in Cellular Neuroscience, 7, 180. 10.3389/fncel.2013.00180 [PubMed: 24130516]

*Wiggs K, Elmore AL, Nigg JT, & Nikolas MA (2016). Pre- and perinatal risk for attention-deficit hyperactivity disorder: Does neuropsychological weakness explain the link? Journal of Abnormal Child Psychology, 44, 1473–1485. 10.1007/s10802-016-0142-z [PubMed: 26961824]

Wolicki SB, Bitsko RH, Cree RA, Danielson ML, Ko JY, Warner L, & Robinson LR (2021). Mental health of parents and primary caregivers by sex and associated child health indicators. Adversity and Resilience Science: Journal of Research and Practice, 2, 125–139. 10.1007/s42844-021-00037-7

Wolford E, Lahti M, Tuovinen S, Lahti J, Lipsanen J, Savolainen K, et al. (2017). Maternal depressive symptoms during and after pregnancy are associated with attention-deficit/hyperactivity disorder symptoms in their 3-to 6-year-old children. PLoS ONE, 12, e0190248. 10.1371/journal.pone.0190248 [PubMed: 29267405]

Wolraich ML, Hagan JF, Allan C, Chan E, Davison D, Earls M, et al. (2019). Clinical practice guideline for the diagnosis, evaluation, and treatment of attention-deficit/hyperactivity disorder in children and adolescents. Journal of Pediatrics, 144, e20192528. 10.1542/peds.2019-2528%JPediatrics

World Health Organization and Calouste Gulbenkian Foundation. (2014). Social Determinants of Mental Health. Geneva: World Health Organization. Accessed at: https://apps.who.int/iris/bitstream/handle/10665/112828/9789241506809_engpdf;jsessionid=CB0B1FD1B1448DBB90970A40A9FA7706?sequence=1

Yang F, Liang H, Chen J, Miao M, Yuan W, Nørgaard M, et al. (2018). Prenatal paternal selective serotonin reuptake inhibitors use and risk of ADHD in offspring. Pediatrics, 141, e20171081. 10.1542/peds.2017-1081 [PubMed: 29229680]

*Yoshimasu K, Kiyohara C, Minami T, Yoshikawa N, Kihira S, Toyonaga K, et al. (2009). Maternal smoking during pregnancy and offspring attention-deficit/hyperactivity disorder: A case–control study in Japan. ADHD Attention Deficit and Hyperactivity Disorders, 1, 223–231. 10.1007/s12402-009-0015-1 [PubMed: 21432585]

Zhao X, Page TF, Altszuler AR, Altszuler AR, & Pelham WE (2019). Family burden of raising a child with ADHD. Journal of Abnormal Child Psychology, 47, 1327–1338. 10.1007/s10802-019-00518-5 [PubMed: 30796648]

*Zhu P, Hao JH, Tao RX, Huang K, Jiang XM, Zhu YD, & Tao FB (2015). Sex-specific and time-dependent effects of prenatal stress on the early behavioral symptoms of ADHD: A longitudinal study in China. European Child and Adolescent Psychiatry, 24, 1139–1147. 10.1007/s00787-015-0701-9 [PubMed: 25791080]

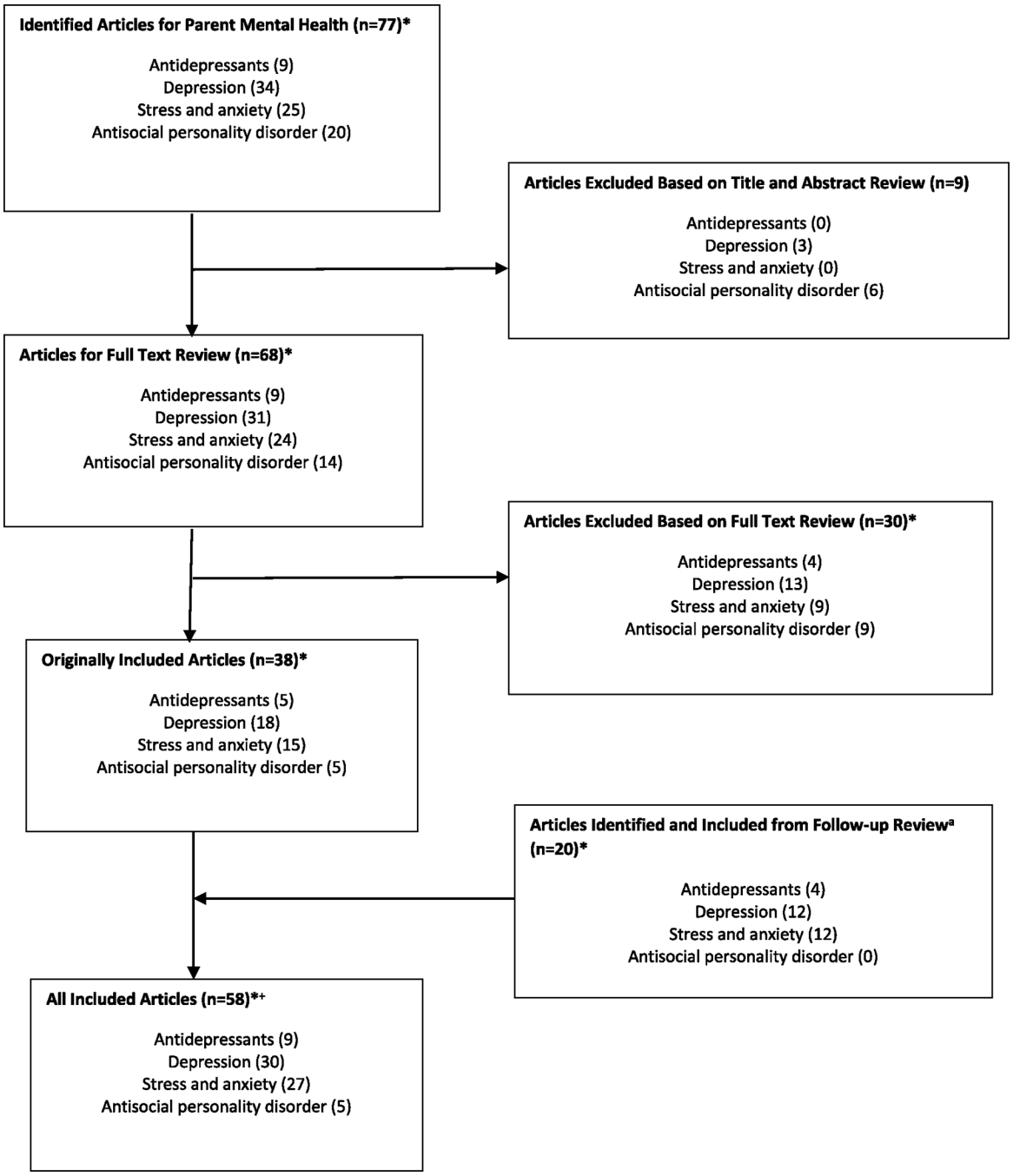

Fig. 1.

Flowchart of triage process for inclusion/exclusion of articles identified for meta-analyses of risk factors for attention-deficit/hyperactivity disorder and parental mental health. *Articles overlap across categories; + Two articles contained two independent data sets; a follow-up review included 2014-January, 2021

Table 1

Characteristics of studies included in meta-analyses of parental mental health risk factors for child attention-deficit/hyperactivity disorder

Study	Risk factors (included)	Sample size	Age at outcome measurement (years)	Male (%)	ADHD measurement (included)	Sample (country)	Measurement
Alpern and Lyonsruth (1993)	Parental depression	20	4.9	57.8	Inattention (SBCL)P and hyperactivity symptoms (PBQ)^{T}	Research study of low-income at risk with matched low-income comparison group (USA)	Prospective parent self-report of depression (CES-D)
Bauer et al. (2013)	Parental depression	2422	3.1–6	52	Diagnosis (clinical medical record)	Cohort study from community health centers (USA)	Prospective parent self-report of depression (PHQ-2 and EPDS-3)
Bolea-Alamañac et al. (2018)	Parental stress and anxiety	4198	8.5	n/a	Inattention (TEA-CH)	Birth cohort (ALSPAC; UK)	Prospective maternal self-report of prenatal anxiety (CCEI)
Bolea-Alamañac et al. (2019)	Parental stress and anxiety	5035	7.5	n/a	Diagnosis (DAWBA)	Birth cohort (ALSPAC; UK)	Prospective maternal self-report of prenatal anxiety (CCEI)
Boukhris et al. (2017)	Antidepressants	144,406	0–11	50.6	Diagnosis (ICD-9/10 codes or ADHD prescription filled)	Birth cohort using medical records (Quebec Pregnancy/Children Cohort; Canada)	Maternal redemption of antidepressant medication prescription 30 days prior or during pregnancy
Brammer et al. (2018)	Parental depression	230	5–10	64–78.2	Inattention (CBCL)^{P,T}	Research study recruited though clinical and nonclinical settings (USA)	Parental prospective self-report of depression (BDI-I)
Brandlistuen et al. (2015)	Antidepressants	20,180	1.5	41.8–51.4	Inattention (CBCL)^{P}	Population-based cohort study with sibling pairs (Norwegian Mother and Child Cohort Study; Norway)	Prospective maternal self-report of antidepressant usage
Breaux & Harvey (2019)	Parental depression, parental stress, and anxiety	197	6	55.8	ADHD symptoms (DISC)^{P}	Longitudinal research study recruited through state birth records and community locations (USA)	Prospective parental report of depression (Millon Clinical Multiaxial Inventory–III) and stress (LES)
Chen et al. (2019)	Antidepressant, parental depression	4750	10.78–10.86	77.5	Diagnosis (ICD-9 code)	Paired ADHD case–control health insurance database study (Taiwan Longitudinal Health Insurance Database, Taiwan)	Maternal perinatal depression measured via ICD-9 code and antidepressants by prescriptions filled
Choenni et al. (2019)	Parental depression	547	8	51.7	ADHD symptoms (CPRS-R)^{P}	Birth cohort (Generation R Study; Netherlands)	Maternal self-report of depression (BSI)
Chronis et al. (2003)	Antisocial personality disorder	146	5.1–5.2	76.7–79.3	Diagnosis (DISC, DSM-III-R, CIRS^{P,T})	Child psychiatry clinical and matched comparison samples (USA)	Maternal report on self and paternal APD(SCID-NP)
Clavarino et al. (2010)	Parental stress and anxiety	3393	5–14	52	Inattention (CBCL, YSR)^{P,C}	Birth cohort (MUSP; Australia)	Prospective maternal self-report of prenatal anxiety (DSSI and SCID)

Study	Risk factors (included)	Sample size	Age at outcome measurement (years)	Male (%)	ADHD measurement (included)	Sample (country)	Measurement
Clements et al. (2015)	Antidepressants	7874	8.3	71.2–73.5	Diagnosis (ICD-9 code)	Matched case and control electronic health records study (USA)	Medical record of antidepressants usage (via inpatient or outpatient pharmacy prescription record)
Day et al. (2000)	Parental depression	672	3.2	49	Inattention and hyperactivity symptoms (SNAP)	Research interviews with women who used alcohol and marijuana prenatally (USA)	Maternal self-report of depression (CES-D)
D'Souza et al. (2019)	Parental depression, parental stress, and anxiety	6246	2	n/a	Inattention/ hyperactivity (SDQ)[P]	Longitudinal prospective birth cohort (Growing Up in New Zealand: New Zealand)	Prospective maternal self-report of postpartum depression (EPDS) and anxiety (Generalised Anxiety Disorder Screener -7)
Earls et al. (1988)	Antisocial personality disorder	43	6–17	58–64	Diagnosis (DICA)[P,C]	Study of hospitalized alcoholics, convicted felons, and hospitalized controls (USA)	Prospective parent report of APD on structured diagnostic interview with confirmation from records
Fergusson and Lynskey (1993)	Parental depression	983	12–13	n/a	ADHD Symptoms (CQ[T]; RS[T], DSM II-R questionnaire[C])	Birth cohort (Christchurch Health and Development Study; New Zealand)	Prospective maternal self-report of depression (Levine-Pilowsky Depression Inventory)
Figueroa (2010)	Antidepressants	38,074	<5	50.6	Diagnosis (ICD-9 code)	MarketScan medical claims data ([**]Two different studies within one article)	Medical records (MarketScan) and report of medication use (national drug coding numbers) for antidepressants
Galéra et al. (2011)	Antisocial personality disorder, parental depression	1665	1.5–8	50.7	Hyperactivity-impulsivity and/or inattention symptoms (Interviewer Computerized Questionnaire)	Birth cohort (Quebec Longitudinal Study of Child Development; Canada)	Retrospective maternal and paternal report of antisocial behaviors and prostpective report of postpartum depression (CES-D)
Grizenko et al. (2012)	Parental stress and anxiety	142	9–9.9	50.7–88.7	Diagnosis (clinical evaluation DSM-IV)	Sibling research study from children's outpatient clinics (Canada)	Maternal report of prenatal stress rated on DSM axis IV scales
Hayatbakhsh et al. (2011)	Parental depression, parental stress, and anxiety	4765	14	51.6	Inattention (CBCL, YSR)[P,C]	Birth cohort (MUSP; Australia)	Prospective materanal self-report of prenatal anxiety and depression (DSSI)
Herndon et al. (2005)	Antisocial personality disorder	2766	17	47.9	Diagnosis (DSM-III-R clinical interview)[P,C]	Population-based research study (Minnesota Twin-Family Study; USA)	Parental APD assessed through clinical interview (SCID-II with at least 3 DSM-III-R criteria met)
Hirshfeld-Becker et al. (2008)	Parental Depression	225	10.1	51–54	Diagnosis (clinical consensus of K-SADS-E interview)[P,C]	Clinical case–control research study of parents with mental health conditions and without (USA)	Parent self-report of depression (SCID)
Huang et al. (2019)	Parental stress and anxiety	1732	8	80.5–80.9	Diagnosis (DSM-IV)	Case–control study with a clinical sample recruited from a hospital (China)	Retrospective maternal report of stress during pregnancy (Chinese version of Pregnancy Stress Rating Scale)

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Study	Risk factors (included)	Sample size	Age at outcome measurement (years)	Male (%)	ADHD measurement (included)	Sample (country)	Measurement
Huizink et al. (2007)	Parental stress and anxiety	804	14.2	53.3–54.3	ADHD symptoms (semi-structured assessment of genetics of alcoholism)	Birth cohort (FinnTwin12) twin study of in utero Chernobyl disaster exposure (Finland)	Prenatal exposure to Chernobyl was determined by child age
Jacobvitz et al. (2004)	Parental depression	83	7	n/a	ADHD symptoms (CBCL)[P,T]	Research study of pregnant women recruited through birthing classes, radio, and flyers (USA)	Maternal self-report of depression (CES-D)
Ji et al. (2018)	Parental stress and anxiety	1479	7–12	48.1	Diagnosis (ICD-9 code)	Birth cohort study using medical records (Boston Birth Cohort, USA)	Maternal retrospective report of prenatal stress
Joelsson et al. (2017)	Parental depression, parental stress, and anxiety	49,534	2–20	n/a	Diagnosis (ICD-9/10 code)	Case control study using the Finnish Nationwide Register (Finland)	Parental prenatal depression and anxiety via medical record ICD-9/10 code
Kim et al. (2009)	Parental depression, parental stress, and anxiety	2419	10	48.6	Diagnosis (DISC-IV)[P]	Research study (Seoul Child and Adolescent Mental Health Survey) using school-based recruitment,South Korea)	Maternal report of stress and depression during pregnancy using Korean version of DISC-IV
Laugesen et al. (2013)	Antidepressants	831,800	8	51.3–51.8	Diagnosis (ICD code or receipt of ADHD prescription)	Birth cohort study using medical records (Danish Medical Birth Registry, Denmark)	Maternal redemption of antidepressant medication prescription 30 days prior or during pregnancy
Letourneau et al. (2019)	Parental depression, parental stress, and anxiety	634	2	52.5	Inattention (CBCL)[P]	Research study (Alberta Pregnancy Outcomes and Nutrition study; Canada)	Parental postpartum depression (EPDS) and stress (SLEQ)
Li et al. (2010)	Parental parental stress and anxiety	1,015,910	≥3	51	Diagnosis (medical record ICD-10 code or receipt of ADHD prescription)	National birth cohort study using six Danish national registers (Denmark)	Mothers who lost a child, or a spouse, or a sibling, or a parent during the pregnancy or up to 1 year before the pregnancy
Martini et al. (2010)	Parental stress and anxiety	208	14–17	n/a	Diagnosis (DSM-IV computer assisted version of DIA-X/M-CIDI)	EDSP community sample study (Germany)	Prospective maternal self-report of DSM-IV anxiety or perceived stress during pregnancy
Meadows et al. (2007)	Parental depression, parental stress, and anxiety	2120	3	52.2	ADHD Symptoms (CBCL)[P]	National longitudinal survey (Fragile Families and Child Wellbeing Study; USA)	Parent self-report of DSM-IV diagnosis of anxiety and depression using the Composite International Diagnostic Interview Short Form Version 1.0
Morrell & Murray (2003)	Parental depression	59	5	52.5	Hyperactivity (RS)[P]	Community hospital sample (UK)	Prospective maternal; report of postpartum depression using EPDS & DISC
Morrison (1980)	Antisocial personality disorder	231	11.8–13.1	79–80	Hyperactivity (clinical interview, DSM-II criteria)	Clinical sample from psychiatry practice (USA)	Structured clinical interview for APD using DSM-II criteria

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Study	Risk factors (included)	Sample size	Age at outcome measurement (years)	Male (%)	ADHD measurement (included)	Sample (country)	Measurement
Murray et al. (2016) **	Parental depression	6849	7	n/a	Diagnosis (DAWBA); Inattention and hyperactivity (SDQ)^{P}	Birth cohort (ALSPAC; UK)	Maternal prospective self-report of prenatal depression (EPDS)
Murray et al. (2016) **	Parental depression	3509	7	n/a	Diagnosis (DAWBA); Inattention and hyperactivity (SDQ)^{P}	Birth cohort (Pelotas, Brazil)	Maternal self-report of prenatal depression
Oberlander et al. (2007)	Antidepressants	36	1.5–5	40–59.1	ADHD Symptoms (CBCL^{P}, TRF^{T}, Crowell observational procedure)	Clinical sample of pregnant mothers with mental disorders (Canada)	SSRI (selective serotonin reuptake inhibitor) use during pregnancy
O'Connor et al. (2002)	Parental depression, parental stress, and anxiety	7448	4	n/a	Hyperactivity/ inattention (RS)^{P}	Birth cohort (ALSPAC; UK)	Maternal self-report of anxiety (CCI) and depression prenatally and postnatally (EPDS)
Park et al. (2014)	Parental depression, parental stress, and anxiety	900	6–15	73.8–85.4	Diagnosis (DSM-IV; K-SADS-PL, DISC-IV)^{P}	Research study with clinical recruitment of ADHD sample from hospital and school-based non-ADHD sample (South Korea)	Maternal report of prenatal stress and postpartum depression
Pedersen et al. (2013)	Antidepressants	225	4–5	n/a	Hyperactivity/ inattention (SDQ)^{P}	Research study drawn from the Danish National Birth Cohort (Denmark)	Maternal self-report of prenatal antidepressant use classified using the Anatomical Therapeutic Chemical Classification System
Ramchandani et al. (2005)	Parental depression	10,024	3.5	n/a	Hyperactivity (RS-PR)	Birth cohort (ALSPAC; UK)	Parental self-report of postnatal depression (EPDS)
Ray et al. (2009)	Parental depression, parental stress, and anxiety	7407	7.1	n/a	Diagnosis (ICD-9)	Study using medical records (Kaiser Permanente Southern California) of children with ADHD and matched comparison group with asthma (USA)	Diagnosis (ICD-9) of maternal postnatal depression and anxiety
Rice et al. (2010)	Parental stress and anxiety	779	6.73	51	ADHD symptoms (Du Paul Questionnaire)	Prenatal cross-fostering design using IVF related and unrelated gametes (UK)	Parent report of prenatal stress (retrospective) and current child ADHD
Rodriguez and Bohlin (2005)	Parental stress and anxiety	128	7.7	49.3	ADHD symptoms (SDQ; DSM-IV Criteria)	Research study using recruitment from prenatal clinics (Sweden)	Maternal self-report of prenatal stress (PSS)
Romano et al. (2006)	Parental depression	2946	2–7	51	Hyperactivity symptoms (adapted from CBCL)	Population-based telephone survey (NLSCY; Canada)	Prospective parent self-report of maternal depression
Sasaluxnanon & Kaewpronsawan (2005)	Parental stress and anxiety	241	6–12	86.9–89.1	Diagnosis (clinical DSM-IV-TR)	Case–control study with a clinical sample recruited from hospital child/adolescent psychiatry unit (Thailand)	Retrospective maternal self-report of emotional distress during pregnancy
Say et al. (2016)	Parental depression, parental stress, and anxiety	180	3–18	71–78	Diagnosis (DSM-IV)	Case–control study recruited from pediatric clinics and child/	Maternal retrospective report of prenatal stressors/traumatic events

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Study	Risk factors (included)	Sample size	Age at outcome measurement (years)	Male (%)	ADHD measurement (included)	Sample (country)	Measurement
						adolescent psychiatry clinics (Turkey)	and postpartum depressive mood/ anhedonia
Simcock et al. (2019)	Parental depression	134	2.5	53.7	Inattention (CBCL)	Research study of women in a flood-affected area (Australia)	Prospective maternal report of prenatal depression (EPDS)
Sciberras et al. (2011)	Parental depression	3777	6.8	51	Diagnosis (parent report of previous diagnosis); hyperactivity/inattention (SDQ)[P,T]	Nationally representative population-based birth cohort (LSAC; Australia)	Prospective maternal self-report of postnatal depression
Van Batenburg-Eddes et al. (2013) **	Parental depression, parental stress, and anxiety	2280	3–4	n/a	Inattention (CBCL)[P]	Birth cohort (Generation R Study; Netherlands)	Parent self-report of anxiety and depression prenatally (BSI)
Van Batenburg-Eddes et al. (2013) **	Parental depression, parental stress, and anxiety	3442	3–4	n/a	Hyperactivity/ inattention (SDQ)[P]	Birth cohort (ALSPAC; UK)	Parent self-report of anxiety (CCI) and depression (EPDS) prenatally
Van den Bergh and Marcoen (2004)	Parental stress and anxiety	72	8.5	52.8	ADHD symptoms (CBCL[P],TRF[T], CATRSB[T], GBO[O])	Prospective research study of maternal anxiety during pregnancy (Belgium)	Maternal self-report of anxiety prenatally (STAI)
Walker et al. (2013)	Parental depression	1452	2–3	50.8	ADHD symptoms (Child Behavioural Scales using DSM-IV criteria)[P]	Population-based telephone survey (NLSCY; Canada)	Maternal self-report of postpartum depression
Weikum et al. (2013)	Antidepressants	64	6.3	38.5–47.4	ADHD symptoms (HBQ)[P]	Research study of prenatal serotonin reuptake inhibitor (SRI) exposure and maternal mood disorders using recruitment from medical clinics (Canada)	SRI exposure defined as maternal SRI use at the time of conception for clinical need and diagnosis of a mood disorder
Wiggs et al. (2016)	Parental stress and anxiety	464	6–17	55	Diagnosis (DSM-IV ADHD Rating Scale, Conners' Rating Scale — Revised Short Form, K-SADS-E)[P,T,S]	Research study recruited from community and clinics (USA)	Parent report of maternal prenatal stressors
Yoshimasu et al. (2009)	Parental stress and anxiety	360	9.9–10.2	47–91	Diagnosis (clinical)	Clinical outpatient study with controls (Japan)	Retrospective maternal self-report of prenatal stress
Zhu et al. (2015)	Parental stress and anxiety	1765	4	53.9	ADHD symptoms (Conners Hyperactivity Index)[P]	Research study recruited prenatally from hospital (China)	Maternal prospective report of prenatal stress (Prenatal Life Events Checklist)

C child report, *P* parent report, *O* observer report, *T* teacher report, *S* self-report, *ADHD* attention-deficit/hyperactivity disorder, *ALSPAC* Avon Longitudinal Study of Parents and Children, *APD* antisocial personality disorder, *BSI* Brief Symptom Inventory, *CATRSB* Conners Abbreviated Teacher Rating Scale, *CBCL* Child Behavior Checklist, *CCI* Crown-Crisp Index, *CES-D* Center for Epidemiologic Studies Depression Scale, *CIRS* Children's Impairment Rating Scale, *CQ* Conners Questionnaire, *CPRS-R* Conners Parent Rating Scale Revised: Short Form, *DAWBA* Development and Well-Being Assessment, *DIA-X/M-CIDI* Munich-Composite International Diagnostic Interview, *DICA* Diagnostic Interview for Children and Adolescents, *DISC* Diagnostic Interview Schedule for Children, *DSM-II* Diagnostic and Statistical Manual of Mental Disorders, 2nd edition, *DSM-II-R* Diagnostic and Statistical Manual of Mental Disorders, 2nd edition. Text Revision, *DSM-III* Diagnostic and Statistical Manual of Mental Disorders, 3rd edition, *DSM-III-R* Diagnostic and Statistical Manual of Mental Disorders, 3rd edition. Text Revision, *DSM-IV* Diagnostic and Statistical Manual of Mental Disorders,

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4th edition, *DSM-IV-TR* Diagnostic and Statistical Manual of Mental Disorders, 4th edition. Text Revision, *DSSI/SAD* Delusions Symptoms-States Inventory: State of Anxiety and Depression, *EDSP* Early Developmental Stages of Psychopathology, *EPDS* Edinburgh Postnatal Depression Scale, *EPSDS-3* Edinburgh Postnatal Depression Scale, 3-item, *GBO* Groninger Behavior Observation Scale, *HBQ* MacArthur Health and Behavior Questionnaire, *ICD-9* International Classification of Diseases, *IVF* In vitro fertilization, *K-SADS-E* Kiddie Schedule for Affective Disorders and Schizophrenia tor School-Age Children, *LES* Life Events Scale, *LSAC* Longitudinal Study of Australian Children, *MUSP* Mater University of Queensland Study of Pregnancy, *NLSCY* National Longitudinal Survey of Children and Youth, *PBQ* Preschool Behavior Questionnaire, *PHQ-2* Parent Health Questionnaire, Version 2, *PSS* Perceived Stress Scale, *RS* Rutter Scale, *RS-PR* Rutter Scale Preschool Version Revised, *SBCL* Simmons Behavior Checklist, *SCID* Structured Clinical Interview, *SCID-NP* Structured Clinical Interview, Non-Patient Edition, *SDQ* Strengths and Difficulties Questionnaire, *SEEQ* Stressful Life Events Questionnaire, *SNAP* Swanson, Nolan, and Pelham Rating Scale, *SRI* Serotonin Reuptake Inhibitor, *STAI* State-Trait Anxiety Inventory, *TEA-CH* Test of Everyday Attention in Children, *TRF* Teacher Report Form, *YSR* Youth Self Report

** Two different studies within one article

Table 2

Results of meta-analysis of studies examining parental mental health indicators as risk factors for child attention-deficit/hyperactivity disorder

	Risk factor	Most common risk factor measure/definition	Outcome measure	ADHD overall[a]		ADHD diagnosis only[b]	
				Total sample size (number of studies)	Pooled effect size (95% CI) OR (dichotomous)/CC (continuous)[c]	Total sample size (number of studies)	Pooled effect size (95% CI)
Depression	Parental depression	Self-report of depression using a validated questionnaire (e.g., Center for Epidemiologic Studies Depression Scale, CES-D or Edinburgh Postnatal Depression Scale, EPDS)	Dichotomous	99,217 (16)	1.77 (1.45; 2.17) *	81,808 (11)	2.27 (1.75, 2.03) *
			Continuous	8,487 (11)	0.15 (0.09; 0.21) *		
	Maternal depression		Dichotomous	96,570 (14)	1.92 (1.51; 2.44) *		
	Parental depression		Dichotomous	65,106 (5)	1.40 (1.00; 1.95) *d		
	Maternal post-partum depression	Self-report of postnatal depression	Dichotomous	30,465 (8)	1.56 (1.18 2.06) *		
Antidepressant exposure	Prenatal antidepressant exposure	1st trimester antidepressant (e.g., selective serotonin reuptake inhibitor, SSRI, usage)	Dichotomous	1,027,129 (6)	1.74 (1.14; 2.65) *		
			Continuous	14,677 (4)	−0.01 (−0.09; 0.02)		
Stress and anxiety	Parental stress and anxiety	Self-report of anxiety using a validated questionnaire (e.g., Delusions Symptoms-States Inventory) or self-report of stress during pregnancy	Dichotomous	1,101,696 (19)	1.80 (1.49; 2.18) *	1,085,921 (14)	1.95 (1.55; 2.46) *
			Continuous	12,538 (8)	0.08 (0.04; 0.12) *		
	Maternal stress and anxiety	Self-report of stress or anxiety via DSM-IV diagnosis, validated questionnaire (e.g., Crown-Crisp Index), or ICD-9 code	Dichotomous	1,101,696 (19)	1.82 (1.51; 2.20) *		
	Paternal stress		Dichotomous	57,376 (4)	1.28 (0.90, 1.83)		
	Maternal prenatal stress	Self-report of stress/distress during pregnancy with or without a validated questionnaire (e.g., Brief Symptom Inventory) or diagnosis of anxiety	Dichotomous	1,087,404 (16)	1.85 (1.49,2.29) *		
Antisocial personality disorder	Parental antisocial personality disorder	Structured Clinical Interview for the Diagnostic and Statistical Manual antisocial personality disorder items	Dichotomous	3,678 (4)	1.80 (1.02; 3.18) *	2,013 (3)	2.33 (1.07; 5.10) *
	Maternal antisocial personality disorder		Dichotomous	3,418 (4)	1.90 (0.86; 4.22)		
	Paternal antisocial personality disorder		Dichotomous	3,299 (4)	1.75 (0.99; 3.10)		

* Significant at $p < 0.05$

[a] ADHD Overall includes all included measures of ADHD with independent study samples

[b] ADHD Diagnosis includes ADHD DSM diagnosis by clinician evaluation or interview, clinical diagnostic tool, ICD-9/10 codes or ADHD prescription filled, or medical record report

[c] Pooled odds ratio (OR) for dichotomous outcomes and pooled correlation coefficient (CC) for continuous outcomes

[d] *p* value significant at $p = 0.047$ level although the confidence interval contains 1.00