



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

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Abstract

Parenting and family environment have significant impact on child development, including development of executive function, attention, and self-regulation, and may affect the risk of developmental disorders including attention-deficit/hyperactivity disorder (ADHD). This paper examines the relationship of parenting and family environment factors with ADHD. A systematic review of the literature was conducted in 2014 and identified 52 longitudinal studies. A follow-up search in 2021 identified 7 additional articles, for a total of 59 studies that examined the association of parenting factors with ADHD outcomes: ADHD overall (diagnosis or symptoms), ADHD diagnosis specifically, or presence of the specific ADHD symptoms of inattention and hyperactivity/impulsivity. For parenting factors that were present in three or more studies, pooled effect sizes were calculated separately for dichotomous or continuous ADHD outcomes, accounting for each study's conditional variance. Factors with sufficient information for analysis were parenting interaction quality (sensitivity/warmth, intrusiveness/reactivity, and negativity/harsh discipline), maltreatment (general maltreatment and physical abuse), parental relationship status (divorce, single parenting), parental incarceration, and child media exposure. All factors showed a significant direct association with ADHD outcomes, except sensitivity/warmth which had an inverse association. Parenting factors predicted diagnosis and overall symptoms as well as inattentive and hyperactive symptoms when measured, but multiple factors showed significant heterogeneity across studies. These findings support the possibility that parenting and family environment influences ADHD symptoms and may affect a child's likelihood of being diagnosed with ADHD. Prevention strategies that support parents, such as decreasing parenting challenges and increasing access to parent training in behavior management, may improve children's long-term developmental health.

Keywords ADHD · Attention-deficit/hyperactivity disorder · Parenting · Family environment

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Parents, and other primary caregivers (hereinafter referred to as parents), have a strong influence on children's development starting in infancy (National Academies of Sciences, Engineering, and Medicine (NASEM), 2016b). Parents affect their child's development directly through daily interaction and communication, parents shape the child's environment and protect them from risks, and parents are the child's first role models for interactions with the larger social world (Kiff et al., 2011). Extensive evidence has shown the importance of early environment on social, emotional, and behavioral development (NASEM, 2019b), and the key role that parents play (NASEM, 2016b). However, the relationship is influenced by both the parent and child, including by the child's communicative and interactive characteristics and by the parent's responses to the child's signals (Kiff et al., 2011).

Attention-deficit/hyperactivity disorder (ADHD) is a neurobehavioral condition, characterized by challenges with regulation of attention, emotion, and behavior (American Psychiatric Association, 2013), with multiple risk factors and possible causes (Faraone et al., 2021). Heritability of ADHD has been well documented, but environmental influences, either directly or through gene-environment interactions, are likely to play a significant role in whether symptoms become severe and impairing, thus warranting diagnosis and treatment (Faraone & Larsson, 2019; Faraone & Mick, 2010; Faraone et al., 2021; Freitag & Retz, 2010; Humphreys & Zeanah, 2015). Given that the development of behavior and emotions is strongly affected by childhood experiences, parenting behaviors and family context may affect the development and expression of behavioral symptoms of ADHD (Humphreys & Zeanah, 2015; Sonuga-Barke & Halperin, 2010). The present paper explores factors related to parenting and the likelihood of developing ADHD.

Parenting can influence the child's development of self-regulation and behavior through multiple pathways. One important influence is through daily interactions with the child (Haltigan et al., 2013; NASEM, 2016). Quality of attachment, which indicates the degree of feeling safe and protected by the parent, has long-term impact on emotional development, including the likelihood of developing mental disorders (Fearon et al., 2010). Parental sensitivity to the child's signals and supportive responsiveness during interactions are necessary components of a secure parent-child relationship (Claussen & Crittenden, 2000). Positive and supportive parenting behaviors include being sensitive and warm in response to emotional needs, being engaged and involved, and having low levels of intrusive or emotionally reactive behavior. By responding sensitively, secure attachment figures can support children in regulating their emotion and behavior and in developing executive function skills (Menon et al., 2020; Pallini et al., 2019). Conversely, a parent's persistent lack of sensitivity and failure to respond supportively can result in a lack of predictability which impacts the development of the child's regulatory processes (Auersperg et al., 2019; Murray & Murray, 2010; Pallini et al., 2019). Negative or hostile responses and harsh discipline have been associated with increased hyperactivity (Romano et al., 2006). At the extremes, parents may neglect basic needs or respond in harmful and abusive ways, and maltreated children may become hypervigilant and attend to their own safety rather than learn and explore, impairing the development of typical attentional processes (Humphreys & Zeanah, 2015; Pallini et al., 2019; Strathearn et al., 2020).

Extended separation from a parent, for example from parental incarceration, or from the instability of care and loss of a key attachment figure that can follow a divorce in some families, has a significant impact on children (D'Onofrio & Emery, 2019; NASEM, 2019b). Such loss affects children

even when the child experienced maltreatment (Goldsmith et al., 2004). Like maltreatment, trauma from separation and loss may impair children's ability to develop executive function, self-regulation, and attention skills (Humphreys & Zeanah, 2015; van der Bij et al., 2020). Another type of family structure, single parenting, has also been identified as a factor that may influence child development, due to associated factors such as increased role demand and decreased economic resources that are often present (Hilton et al., 2001).

In addition to the direct impact through interactions, parents can also shape children's experiences and daily lives, such as by determining the amount and content of screen media such as television and video games to which a child is exposed (Maniccia et al., 2011). Excessive screen media exposure in early childhood has been examined as a possible risk factor for attention and self-regulation issues (Beyens et al., 2018; Christakis et al., 2004; Radesky et al., 2014). Healthy habits such as limiting young children's access to screen media and monitoring the content are strongly influenced by parents' choices (Coyne et al., 2017). The amount and content of screen time may indicate parents' choices regarding their child's leisure time; excessive use of screen time may also indicate less time spent playing and interacting with parents and others (Mendelsohn et al., 2011).

Understanding broad patterns of potential risk factors can help identify those that are potentially modifiable and might be addressed through prevention and intervention (Bitsko et al., [this issue](#)). The focus of the present paper is to summarize the risks for ADHD associated with parenting behaviors and the parent-child relationship as potentially modifiable factors. Family-centered interventions have been well documented to support parents and improve their ability to provide sensitive, stable, and nurturing care for their child (NASEM, 2016b). Parenting thus represents a potentially modifiable risk factor through which the likelihood of developing ADHD, or more severe ADHD symptoms, may be changed. Given prior evidence, it was expected that characteristics of parenting would emerge as associated with ADHD symptoms and diagnosis. The present paper leverages a large set of meta-analyses to examine the associations between parenting in early childhood and increased likelihood of later ADHD symptoms and diagnosis.

Methods

Procedure

This paper is part of a series of systematic reviews and meta-analyses of potentially modifiable broad risk factors for ADHD. See Bitsko et al. ([this issue](#)) for details. Studies for the meta-analysis were identified using a comprehensive

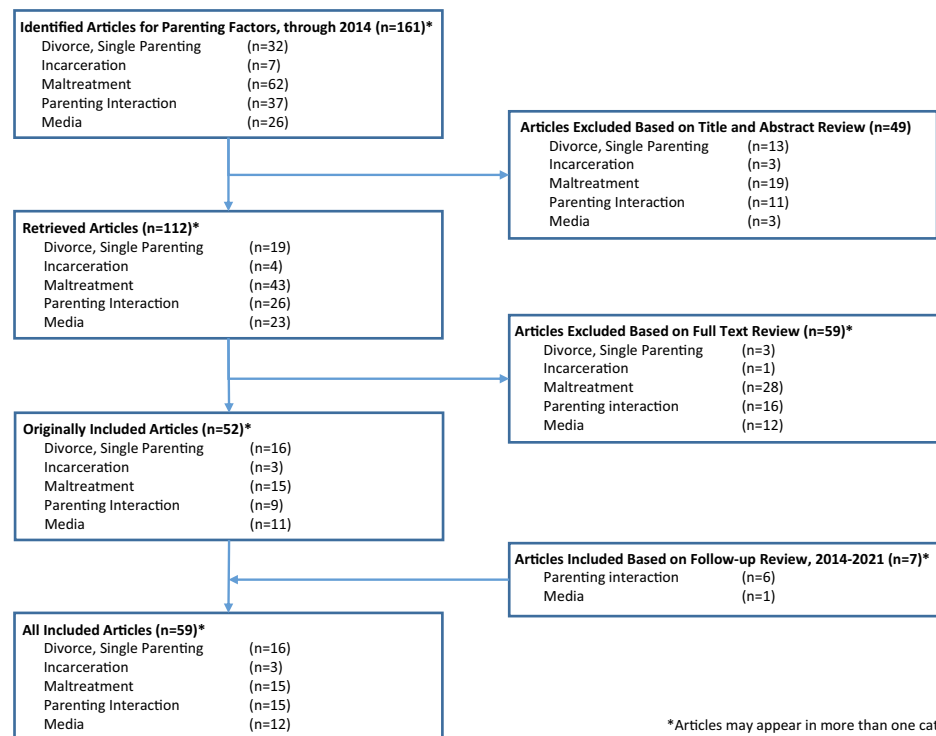
literature search of PubMed, Web of Science (WOS), and EMBASE in 2014 using both a top-down and a bottom-up approach to identify articles that captured ADHD or symptoms of ADHD and studies indicating risk factors. See the 17 for search terms. The initial review for inclusion was based on abstracts; for articles that received a full review, cited references also were checked for potential inclusion (iterative reference mining). The studies were examined for suitability using the abstract, reviewed based on methods, and clustered into conceptually related factors. Of the studies, 161 included parenting-related factors. Within these factors, clusters emerged around parental relationship status (divorce or single parenting), parental incarceration, maltreatment, parenting interaction quality, and child media exposure. Figure 1 describes the flow chart for the review and inclusion process.

The final selection of articles was limited to those that involved human subjects, were published in English, and described research not duplicated in other included studies. Studies were included if they were longitudinal or retrospective; the parenting factor of note was identified prior to the assessment of ADHD. For example, studies that measured child media exposure or parenting interaction quality were only included if the measurement of ADHD symptoms or diagnosis was conducted at a later time. Reports of factors could be retrospective, for example for maltreatment or marital status. The studies also needed to have sufficient statistical details

to calculate effect sizes for the specific factor in question (see Bitsko et al., [this issue](#), for details). Statistical reporting of ADHD associations included dichotomous and continuous measurement, (e.g., dichotomous = odds ratios or categorical analyses; continuous = correlation coefficients or beta weights) which were analyzed separately. Forest plots and overall effect sizes were calculated for any ADHD outcomes, including diagnosis or symptoms (referred to as “ADHD overall”), as well as for studies assessing ADHD diagnosis, inattention, or hyperactivity/impulsivity separately, when available.

Of the general parenting factor categories, parental relationship status, maltreatment, and parenting interaction quality were further separated into individual clustered factors when sufficient data were available, i.e., a minimum of three effect sizes. Parental relationship status factors were divorce and single parenthood. Parental incarceration was a single factor that included arrest. Maltreatment-related factors were general maltreatment (not differentiated by type, could include physical and emotional abuse and neglect, sexual abuse, exposure to violence, or unspecified maltreatment) and physical abuse. Parenting interaction quality included sensitivity/warmth, intrusiveness/reactivity, and negativity/harsh discipline. Childhood media exposure was a single factor that included TV, video, and gaming. Several factors were initially targeted for analysis but not included in the final set of analyses due to fewer than three studies that met inclusion criteria, i.e., sexual abuse, neglect, foster

Fig. 1 Flow chart of triage process for inclusion/exclusion of articles identified for meta-analyses of parenting risk factors for attention-deficit/hyperactivity disorder (ADHD)



care, parental permissiveness/inconsistent parenting, and parental involvement.

Search Strategy

The search used terms related to ADHD diagnoses, or ADHD symptoms such as inattention, hyperactivity, and impulsivity including terms more commonly used in previous decades such as attention-deficit disorder, hyperkinetic disorder, or minimal brain dysfunction (see Bitsko et al., [this issue](#), for details). The search strings relevant to parenting were foster care, single parent, institution, advers*, maltreatment, deprivation, trauma, rejection, discipline, attachment, electronic, television, TV, video game, or screen time. See the [17](#) for search terms. There were 50 studies that met inclusion criteria. Because the initial search strings did not include all of the key terms that emerged as potential factors (i.e., “abuse,” “neglect,” “involvement,” “intrusive,” “permissive,” and “sensitive”), a follow-up literature search using these terms was conducted to ensure that no relevant articles were omitted, which identified two further articles that had been included in the larger systematic search but not previously identified as assessing abuse. No additional articles on the other factors emerged for inclusion. The original set of 52 papers was used to establish the parenting factors of interest that are addressed in the present study.

The search focused on selected words describing the social environment (see the [17](#)) rather than all aspects of parenting; therefore, the included clusters are not an exhaustive representation of all possible parent–child-related factors. Parental factors that are characteristics of the parent, such as mental health and stress, or substance abuse, are reviewed elsewhere (Maher et al., [under review this issue](#); Robinson et al., [this issue](#)).

Follow-up Literature Search

After the parenting factors of interest were established in the initial systematic review, an additional review of all literature published from 2014 until January 2021 was conducted using the same search terms (see the [17](#)) to ensure that all relevant studies were included in the final manuscript. We identified 7 additional studies that met methodological and statistical criteria for inclusion in the final set of articles for the analyses.

Analyses

For each factor that reached or exceeded the minimum number of effect sizes ($k \geq 3$), pooled analyses were conducted to calculate an overall pooled effect size for the association between the risk factor and any ADHD outcomes. Effect

sizes were calculated separately for ADHD outcomes depending on whether study findings were reported as dichotomous versus continuous. More detailed analyses calculated separate pooled effect sizes for ADHD diagnosis, inattentive symptoms, or hyperactive/impulsive symptoms, whenever three or more eligible effect sizes were available. For studies that reported on male and female children separately, effect sizes were averaged, and for studies that assessed mothers and fathers on the same predictive factor, scores were averaged across both parents. When multiple levels, dosages, or severities of exposures had possible effect sizes, the most severe exposure that met other inclusion criteria (e.g., measured at least 6 months prior to the measurement of ADHD) was included, to increase the sensitivity for detecting an association if present. See Bitsko et al. ([this issue](#)), for details on the meta-analytic methods.

For each dichotomous analysis, odds ratios (OR) with 95% confidence intervals (CI) were calculated, and for continuous factors, correlation coefficients (CC) with 95% CI were calculated. To examine heterogeneity of effects, Cochran’s Q test was used to describe the variation across study estimates (DerSimonian & Laird, 1986). As in other studies in this issue, the analyses used random-effects models, using weights to account for the variation in effect size between studies (Sutton et al., 2000). Compared to a fixed-effect model, this provides a more conservative estimate of effect size (Berlin et al., 1989).

Results

The first literature search conducted in 2014 resulted in 17,734 studies and the follow-up search resulted in 11,506 additional studies. Among these studies, 161 were identified as relevant for parenting-related factors and a full review was conducted. Of the 161 studies fully reviewed, 59 studies addressed parenting-related factors and met all criteria, and thus were included in this meta-analysis. General parenting factor categories were parental relationship status ($n = 16$), parental incarceration ($n = 3$), maltreatment ($n = 15$), parenting interaction quality ($n = 16$), and child media exposure ($n = 12$). See Fig. 1 for the selection flow chart and Table 1 for studies included in the analyses.

Relation of Risk Factors to ADHD Outcomes

Across all analyses, these parenting factors were significantly associated with ADHD outcomes, including all factors related to parental relationship status, parental incarceration, maltreatment, parenting interaction, and child media exposure. See Table 2 for the results of analyses. Forest plots are included in the Supplemental material.

Table 1 Characteristics of studies included in meta-analyses of the association of parenting factors to child attention-deficit/hyperactivity disorder (ADHD)

Article	Risk factors ^a	Forest plot N ^b	Age at outcome (years) ^c	Male (%)	ADHD measurement (method of assessment)	Country	Study design	Parenting factor measurement
Becker-Blease and Frey (2008)	Maltreatment	28	9.27	38–60	ADHD symptoms (ADHDT; SNAP-IV)	USA	Community sample, recruitment through flyers in public spaces	Retrospective parent report on maltreatment (including physical abuse, sexual abuse, emotional abuse or neglect)
Bonde et al. (2004)	Divorce and single parenthood	1,345	3.5	69	Hyperactivity (Behar Scale Questionnaire)	Denmark	Birth cohort (Aarhus)	Retrospective report of family structure at outcome (divorce)
Breaux and Harvey (2019)	Parenting	167	6	55.8	ADHD symptoms (DISC)	USA	Longitudinal study of community sample of children at risk for ADHD or ODD	Observer rating of sensitive/warm parenting (play and cleanup interaction); parent self-report of intrusiveness/reactivity (overreactivity using the Parenting Scale)
Briscoe-Smith and Hinshaw (2006)	Maltreatment	228	6–12	0	Diagnosis (included CBCL, SNAP, and DISC-IV; DSM-IV)	USA	Community sample, 3 cohorts of summer camp participants, recruitment through educational and health-care settings	Maltreatment determined from records (including physical abuse, sexual abuse, neglect, witnessing domestic violence, or combination)
Cheng et al. (2010)	Media	241	2.5	50.7	ADHD symptoms (SDQ)	Japan	Birth cohort (Japan Children's Study), 3 study sites	Maternal report of TV exposure (≥ 4 h daily at 18 and 30 months vs < 4 h at both times) ^d
Choenni et al. (2019)	Parenting	547	8	51.7	ADHD symptoms (CPRS-R:S)	Netherlands	Prospective population-based cohort study (Generation R Study)	Observer rating of sensitive/warm parenting and negativity/harsh parenting (do not touch videotaped procedure, supportive presence, negative discipline)
Cohen et al. (2002)	Divorce and single parenthood; maltreatment	62–80	15	35–63.6	Diagnosis (K-SADS-E; DSM-III-R)	USA	Cohort of cases from the New York State Central Register for child abuse, randomly selected community control sample	Parent report of family structure (marital disruption, defined as divorce or separation) ^e Maltreatment determined from records (physical abuse) ^f
de Paul and Arruabarrena (1995)	Maltreatment	42	5–11	n/a	Inattention (TRF)	Spain	Sample randomly selected from cases reported to child protective services, matched comparison from a stratified community sample	Maltreatment determined from records (physical abuse) ^g

Table 1 (continued)

Article	Risk factors ^a	Forest plot N ^b	Age at outcome (years) ^c	Male (%)	ADHD measurement (method of assessment)	Country	Study design	Parenting factor measurement
Famularo et al. (1992)	Maltreatment	96	5–10	43–44	Diagnosis (DICA-6-R; DSM-III-R)	USA	Cases selected from court cases and hospital, comparison from hospital sample	Maltreatment determined from records (abuse or neglect)
Fitzpatrick et al. (2012)	Media; parenting	1,786	8.08	n/a	Inattention (teacher SBQ)	Canada	Birth cohort (Quebec Longitudinal Study of Child Development)	Parent report of any exposure to violent film/TV content Observer rating of maternal negativity/harsh parenting (hostility using the HOME)
Foster and Watkins (2010)	Media	1,033	7	n/a	Inattention (BPI)	USA	Cohort from the National Longitudinal Survey of Youth	Parent report of TV exposure (> 7 h vs 0 h daily) ^b
Gabel and Shindedecker (1993)	Parental incarceration	31	5.5–12.5	70.3	Inattention (TRF)	USA	Cohort of clinical clients of a day hospital	Parent or caregiver report of prior incarceration of either parent
Geller et al. (2012)	Parental incarceration	2,695	5	52.1	Inattention (CBCL)	USA	Birth cohort (Fragile Families)	Father self-report, mother report, and disposition data of parent incarceration
Giannotta and Rydell (2017)	Parenting	596	15	50	ADHD symptoms (ADHD-RS)	Sweden	Population-based, regional longitudinal cohort study	Parental self-report of sensitivity/warmth and negativity/harsh discipline (Parental Environment Questionnaire)
Graziano et al. (2011)	Parenting	357	2–4.5	53.4	Sustained attention (lab video)	USA	Longitudinal sample selected at risk for behavior problems, 3 cohorts of 2-year-old children from community samples screened for risk	Observer rating of Intrusive/reactive and sensitive/warm parenting (warmth, over-control/intrusiveness using the Early Parenting Coding System)
Haj-Yahia and Abdolkaloti (2008)	Maltreatment	1,185	16.58	49.8	Inattention (YSR)	Palestine	Convenience sample, 3 classes randomly selected from 13 high schools	Maltreatment based on child self-report using Conflict Tactics Scale (aggregate of physical violence by father and mother)
Hjern et al. (2010)	Divorce and single parenthood	1,162,524	6–19	51.3	ADHD medication purchase	Sweden	Birth cohort from National Register 1987–2000, excluding foreign-born parents	Family structure based on register information (lone parenting)
Hurtig et al. (2005)	Divorce and single parenthood	4,634	15	47.9	ADHD symptoms (SWAN)	Finland	Birth cohort from two provinces	Parent self-report of family structure (divorced or widowed) (always single parent) ^j

Table 1 (continued)

Article	Risk factors ^a	Forest plot N ^b	Age at outcome (years) ^c	Male (%)	ADHD measurement (method of assessment)	Country	Study design	Parenting factor measurement
Jacobovitz and Stroufe (1987)	Parenting	68	6	70.6	Hyperactivity (CBCL)	USA	Case/control sample of hyperactive with matched comparison selected from a prospective longitudinal sample of primiparous mothers attending prenatal clinics	Observer rating of intrusive/reactive parenting (overstimulation during structured play interaction)
Johnson et al. (2007)	Media	678	14–22	50	Inattention (DISC)	USA	Community-based prospective longitudinal sample of adolescents (Children in the Community Study)	Parent report of TV exposure (> 1 h daily)
Kashala et al. (2005)	Divorce and single parenthood	185	8.4	45	ADHD symptoms (SDQ)	Democratic Republic of Congo	School-based sample, Teacher SDQ plus DBD high screened hyperactive/inattentive and matched control (nested case/control)	Parent report of family structure (divorced) (single parent)
Kelly et al. (2001)	Divorce and single parenthood	5,181	4–15	50	Hyperactivity (SDQ)	England	Representative survey, Health Survey for England	Parent reported family structure (lone parenting)
Keown (2012)	Parenting	81	7	100	ADHD symptoms (ADHD-RS)	New Zealand	Prospective longitudinal community sample, case/control on hyperactivity using PACS	Observer rating of intrusive/reactive, sensitive/warm parenting by both parents Intrusiveness and sensitivity using Early Head Start 3-bag coding scheme
Kerr and Michalski (2007)	Divorce and single parenthood	1,920	4–11	n/a	ADHD symptoms (interview)	Canada	Cohort of children age 4–5 in 1994 (Canadian National Longitudinal Survey of Children and Youth)	Parent report of family structure (separation or divorce) ^k
Kim et al. (2009)	Divorce and single parenthood	2,419	10	48.6	Diagnosis (DISC-IV)	Korea	School-based sample (Seoul Child and Adolescent Mental Health Survey)	Parent report of family structure (separation or divorce)
King et al. (2011)	Maltreatment	600	10–18	63.1	Diagnosis (DISC-III-R/DISC-IV)	USA	Random sample from juvenile temporary detention center	Self-report and record review of maltreatment (presence/absence of combined severe physical and sexual abuse) ^l

Table 1 (continued)

Article	Risk factors ^a	Forest plot N ^b	Age at outcome (years) ^c	Male (%)	ADHD measurement (method of assessment)	Country	Study design	Parenting factor measurement
Kočovská et al. (2012)	Maltreatment	66	9	43.1–51.5	Diagnosis (clinician, DAWBA)	UK	Sample recruited from adoption charity selected for indiscriminately friendly behavior and history of maltreatment, and matched controls	Maltreatment recorded from adoption records (includes physical abuse, sexual abuse, physical neglect, emotional neglect)
Landhuis et al. (2007)	Media	980	3–15	52	Inattention (Quay-Peterson RBPC/Rutter Scale/Child DISC)	New Zealand	Birth cohort (Dunedin Multidisciplinary Health and Development Study)	Parent of TV exposure (hours of daily exposure)
Larsson et al. (2011)	Divorce and single parenthood	2,160	8–20	49	Hyperactivity and Inattention Symptoms Checklist ^m	Sweden	Birth cohort (Twin study of Child and Adolescent Development)	Parent report of family structure (divorce; comparison included single parent, married, widowed)
Lifford et al. (2008)	Parenting	194	11–13	45.8	ADHD symptoms (CBCL)	UK	Longitudinal community study	Child report of sensitive/warm parenting (acceptance/rejection using the Child's Report of Parental Behavior Inventory)
Lifford et al. (2009)	Parenting	282	11–14	49.6	ADHD symptoms (CBCL)	UK	Longitudinal community study	Child report of negativity/harsh parenting (hostility using the Iowa Youth Family Project Hostility scale)
Liu et al. (2000)	Divorce and single parenthood	174	10.3	51.7	Inattention (CBCL, TRF)	China	Cases and controls (divorced and not divorced) selected from a representative community sample	Parent report of family structure (divorce)
Meysamie et al. (2011)	Divorce and single parenthood	1,403	3–6	51.8	ADHD symptoms (parent and teacher BRPC)	Iran	School-based sample from randomly selected kindergartens	Parent report of family structure (single parenting)
Miller et al. (2019)	Parenting	241	9	46	ADHD symptoms (SNAP-IV)	USA	Longitudinal study on temperament, oversampled on infant reactivity	Observer rating of sensitivity/warmth (Ainsworth's Maternal Care Behavior rating scales)
Mimouni-Bloch et al. (2013)	Divorce and single parenthood	107	6–12	52.9–73.2	Diagnosis (medical records)	Israel	Retrospective matched study, medical center, case and control (ADHD)	Parent report of family structure (divorce)

Table 1 (continued)

Article	Risk factors ^a	Forest plot N ^b	Age at outcome (years) ^c	Male (%)	ADHD measurement (method of assessment)	Country	Study design	Parenting factor measurement
Mistry et al. (2007)	Media	2,306	5.5	49	Inattention (CBCL)	USA	Prospective longitudinal study (Healthy Steps for Young Children)	Parent report of TV exposure (> 2 vs ≤ 2 h daily)
Morrell and Murray (2003)	Parenting	59	5–8	52.5	Hyperactivity (RS)	UK	Case control study (depression) from representative sample, birth cohort	Observer rating of maternal negativity/harsh and sensitive/warm parenting (hostility and positive composite using the HOME)
Nolin and Ethier (2007)	Maltreatment	109	6–12	55.7	Inattention (Visual Attention Test – NEPSY)	Canada	Case control study (maltreated vs matched control)	Record review (neglect with physical abuse, comparison) ⁿ
Obel et al. (2004)	Media	244	3.5–12	n/a	Probable diagnosis (Rutter Scale, CBCL, SDQ)	Denmark	Longitudinal study of birth cohort from hospital	Parent report of TV exposure (> 2 vs < 1/2 h daily) ^o
Parkes et al. (2013)	Media	10,500	5–7	48.9	ADHD symptoms (SDQ)	UK	Prospective birth cohort study (UK millennium)	Parent report of TV/video/DVD and electronic games exposure (> 3 vs < 1 h daily) ^p
Pauli-Pott et al. (2018)	Parenting	120	5	57	ADHD symptoms (FBB-ADHS-V and PrePacs composite)	Germany	Longitudinal study of pre-schooler, oversampled on ADHD risk	Observer rating of sensitivity/warmth (responsiveness scale on the Mannheim Rating Scale for the Assessment of Mother–Child Interaction)
Pinto et al. (2006)	Parenting	104	6–8	n/a	ADHD symptoms (ADHD-RS, mother and teacher)	UK	Community-based case control (stillbirth and matched control)	Observer rating of sensitive/warm parenting (disorganization of attachment scale based on strange situation behavior)
Poulain et al. (2018)	Media	527	3–7	52	ADHD symptoms (SDQ)	Germany	Longitudinal childhood cohort study (LIFE Child study)	Parent and child report of TV, videogame, and mobile phone exposure (hours of daily exposure)
Robinson et al. (2012)	Maltreatment	102	7.14	44.3–53.1	Inattention (CBCL)	USA	Cohort of maltreated children taken into state custody and matched controls	Record review of maltreatment status (includes physical abuse, sexual abuse, and neglect)
Rodriguez et al. (2011)	Divorce and single parenthood	805	7–9	51.7	Hyperactivity (SDQ)	Brazil	Birth cohort, stratified random sampling based on birth weight	Parental report of family structure (single parenting) ^q

Table 1 (continued)

Article	Risk factors ^a	Forest plot N ^b	Age at outcome (years) ^c	Male (%)	ADHD measurement (method of assessment)	Country	Study design	Parenting factor measurement
Rogosch et al. (2011)	Maltreatment	247	9.42	52.2	Inattention (TRF)	USA	Community-based case control (maltreated and SES matched comparison)	Maltreatment status coded from records (includes neglect, emotional maltreatment, physical abuse, and sexual abuse)
Rydell (2010)	Divorce and single parenthood	1,124	10.2	52	ADHD symptoms (ADHD-RS)	Sweden	Population-based random sample of age cohort	Parental report of family structure (single parenting) ^f
Schachar and Wachsmuth (1991)	Divorce and single parenthood	63	7–11	100	Diagnosis (Teacher Rutter Scale, CATRSB, SNAP; parent and child interview)	Canada	Clinic referred case-control study behavior problems and community comparison (boys)	Parental report of family structure (divorce) ^g
Sesar et al. (2008)	Maltreatment	458	15–20	39	ADHD symptoms (YSR)	Bosnia and Herzegovina	Population-based sample of high school students from a specific canton	Self-report of maltreatment based on Child Maltreatment Questionnaire (includes emotional abuse, physical abuse, sexual abuse, neglect, and witnessing family violence)
Simmel et al. (2001)	Maltreatment	808	10 (5–18)	50.7	ADHD symptoms (BPI, IOWA Connors)	USA	Population-based cohort of adoptive families (California Long-Range Adoption Study)	Parent report of maltreatment based on information by birth parent or social worker (includes physical/sexual abuse and neglect)
Stadelmann et al. (2010)	Divorce and single parenthood	187	5.27–6.23	59.4	Hyperactivity (SDQ)	Switzerland	Community sample of Kindergarten students plus participants of longitudinal sample recruited prenatally plus sample of children referred for behavior problems	Parent report of family structure (separation)
Stevens and Muslow (2006)	Media	2,500	Kindergarten	n/a	ADHD symptoms (SRS)	USA	Random sample from the Early Childhood Longitudinal Study, Kindergarten Class 1998–1999	Parent report of TV or video exposure (hours daily)
Stright and Neitzel (2003)	Parenting	52	8.6	55.8–92.3	Inattention (TRF; behavior observation)	USA	Community sample	Observer rating of negativity/hostile parenting (maternal and paternal rejection using the System for Coding Interaction and Family Functioning)

Table 1 (continued)

Article	Risk factors ^a	Forest plot N ^b	Age at outcome (years) ^c	Male (%)	ADHD measurement (method of assessment)	Country	Study design	Parenting factor measurement
Swing et al. (2010)	Media	1,323	6–12	47	Inattention/impulsivity (ASRS; BSCS, BIS-11)	USA	Sample from obesity prevention study	Parent and child report of TV and videogame exposure (combined average weekly exposure)
Thompson and Tabone (2010)	Maltreatment	242	4	44.3–48.7	Inattention (CBCL)	USA	Longitudinal multisite study of high-risk infants	Maltreatment based on case record review (includes physical abuse, sexual abuse, and neglect)
Umemura et al. (2015)	Parenting	85	7	n/a	ADHD symptoms (CBCL and TRF composite)	USA	Longitudinal pregnancy follow-up study	Observer rating of and negativity/harsh discipline (Parental Coping with Children's Negative Emotions Questionnaire)
Wolfe and Mosk (1983)	Maltreatment	70	6–16	45.7–51.4	Hyperactivity (CBP)	Canada	Case control study of abused agency cases, non-abused agency cases, and community groups	Maltreatment based on case record review or on observation (includes physical aggression and coercion)
Zimmerman and Christakis (2007)	Media	391	5–10	n/a	Inattention (BPI)	USA	Longitudinal survey, nationally representative, Panel Survey of Income Dynamics	Parent report (time diary) of violent media exposure (average hours daily)
Ziv et al. (2010)	Parental incarceration	1,347	n/a	50–51.1	Hyperactivity (BPI)	USA	Nationally representative survey (Head Start Family and Child Experiences Survey)	Parent incarceration based on parent report of arrest or charges against household member including parent

ADHDT Attention Deficit Hyperactivity Disorder Test, *ADHD-RS* ADHD Rating Scale-IV, *ASRS* Adult ADHD Self Report, *BSCS* Brief Self-Control Scale, *BRPC* Behavior Rating for the Pre-school Child, *BIS-11* Barratt Self-Control Scale, *BPI* Behavior Problems Inventory, *CATRSB* Conners Abbreviated Teacher Rating Scale, *CBCL* Child Behavior Checklist, *CBP* Child Behavior Profile, *CPRS-R:S* Conners' Parent Rating Scale Revised, *DAWBA* Development and Well-Being Assessment, *DBD* Disruptive Behavior Disorder Rating Scale, *DICA* Diagnostic Interview for Children and Adolescents, *DISC* Diagnostic Interview Schedule for Children, *DSM-III-R* Diagnostic and Statistical Manual of Mental Disorders, 3rd edition, Text Revision, *DSM-IV* Diagnostic and Statistical Manual of Mental Disorders, 4th edition, *FBF-ADHS-V* preschool version of the ADHD rating scale, *HOME* Home Observation for Measurement of the Environment, *K-SADS-E* Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children, epidemiological version, *NEPSY* developmental neuropsychological assessment, *PACS*, Parental Account of Children's Symptoms, *PrePACS* Parental Account of Children's Symptoms, preschool version, *RBPC* Revised Behavior Problem Checklist, *SBQ* Social Behavior Questionnaire, *SDQ* Strengths and Difficulties Questionnaire, *SNAP* Swanson, Nolan, and Pelham, *SRS* Social Rating Scale, *SWAN* Strengths and Weaknesses of ADHD Symptoms and Normal Behaviors Questionnaire, *TRF* Teacher Report Form, *YSR* Youth Self Report

^aEffect size information was extracted whenever possible, regardless of whether the risk factor was the main variable of interest in a study or was simply included as a covariate or statistical control

^b *N* may differ across forest plots for studies with multiple effect sizes

^cMean ages are reported if available; otherwise, the range is reported

^dChildren who watched ≥ 4 h at one time and < 4 h at the other were not included in the analyses

^eDivorce analyses excluded all cases with maltreatment

Table 1 (continued)

^fMaltreatment analyses excluded all cases with marital disruption

^gCases of neglect were not included in the analyses

^hChildren with between > 0 and < 7 h were not included in the analyses

ⁱThe sample also included formerly divorced/widowed and now reconstructed families who were not included in the analyses

^jChildren with 1–3 h and > 3 h were combined

^kThis study also addressed single parenting (lone parenting) but there were insufficient numbers of studies for continuous outcomes, so lone parenting and step families were not included in the analyses

^lCases with moderate or severe physical abuse without sexual abuse were not included in the analyses

^mJoint trajectory across ages 8–9, 13–14, and 16–17 years, DSM-IV-based symptom scale

ⁿNeglect only cases were not included in the analyses

^oChildren who watched between ½ and 2 h were not included in the analyses

^pChildren who watched between 1 and 3 h were not included in the analyses

^qThe sample also included cohabiting couples who were not included in the analysis. Comparisons were between single and married

^rThe sample also included parent and stepparent families who were not included in the analyses. Comparisons were between single and married/two biological parents

^sThe sample also included children with learning disability, emotional disability, and conduct disorder who were not included in the analyses. Comparisons were between children with ADHD, alone and combined with conduct disorder, and those without diagnoses

Parental Relationship Status

Divorce was significantly associated with risk for ADHD overall for both dichotomous (OR = 2.93; 95% CI: 1.54, 5.55; $k=9$) and continuous (CC = 0.11; 95% CI: 0.04, 0.18; $k=4$) effect sizes. These effect sizes showed significant heterogeneity for dichotomous ($Q_{(8)}=14.32$, $p=0.07$) as well as continuous ADHD overall ($Q_{(3)}=9.48$, $p=0.02$). There were also sufficient studies with dichotomous effect sizes ($k=4$) for an analysis of divorce and ADHD diagnosis. Children of divorced parents had a significantly increased risk of having an ADHD diagnosis later (OR = 4.84; 95% CI: 2.22, 10.56), and this test was not significantly heterogeneous. For single parenting, only dichotomous effect sizes on ADHD overall had enough studies for analysis ($k=5$). The test of heterogeneity was not significant. Single parenting was significantly associated with increased risk of later ADHD in children (OR = 1.61; 95% CI: 1.17, 2.22), and heterogeneity was not significant. There were insufficient studies to separately examine any effects on inattention or hyperactivity.

Parental Incarceration

For research on parental incarceration, only overall continuous effect sizes had enough studies for analysis ($k=3$). Parental incarceration significantly predicted later ADHD overall (CC = 0.10; 95% CI: 0.06, 0.14). The test for heterogeneity was not significant.

Maltreatment

For general maltreatment, the association with ADHD overall was positive for both dichotomous (OR = 7.27; 95% CI: 4.23, 12.49; $k=6$) and continuous (CC = 0.30; 95% CI: 0.18, 0.42; $k=9$) effect sizes. Tests of heterogeneity for general maltreatment were significant for continuous ADHD overall outcomes ($Q_{(8)}=52.82$, $p<0.001$) but not for dichotomous outcomes. General maltreatment was also significantly associated with ADHD diagnosis specifically, using dichotomous effect sizes (OR = 7.63; 95% CI: 3.95, 14.75; $k=5$). There were sufficient studies ($k=7$) to investigate the association of general maltreatment and inattentive symptoms using continuous effect sizes; children who experienced general maltreatment were significantly more likely to show inattentive symptoms (CC = 0.26; 95% CI: 0.12, 0.40), which had significant heterogeneity ($Q_{(6)}=36.54$, $p<0.001$). When investigating specific types of maltreatment, the only type that had sufficient studies for analysis was physical abuse using continuous ADHD outcomes overall ($k=4$). Experiencing

Table 2 Results of the systematic review and meta-analysis of studies examining attention-deficit/hyperactivity disorder (ADHD) outcomes for selected parenting risk factors

Risk factor	Outcome measure	ADHD overall		ADHD diagnosis only		Inattention		Hyperactivity/impulsivity	
		Sample size (k^{xx})	Pooled effect size ^{xxi} (95% CI)	Sample size (k)	Pooled effect size ² (95% CI)	Sample size (k)	Pooled effect size ² (95% CI)	Sample size (k)	Pooled effect size ² (95% CI)
Parental relationship status	Dichotomous	11,929 (9)	2.93 (1.54, 5.55) +	2,651 (4)	4.84 (2.22, 10.56)				
	Continuous	3,405 (4)	0.11 (0.04, 0.18) +						
Parental incarceration	Dichotomous	1,174,547 (5)	1.61 (1.17, 2.22)						
	Continuous	4,073 (3)	0.10 (0.06, 0.14)						
Maltreatment	General maltreatment ^{xvii}	1,878 (6)	7.27 (4.23, 12.49)	1,070 (5)	7.63 (3.95; 14.75)				
	Continuous	2,483 (9)	0.30 (0.18, 0.42) +			1,955 (7)	0.26 (0.12, 0.40) +		
Parenting interaction quality	Physical abuse	1,406 (4)	0.39 (0.31, 0.47)						
	Sensitivity/warmth	2,475 (10)	-0.16 (-0.20; -0.12)			1,379 (5)	-0.17 (-0.24; -0.10)	1,054 (5)	-0.14 (-0.21; -0.07)
Child media exposure	Intrusive/reactive	682 (4)	0.17 (0.08; 0.26)						
	Negativity/harsh discipline	3,407 (7)	0.19 (0.06; 0.32) +						
	Media exposure	3,853 (6)	1.94 (1.57; 2.30)			2,049 (3)	1.45 (0.84, 2.50)		
	Continuous	22,235 (9)	0.07 (0.02; 0.12) +			6,395 (4)	0.12 (0.04, 0.20) +		

^x K = number of studies included

^{xii}Pooled effect size is calculated as odds ratio for dichotomous analyses and as a correlation coefficient for continuous analyses. All effect sizes were considered statistically significant at $p < .05$. + indicates tests of heterogeneity statistically significant at $p < 0.05$

^{xvii}Included physical and emotional abuse, neglect, sexual abuse, or unspecified maltreatment

physical abuse was significantly associated with continuous ADHD outcomes overall ($CC = 0.39$; 95% CI: 0.31, 0.47). The test for heterogeneity was not significant.

Parenting Interaction Quality

Among possible factors describing quality of parent–child interaction, three emerged as having sufficient studies to estimate pooled effect sizes for continuous ADHD overall. Pooled data from a cluster of 10 studies measuring sensitivity/warmth showed a negative correlation with continuous ADHD outcomes overall ($CC = -0.16$; 95% CI: $-0.20, -0.12$) and data from 4 studies investigating intrusive/reactive interaction behavior showed a positive correlation with continuous ADHD outcomes overall ($CC = 0.17$; 95% CI: 0.08, 0.26). Neither of the tests for heterogeneity was significant. Data from the 7 studies investigating negativity/harsh discipline showed a positive association with continuous ADHD outcomes overall ($CC = 0.19$; 95% CI: 0.06, 0.32). For this factor, the test of heterogeneity showed significant heterogeneity ($Q_{(6)} = 57.21, p < 0.001$). As seen in the forest plot (Supplemental Fig. S15), a single study (Morrell & Murray, 2003) showed a correlation that was negative in direction while other effect sizes were all positive. Upon inspection, this correlation coefficient (-0.232) was with a factor described as hostility, which was identical to the coefficient listed for positivity, coded at the same time from the same observation. No reverse coding was mentioned so the possibility of a reporting error could not be excluded. We re-calculated the effect size and heterogeneity for the factor with the correlation coefficient from Morrell and Murray (2003) excluded, and still found significant heterogeneity among the remaining effect sizes.

Of these three parenting interaction factors, only sensitivity/warmth had sufficient studies to examine specific symptoms using continuous outcome scales (inattention and hyperactivity $k = 5$); sensitivity/warmth was inversely correlated with inattention symptoms ($CC = -0.17$; 95% CI: $-0.24, -0.10$) as well as hyperactivity ($CC = -0.14$, 95% CI: $-0.21, -0.07$). Neither set of pooled correlation coefficients was significantly heterogeneous.

Child Media Exposure

For child media exposure, there was a positive association with overall ADHD for both dichotomous outcomes ($OR = 1.94$; 95% CI: 1.57, 2.30; $k = 6$) and continuous outcomes ($CC = 0.07$; 95% CI: 0.02, 0.12; $k = 9$); children with more media exposure were more likely to have ADHD. Pooled effect sizes were significantly heterogeneous for the continuous overall ADHD outcomes ($Q_{(8)} = 83.25,$

$p < 0.001$) but not for the dichotomous overall ADHD outcomes. There were also sufficient studies to examine the association of child media exposure and inattention using dichotomous ($k = 3$) and continuous effect sizes ($k = 4$), and each association was positive and statistically significant ($OR = 1.45$; 95% CI: 0.84, 2.50; and $CC = 0.12$; 95% CI: 0.04, 0.20; respectively). For inattention, pooled estimates for continuous ($Q_{(3)} = 27.74, p < 0.001$) but not dichotomous effect sizes showed significant heterogeneity.

Discussion

The results of the meta-analysis showed a pattern of statistically significant associations between multiple factors related to parenting and later ADHD symptoms and diagnosis. Poorer quality of interaction, maltreatment, divorce and single parenting, and higher child media exposure were statistically significantly associated with an increased likelihood of later ADHD symptoms and diagnosis, and thus emerged as potential risk factors. These findings suggest opportunities for potential prevention of ADHD symptoms through addressing parental risk factors. This study adds to the literature by suggesting that the focus of public health efforts that address outcomes such as maltreatment and positive parenting can be expanded to address these factors as prevention for clinical disorders such as ADHD. However, the results also point to gaps in knowledge, with limited numbers of high-quality studies available to examine the associations more thoroughly.

Overall, maltreatment was most strongly associated with ADHD diagnosis and symptoms; based on the odds ratios, children who experienced maltreatment were about 7 times as likely to have ADHD symptoms or diagnoses than the comparison groups. Based on Cohen's method to estimate variance explained, general maltreatment explained about 9% and physical abuse explained about 15% of the variance in continuous ADHD measures, thus indicating a sizeable association of each type of maltreatment on children's likelihood of developing ADHD symptoms (Chen et al., 2010; Cohen, 1988). Children whose parents experienced separation or divorce were about 3 times as likely to have ADHD overall, including diagnosis or symptoms, based on the odds ratio, showing moderate pooled effects (Chen et al., 2010). Other factors showed smaller pooled effect sizes, indicating that these factors, while statistically significantly associated with the ADHD outcome, may have a smaller impact, or may impact a subset of children who are particularly vulnerable to the risks.

The review indicates that despite decades of research, there are still significant gaps, due to limited high-quality studies that contained the necessary data for inclusion in this meta-analysis. Most factors included in these analyses could

only be examined for overall ADHD outcomes; few factors had enough studies that met inclusion criteria to examine associations with inattention or hyperactivity/impulsivity separately. For inattention, general maltreatment, higher child media exposure, and lower sensitivity/warmth during interactions emerged being statistically significantly associated. For hyperactivity, only sensitivity/warmth could be evaluated and was inversely associated. The analyses of specific outcomes showed similar magnitude for pooled effects as for the overall ADHD analyses, thus not pointing to differential associations of these factors on specific symptoms.

The data support associations between these parenting and family environment factors and child ADHD. There are multiple possible pathways by which they are related, such as directly through the parent–child relationship, indirectly through factors that parents may influence, or through common risk factors that affect both the child and the parent, including genetic factors. These possible pathways are likely to each play a role and thus present multiple opportunities for prevention and intervention (Faraone et al., 2021).

As established in previous research, parenting can have a strong influence on child development (NASEM, 2016b). The quality of the parent–child relationship and the cumulative effect of parent–child interactions has a measurable influence not just on observable behavior but also on underlying cognitive and emotional processes, including those that underly ADHD (Pallini et al., 2019). Adverse parenting such as insensitivity, lack of responsiveness, or maltreatment can have a negative effect on brain development, whereas sensitivity and supportive parenting particularly in early childhood is significantly related to more optimal structural brain development (Belsky & de Haan, 2011; Kok et al., 2015). Such impact on brain development in turn can influence the development of ADHD symptoms (Humphreys & Zeanah, 2015; Jimenez et al., 2017; Strathearn et al., 2020) and also of executive function skills, which play a major role in ADHD (Hughes & Devine, 2017; Pallini et al., 2019).

Parents and children also may have shared risk for ADHD, adding to the intergenerational transmission of ADHD, and thus pointing to the family needing support as a unit, rather than the child with a diagnosis alone. Heritability of ADHD has been well documented, showing that genes can contribute to the probability of developing ADHD (Faraone & Larsson, 2019; Faraone & Mick, 2010; Freitag & Retz, 2010). Parents who share the genetic vulnerability and themselves have ADHD symptoms such as inattention or impulsivity may make different reproductive choices such as having children at a younger age or having more children (Ni et al., 2019), may have more difficulty providing resources for their children (Rowland et al., 2018), and may struggle more than other parents with creating a predictable and consistently supportive environment for their child (Storebø et al., 2013). Some parents with a history of

ADHD symptoms may have experienced adversity in their own childhood, and may have lacked positive role models, which increases the risk of ADHD symptoms in their offspring (McDonald et al., 2019; Park et al., 2017; Radesky et al., 2014; Roberts et al., 2018). Parents of children with ADHD may be at a higher risk of mental disorders, which further contributes to the likelihood of children developing ADHD (Robinson et al., [this issue](#)). Thus, the genetic vulnerability towards ADHD that parents may share with their child is also associated with the parenting factors that may contribute to the child's symptoms of ADHD. Moreover, animal and emerging human research suggests parents' own trauma history can result in epigenetic changes associated with stress reactivity and regulation which then can be transmitted to their offspring (Hays-Grudo & Morris, 2020) pointing to additional possible pathways of influence and of opportunities for intervention.

The present analysis included parenting factors that preceded the assessment of ADHD symptoms or the diagnosis of ADHD, but possible causal pathways by which parents contribute to ADHD symptoms are likely to be one part of a much larger, complex pattern of possible influences (Faraone et al., 2021). Early signs of ADHD may have already been present in the child before ADHD outcomes were measured. As parenting can influence child development, children can also influence parenting (Darling Rasmussen et al., 2019; Johnston et al., 2012). Children who are predisposed to develop ADHD may show early neuro-atypical characteristics such as lacking attention to social cues, acting impulsively, and not attending to consequences of actions that may present challenges for parents (Deault, 2010; Johnston et al., 2012) and affect the quality of the parent–child relationship (Darling Rasmussen et al., 2019). ADHD may impact how children perceive and react differently to their parents' behavior and thus influence parenting styles (Molina & Musich, 2016), particularly given the increased likelihood of co-occurring behavior disorders (Deault, 2010).

Moreover, ADHD is associated with several child physical health risks (Bitsko et al., [this issue](#); So et al., [under review this issue](#)). Combined with an elevated likelihood for environmental risks (Dimitrov et al., [under review this issue](#)) and parental risks such as poor mental health and substance abuse (Maher et al., [this issue](#); Robinson et al., [under review this issue](#)), these risk factors may place additional demands on the subset of parents who experience risks themselves (Deault, 2010). Thus, by the time the child is diagnosed with ADHD (typically early school age), a range of parental and child factors related to ADHD may have jointly impacted the child's developmental trajectory.

In addition, it is also likely that both the parenting factors and ADHD are affected by other factors and potentially functioning as flags for underlying risks. For example, divorced and single parents can fully support their child's healthy development, but among groups of children, those whose

parents are divorced may have higher odds of experiencing family conflict, and single parenting has higher odds of economic disadvantage (Aizer, 2017; Bramlett & Mosher, 2002). Similarly, parental incarceration is more prevalent in households with lower income and lack of resources (Geller et al., 2009). Adverse experiences may compound risk, such as socioeconomic risks coupled with increased difficulties with relationships and decreased ability to cope with adversity, as well as increased chance of exposing the child to violence along with poor parenting and mental health issues, pointing to a cluster of disadvantages across the factors measured in this paper (Fredland et al., 2018; Roberts et al., 2018; Schickedanz et al., 2018). Nationally, early indicators of self-regulation are associated with social determinants of health such as living in financially and socially disadvantaged families and communities, and experiencing family adversity (Claussen et al., 2021). Such lack of resources and support, in turn, may make life more challenging, increase the likelihood of depression and anxiety, and decrease the parents' ability to help their child manage their behavior (Deault, 2010; Johnston et al., 2012; Robinson et al., [this issue](#)). Lack of resources may serve as a marker for communities that are unable to provide necessary supports, which may compound parenting challenges (Midouhas et al., 2014).

It may also be possible that parenting factors influence other conditions that are commonly co-occurring with ADHD and that the presence of these conditions can make ADHD symptoms worse. For example, there is stronger evidence for media exposure as a risk for obesity and depression than for ADHD symptoms (Stiglic & Viner, 2019). Given co-occurrence of obesity and depression with ADHD (Danielson et al., 2018; Li et al., 2020), it is unclear whether the association of media exposure and ADHD would remain if controlling for these co-occurring outcomes, but presence of multiple conditions may warrant additional need for support.

Strengths and Limitations

The meta-analysis had multiple strengths. It specifically focused on studies where the exposure preceded the ADHD outcome. We also included ADHD symptoms, rather than relying only on existing diagnosis (see Table 1). Finally, the studies included large datasets as well as smaller samples, included males and females, and drew on data from multiple countries, broadening the scope of inquiry.

There were also several limitations. As discussed, causal pathways cannot be determined from any of the included studies in our meta-analysis. We observed significant heterogeneity for multiple potential risk factors examined, suggesting variability in the magnitude or direction of estimates from individual studies. This finding may not be surprising, as the studies were from different countries, employed different study designs, and used different measurement approaches

for risk factors and ADHD outcomes. Therefore, factors had a common conceptual definition but were assessed in different ways. For example, media exposure included studies that examined exposure to TV (Cheng et al., 2010; Landhuis et al., 2007; Mistry et al., 2007) and TV and gaming (Poulain et al., 2018; Stevens & Mulsow, 2006; Swing et al., 2010), as well as exposure to violent TV content (Fitzpatrick et al., 2012) or violent TV and gaming (Parkes et al., 2013). Given that content, pacing, and duration of media exposure may well have differential effects on symptoms (Beyens et al., 2018), such variability may have contributed to heterogeneity. Bias in assessment may also affect heterogeneity; while qualitative constructs such as sensitivity and responsiveness apply across cultures (Claussen & Crittenden, 2000), the behaviors used to measure sensitivity or responsiveness may be impacted by racial, ethnic, and cultural bias (Guerrero et al., 2021). Furthermore, studies used different types of data sources, for example, maltreatment included case records and assessed reported maltreatment, but also utilized parent report (Becker-Blease & Freyd, 2008; Simmel et al., 2001), child self-report (Haj-Yahia & Abdo-Kaloti, 2008; King et al., 2011; Sesar et al., 2008), or observation (Wolfe & Mosk, 1983). The studies of maltreatment varied in whether they focused on physical abuse, neglect, sexual abuse, psychological maltreatment, or combinations thereof, even though these may have different effects on children's development (Strathearn et al., 2020) thus impacting heterogeneity.

Variability in the measured ADHD outcomes may also impact the heterogeneity. Studies included parent, teachers, case record review, clinical diagnosis, and direct child observation. Generally, ADHD symptoms vary among children and present differently across context, different observers may witness dissimilar behaviors, and single assessments may not capture all facets. For case records, the validity of the original diagnosis often cannot easily be ascertained, and parents with poor parenting skills may not be reliable observers of behavior concerns (Bennett et al., 2006; Lau et al., 2006), thus adding a potential source of error or bias. Thus, while the overall analyses showed statistically significant associations that were generally consistent in direction (positive or negative), such heterogeneity limits the ability to interpret the accuracy of the magnitude of the pooled estimates. For multiple factors such as divorce, maltreatment, negativity/harsh punishment, and media exposure, several of the presented pooled effect sizes need to be interpreted with caution.

Co-occurring disorders were not assessed systematically or in detail across studies. Thus, it is unclear whether symptoms of ADHD may have been caused by other conditions with similar symptoms, such as difficulties with attention and regulation due to learning disorders or sleep disorders (Wolraich et al., 2019). Trauma in specific may be likely to occur with maltreatment and unsupportive parenting, and careful clinical diagnosis beyond use of rating scales may be needed to differentiate symptoms of trauma from ADHD

(Wolraich et al., 2019; American Psychiatric Association, 2013). Moreover, factors such as parental mental disorders were also not consistently taken into considerations in these studies.

The diversity of studies drawing from samples from different countries and using different study design also represents a limitation. With samples ranging from population samples, community samples, convenience samples, to clinic samples, it is not possible to adjust for selection bias and other confounding variables.

We were also not able to assess several parenting factors of interest due to fewer than three effect sizes from studies that met inclusion criteria. For example, physical neglect or sexual abuse may have a different impact on children than physical abuse, but insufficient data were present to examine those factors. The available literature also did not allow a thorough examination of ADHD diagnosis, hyperactivity, or impulsivity as separate from the overall outcome for many parenting factors of interest. Other factors relevant to parenting may have also been missed by the search strategy given that it was focused on a broad range of factors rather than focused on all possible relevant search terms related to parenting (Bitsko et al., [this issue](#)).

Gaps and Future Directions

In addition to the reported findings, this meta-analysis revealed gaps in the literature on parenting factors and ADHD. Between 2014 and early 2021, only 7 studies had sufficient details to meet the criteria for inclusion in this paper. Important factors such as the interaction of child sex, socioeconomic, and parenting factors on ADHD outcomes could not be examined. Future studies can examine which factors predict hyperactive/impulsive versus inattentive symptoms and the impact of different measures of ADHD (e.g., clinical, observational, parent or teacher report). More thorough research could contribute to understanding which among the possible causal pathways may play stronger roles, and for which subsets of parents and children these risk factors play a role.

Implications for Public Health and Prevention

The parenting factors associated with ADHD identified in this analysis point to potential targets for lowering the odds of children having clinically significant ADHD symptoms and receiving an ADHD diagnosis. Given heritability and multiple causal pathways of influence, interventions are unlikely to prevent overall occurrence of ADHD symptoms, but may lessen the severity and impact on functioning, thus lessening the odds of meeting diagnostic criteria. The focus of well-established public health efforts to improve healthy child development, such as preventing maltreatment CDC, 2016; Fortson et al., 2016), can be expanded to address clinically diagnosed disorders such as ADHD. Even when specific

parenting factors contribute only modestly to individual risk, supporting parents may have a notable impact on population health given the considerable challenges that parents face (NASEM, 2016b). Strategies to support parents by enhancing their parenting skills and by promoting their own health and well-being can promote positive outcomes in children (NASEM, 2019a).

Expanding access to parenting intervention may improve outcomes. Significant evidence exists that behavioral parenting interventions have a positive effect on ADHD symptoms (Epstein et al., 2015; Evans et al., 2018). In fact, for young children with ADHD, parent behavior training is the recommended first-line treatment because it has the best evidence to benefit children and parents (Barbarese et al., 2020; Rimestad et al., 2016; Wolraich et al., 2019). Many of the evidence-based parenting interventions for ADHD were also used to prevent maltreatment (Altafim & Linhares, 2016), demonstrated effectiveness for children who have ADHD and other conditions such as anxiety (Lebowitz et al., 2020), and can be used if a diagnosis of ADHD may not be easily ascertained (Barbarese et al., 2020). By decreasing behavior problems in at-risk populations, parenting interventions can be used as prevention (van Aar et al., 2017). For parents who themselves struggle with ADHD symptoms while raising children at risk for ADHD, interventions may benefit from adaptation to individual families' needs and to address factors in the home and community so parents can change their own behaviors and cognition to support their child's development more effectively (Johnston et al., 2012).

Interventions that are centered on the whole family may benefit parents and children with ADHD. Strategies that support parenting, promote parental mental health, and address stress may prevent or reduce the impact of childhood mental disorders including ADHD (NASEM, 2019a). For example, given the possible connection between family conflict, divorce, and maltreatment, supporting families during the process of divorce with mediation and mental health support may positively impact children's development (D'Onofrio & Emery, 2019). However, many families face substantial barriers when trying to access treatment and support for children's behavioral health; therefore, public health strategies may benefit from including efforts to identify barriers to access to behavioral health interventions and to reduce such barriers, including by addressing funding and payment challenges (Brundage & Shearer, 2019; So et al., 2019). From a public health perspective, supporting parents may also include public health education on specific parenting topics, for example, by working with health-care providers to inform parents about appropriate limits on screen media (American Academy of Pediatrics, 2016) or by directly providing parents with tools and resources to learn behavioral strategies to support their children and cope with parenting challenges (NASEM, 2021).

For public health, supporting parents can include addressing the social determinants of risk and adversity (CDC, 2019), family conflict and violence (CDC, 2016; Fortson et al., 2016), and the root cause of structural inequalities of parental incarceration and trauma (Bailey et al., 2021). Support for parents may also be provided by directly reducing factors that negatively impact parenting such as lack of resources, health disparities, and systemic disadvantages (NASEM, 2016). Given that ADHD is associated with increased socioeconomic risk, which can be transmitted intergenerationally (Aizer, 2017), interventions that support parents and decrease poverty-associated challenges (CDC Foundation, 2020; Hamad & Rehkopf, 2016) may also improve outcomes for children with ADHD, potentially decreasing the number of children who will be diagnosed with ADHD. For example, the Earned Income Tax Credits which may benefit children's mental health overall (CDC Foundation, 2020) could potentially improve ADHD outcomes as well. Systemic approaches that address adverse childhood experiences (ACEs) such as child maltreatment, separation, and parental incarceration, may prevent long-term negative consequences for health and development that compound the impact of ADHD (CDC, 2019; Fortson et al., 2016; Jimenez et al., 2017). In addition to broadening access to evidence-based parenting programs and high-quality early childhood programs, prevention of adverse childhood experiences can include strengthening household financial security, supporting family friendly work policies, and enhancing norms that protect against violence (CDC, 2019). A broad approach to supporting parents may result in decreasing risk for ADHD symptoms and in strengthening factors that allow children with ADHD to live healthy and supported lives.

Appendix. Search terms

Component	Search terms
Attention-deficit/hyperactivity disorder (ADHD)-related terms	((("attention deficit") OR ("hyperactivity disorder*") OR ("deficit hyperactiv*") OR ("ADHD") OR ("deficit disorder*") OR ("minimal brain dysfunction") OR ("minimal brain damage") OR ("MBD") OR ("brain injured child syndrome*") OR ("hyperactive child syndrome*") OR ("hyperactive syndrome*") OR ("impulse disorder*") OR ("hyperkinetic disease") OR ("hyperkinetic syndrome*") OR ("hyperkinetic reaction of childhood")) OR (("ADD" AND (disorder OR attention OR hyperactiv*))) OR (("attention problem*") OR ("inattenti*") OR ("hyperactiv*") OR ("hyperkines*"))

Component	Search terms
Child health terms	AND ((("nutrition*") OR ("deficienc*") OR ("iron") OR ("ferritin") OR ("transferrin") OR ("anemia") OR ("copper") OR ("zinc") OR ("magnesium") OR ("polyunsaturated fatty acids") OR ("fatty acid*") OR ("folate") OR ("nutritional surplus*") OR ("fat") OR ("sugar*") OR ("sodium") OR ("food additive*") OR ("food color additive*") OR ("food color*") OR ("FD&C Yellow") OR ("FD&C Red") OR ("preservatives") OR ("sodium benzoate") OR ("diet") OR ("IgG") OR ("western diet") OR ("malnutrition") OR ("electronic*") OR ("television") OR ("TV") OR ("video game*") OR ("screen time") OR ("sleep") OR ("built environment") OR ("nature") OR ("green space") OR ("physical activity") OR ("exercise"))
Social environment terms	AND ((("socioeconomic") OR ("SES") OR ("income") OR ("social class") OR ("urban*") OR ("rural*") OR ("conflict") OR ("discord") OR ("stress") OR ("foster care") OR ("single parent*") OR ("institution*") OR ("advers*") OR ("maltreatment") OR ("deprivation") OR ("trauma") OR ("rejection") OR ("discipline") OR ("attachment"))
Follow-up search terms	AND ((("abuse") OR ("neglect") OR ("involvement") OR ("intrusive") OR ("permissive") OR ("sensitive"))

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Declarations

Ethical Approval Not applicable. This study includes analyses of data previously published in the literature.

Informed Consent Not applicable. This study includes analyses of data previously published in the literature.

Disclaimer The findings and conclusions in this manuscript are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Conflict of Interest The authors declare no competing interests.

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