Familial Factors in Children and Adolescents With Attention-Deficit/Hyperactivity Disorder (ADHD): Associations With Symptom Severity and Comorbid Symptoms

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Summary

As the primary, immediate environment of children and adolescents, the family is associated with protective and risk factors for child development, especially child mental health. This familial impact on children's mental health may be attributable to the transmission of genetic material, the parental shaping of the child's environment, and the interaction of genetic and environmental factors. One of the most common mental disorders in childhood and adolescence is attention-deficit/hyperactivity disorder (ADHD).

This cumulative dissertation presents two studies that examined the associations between several family characteristics and
(a) the severity of ADHD symptoms as well as
(b) the presence of comorbid oppositional symptoms
in children and adolescents with a clinical diagnosis of ADHD.

In the first study, a meta-analysis was conducted. A systematic search was run for primary studies that examined associations between various familial factors and child ADHD symptom severity. Suitable primary studies were then quantitatively summarized in a meta-analysis and also qualitatively summarized in a supplemental review. The second study analyzed data from a multicenter intervention study of school-aged children with ADHD (ESCAschool), using structural equation modeling (SEM) to examine the relationships among four familial factors and their respective effects on ADHD and comorbid oppositional symptoms in children.

Both studies identified family characteristics that were associated with increased severity of child ADHD symptoms. Additionally, the findings of the second study support the hypothesis that the economic or (psycho-)social burden of families is associated with parental mental health problems and impairments in parenting, and that these adverse family characteristics are in turn related to increased externalizing behaviors in children.

The findings of the cumulative dissertation emphasize the importance of familial factors for the mental health of children and adolescents.

Zusammenfassung

Als die primäre, unmittelbare Umgebung von Kindern und Jugendlichen ist die Familie sowohl mit Schutz- als auch Risikofaktoren für die kindliche Entwicklung im Allgemeinen und die psychische Gesundheit im Besonderen assoziiert. Der familiäre Einfluss auf die psychische Gesundheit von Kindern und Jugendlichen kann auf die Vererbung genetischer Merkmale, auf die elterliche Gestaltung der Umwelt der Kinder sowie auf die Interaktion von Gen- und Umweltfaktoren zurückgeführt werden. Eine der häufigsten psychischen Störungen im Kindes- und Jugendalter ist die Aufmerksamkeitsdefizit-/Hyperaktivitätsstörung (ADHS).

Im Rahmen der vorliegenden kumulativen Dissertation werden zwei Studien vorgelegt, welche die Zusammenhänge zwischen verschiedenen Merkmalen von Familien und
(a) dem Schweregrad der ADHS-Symptome sowie
(b) dem Vorhandensein von komorbiden oppositionellen Symptomen
bei Kindern und Jugendlichen mit einer klinischen ADHS-Diagnose untersucht haben.

In Rahmen der ersten Studie wurde eine Meta-Analyse durchgeführt. Es wurde systematisch nach Primärstudien gesucht, die den Zusammenhang zwischen verschiedenen familiären Faktoren und dem Schweregrad der kindlichen ADHS-Symptome analysieren. Geeignete Primärstudien wurden anschließend quantitativ und im Rahmen eines ergänzenden Reviews auch qualitativ zusammengefasst. In der zweiten Studie wurden Daten aus einer multizentrischen Interventionsstudie zu ADHS im Schulalter (ESCAschool) mithilfe eines Strukturgleichungsansatzes (SEM) analysiert, um die Beziehung zwischen vier familiären Faktoren und deren jeweilige Effekte auf ADHS-Symptome sowie auf komorbide oppositionelle Symptome bei Kindern zu untersuchen.

In beiden Studien wurden Merkmale von Familien identifiziert, die mit einer gesteigerten Ausprägung von kindlichen ADHS-Symptomen einhergehen. Darüber hinaus untermauern die Befunde der zweiten Studie die Hypothese, dass eine ökonomische oder (psycho-)soziale Benachteiligung von Familien mit psychischen Problemen der Eltern und beeinträchtigten Erziehungsverhaltensweisen einhergeht und diese ungünstigen familiären Merkmale mit gesteigerten externalen Verhaltensweisen bei Kindern assoziiert sind.

Die Ergebnisse der beiden Studien der vorliegenden, kumulativen Dissertation betonen die Bedeutung familiärer Faktoren für die mentale Gesundheit von Kindern und Jugendlichen.

List of Abbreviations

AIC	Akaike information criterion
ADHD	Attention-deficit/hyperactivity disorder
BIC	Bayesian information criterion
CFI	Comparative fit index
CD	Conduct disorder
CI	Confidence interval
CFA	Confirmatory factor analysis
DSM	Diagnostic and Statistical Manual of Mental Disorders
ESCAlife	Evidence-based, Stepped Care of ADHD along the lifespan (research network)
ESCAschool	Evidence-based, Stepped Care of ADHD in school-aged children (clinical trial)
FAI	Family Adversity Index
ICD	International Statistical Classification of Diseases and Related Health Problems
MCAR	Missing completely at random
MI	Modification indices
MAS	Multiaxial Classification System
ODD	Oppositional defiant disorder
QoL	Quality of life
RMSEA	Root mean square error of approximation
SES	Socioeconomic status
SRMR	Standardized root mean square residual
SEM	Structural equation modeling

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1 Introduction

This cumulative thesis focuses on the family, as children's immediate environment, and discusses which characteristics within a family are associated with externalizing behaviors in children and adolescents. The term externalizing behaviors is used to refer to symptoms of attention-deficit/hyperactivity disorder (ADHD), oppositional defiant disorder (ODD), and conduct disorder (CD; American Psychiatric Association, 2022). The overriding aim was to examine associations of various familial factors with ADHD symptom severity and comorbid oppositional symptoms in children and adolescents with a clinical diagnosis of ADHD. There is compelling evidence that genes play a central role in causing ADHD, but at the same time, this does not exclude the environment as a source of etiology (Faraone et al., 2015; Faraone et al., 2021; Kennedy et al., 2016; Kian et al., 2022). Nevertheless, environmental factors, including familial factors, appear to be most significant for the severity of ADHD symptoms (Claussen et al., 2022; Hinshaw et al., 2015).

Chapter one of this thesis provides information on the classification of ADHD according to the two most common systems used to classify mental disorders (Diagnostic and Statistical Manual of Mental Disorders [DSM], American Psychiatric Association, 2022; International Statistical Classification of Diseases and Related Health Problems [ICD], World Health Organization, 2016). Furthermore, the chapter outlines the prevalence rate of ADHD, common comorbid problems, ADHD-related impairments in children, and the economic costs of this disorder. The current state of research on the etiology of ADHD, involving genes and environment, is reported and the importance of the child's family for child development in general and child externalizing problems in particular is clarified. Finally, the objectives of the two studies of the present cumulative thesis are described.

Chapter two contains the two scientific publications of this cumulative dissertation, which provide a detailed description of the methods and results of the thesis. The first study systematically reviewed primary studies examining associations between family characteristics and the severity of symptoms in children and adolescents diagnosed with ADHD (cf. Jendreizik, von Wirth, et al., 2022). The second study investigated the interrelationships of four familial factors and their effects on ADHD and comorbid symptoms in children diagnosed with ADHD (cf. Jendreizik, von Wirth, et al., 2022).

Chapter three summarizes and discusses the results of the two peer-reviewed studies, and presents initial suggestions for subsequent analyses to further explore the research questions of this thesis. Finally, a conclusion is provided based on the two studies in this thesis.

1.1 Classification, Prevalence, Impairments, and Economic Costs of ADHD

Inattention, hyperactivity, and impulsivity are defined as the core symptoms of ADHD (American Psychiatric Association, 2022). According to the *Diagnostic and Statistical Manual of Mental Disorders* in its fifth edition (text revision, DSM-5-TR), a diagnosis of ADHD requires the presence of at least six of the nine criteria for inattention (e.g., fails to give close attention to details or makes careless

mistakes) and/or at least six of the nine criteria for hyperactivity and impulsivity (e.g., often leaves seat in situations when remaining seated is expected; often interrupts or intrudes on others), which should exceed norms regarding age, developmental level, and intelligence level (American Psychiatric Association, 2022). Depending on whether the criteria are met for only one or both domains, the specifier of predominantly inattentive, predominantly hyperactive-impulsive, or combined type is assigned. Further criteria for an ADHD diagnosis are (a) onset of first symptoms before the age of 12, (b) presence of symptoms in multiple settings (e.g., home, school, peer contact), (c) presence of symptoms for at least six months, and (d) impairment in social, educational, or occupational functioning. Finally, the symptoms must not occur in relation to schizophrenia or any other psychotic disorder and should not be better explained by other mental disorders (e.g., affective disorder, anxiety disorder, substance disorder; American Psychiatric Association, 2022). An alternative, widely used classification system is the *International Statistical Classification of Diseases and Related Health Problems* (World Health Organization, 2016). However, with the implementation of the 11th version of the ICD, which came into effect globally on 01.01.2022, the classification of ADHD is broadly consistent with the DSM-5-TR (Döpfner & Banaschewski, 2022).

The worldwide prevalence of ADHD in children and adolescents, according to the DSM or ICD, was found to lie at 3.4% (Polanczyk et al., 2015) and independent of geographical location (Polanczyk et al., 2014). As the rate of ADHD diagnoses has increased over the past three decades, there has been some debate about whether the true prevalence of ADHD has increased (Polanczyk et al., 2014). However, in their meta-analysis, Polanczyk et al. (2014) found no evidence of increased prevalence rates of ADHD when standardized diagnostic procedures were implemented. During childhood and adolescence, boys are twice likely as girls to receive an ADHD diagnosis (Willcutt, 2012). Although most children no longer meet the full criteria for ADHD in adulthood, subthreshold, impairing symptoms of ADHD persist into adulthood in two thirds of cases (Faraone et al., 2006). Children and adolescents diagnosed with ADHD often show educational underachievement, have special educational needs, drop out of school, or are subject to school exclusion (Breslau et al., 2011; Fleming et al., 2017). Later in life, individuals with ADHD frequently show reduced work performance, experience unemployment, and have a lower socioeconomic status (Faraone et al., 2015). In addition, children and adolescents with ADHD often have impaired peer relationships (Strine et al., 2006) and are more likely to suffer accidents or injuries (e.g., Chang et al., 2014; Yeh et al., 2020). In adolescence and adulthood, individuals with ADHD are more likely to experience marital discord and divorce, as well as incarceration (Faraone et al., 2015; Mohr-Jensen et al., 2019). Finally, studies have demonstrated impaired quality of life (Agarwal et al., 2012; Danckaerts et al., 2010; Lee et al., 2016) and an increased mortality rate (e.g., Dalsgaard et al., 2015) in individuals with ADHD.

The adverse outcomes of ADHD entail high economic costs for patients, their families, and society. An analysis of claims data from a German statutory health insurance database, for instance, revealed that patients with ADHD cost roughly 1500 euros more per year than patients without ADHD (Libutzki et al., 2019). These costs are mainly driven by inpatient and outpatient care provided by psychiatrists and psychotherapists and are further increased when other medical problems (e.g., substance use disorders, obesity) are present (Libutzki et al., 2019).

1.2 Oppositional Defiant Disorder, Conduct Disorder, and Other Comorbidities of ADHD

Comorbid mental disorders are highly prevalent in individuals with ADHD and increase the associated burden (Cuffe et al., 2020). The most common psychiatric diagnoses coexisting with ADHD include oppositional defiant disorder (ODD, 50-60%) and conduct disorder (CD, 20-50% in children and 40-50% in adolescents; Reale et al., 2017). The central feature of ODD are defiant, disobedient, and hostile behaviors toward authority figures lasting at least six months and causing significant impairment in the child's life (American Psychiatric Association, 2022). Some typical behaviors include losing one's temper, arguing with adults, deliberately provoking people, and blaming others for one's misbehavior (American Psychiatric Association, 2022). This behavioral disorder usually begins in early childhood and the corresponding behaviors occur more frequently and intensely than in children of comparable age and developmental level. The central feature of CD is the violation of others' rights through physical aggression towards people or animals, theft, property damage, or serious violations of rules (American Psychiatric Association, 2022). For a diagnosis of CD, at least three of the 15 behaviors listed in the DSM-5-TR must have been overtly present in the past year, and at least one behavior must have occurred in the past six months. Furthermore, the DSM-5-TR provides for the assignment of two specifiers of CD: (a) early onset (before the age of 10) vs. late onset (after the age of 10) and (b) with vs. without callous-unemotional traits (American Psychiatric Association, 2022).

Further comorbid diagnoses likely to co-occur with ADHD – albeit much more rarely than ODD and CD – are depressive disorders (16-26%), anxiety disorders (10-40%), bipolar disorder (11-75%), tic disorders (20%), and obsessive-compulsive disorder (6-15%; Reale et al., 2017). Children and adolescents with ADHD also frequently exhibit learning disabilities (56%) and sleep disorders (23%; Reale et al., 2017). Accordingly, the proportion of children and adolescents with at least one other psychiatric diagnosis is estimated to lie between 40% and 80% (depending on the sample), with higher rates among clinically referred children with ADHD (Reale et al., 2017). In addition to mental health problems, individuals diagnosed with ADHD are more likely to exhibit non-psychiatric health problems including obesity, asthma, diabetes mellitus, epilepsy, and sleep problems (Bertelsen et al., 2016; Brikell et al., 2018; Chen et al., 2018; Chou et al., 2013; Cortese et al., 2018; Kapellen et al., 2016; Nigg et al., 2016; Sedky et al., 2014).

1.3 Etiology of ADHD, ODD, and CD

Genetic factors play a major role in the development of ADHD. Parents and siblings of patients with ADHD have a four- to ninefold increased risk of also having ADHD compared with relatives of controls (Biederman et al., 1992; Chen et al., 2008). Adoption studies demonstrate that adoptive parents of children with ADHD have significantly lower rates of ADHD than biological parents of children with ADHD, and similar rates to biological parents of control children (Sprich et al., 2000). As such, it can be assumed that the familial aggregation of ADHD is due to genetic factors rather than shared environmental factors. In twin studies, the heritability of ADHD (reflecting the impact of genes and gene-environment interactions) has been estimated at 74%, with heritability estimates being similar for males and females and for the inattentive and impulsive/hyperactive domain of the disorder (Faraone & Larsson, 2019). A genome-wide association meta-analysis comprising approximately 20,000 individuals with ADHD and 35,000 controls found multiple genetic risk variants, although each risk variant alone had only a small effect on the risk for the disorder (Demontis et al., 2019). Accordingly, in most cases of ADHD, the combination of many genetic variants, each exerting a small effect, generates a polygenic risk for the disorder. In rare cases, however, a single genetic abnormality may lead to ADHD (Faraone & Larsson, 2019). Interestingly, the polygenic risk for ADHD seems to be associated not only with ADHD symptoms in clinical and population samples but also with general childhood psychopathology and several other mental disorders (Brikell et al., 2020; Lee et al., 2019; Ronald et al., 2021). For instance, research has reported an increased polygenic risk in ADHD patients with comorbid ODD and CD symptoms compared to those with ADHD alone (Demontis et al., 2021; Hamshere et al., 2013). Furthermore, Demontis et al. (2021) identified gene loci that represent a specific risk locus for ADHD (chromosome 1), a specific risk locus for comorbid symptoms (chromosome 11), or a shared risk locus for ADHD and comorbid symptoms (chromosome 7). The heritability of ODD and CD is estimated to be slightly lower than that of ADHD (Coolidge et al., 2000).

The strong evidence for genes as risk factors for all three externalizing disorders (ADHD, ODD, CD) does not exclude the environment as a source of etiology. The very fact that the heritability estimates in twin studies (encompassing gene-environment interactions) are below 100% suggests that environmental factors must be involved. Based on case-control, observational, and epidemiological studies, many environmental factors have been identified to be associated with the presentation of ADHD. Environmental factors that have reached a high level of evidence include prenatal and perinatal factors (e.g., maternal smoking or hyperthyroidism during pregnancy or low birth weight), environmental toxins (e.g., exposure to lead), and individual psychosocial factors (e.g., child maltreatment or social status of the family; see Faraone et al., 2021 for a complete overview). Although there is strong evidence for a causal role of some environmental factors, for others, it can be assumed that the uncovered associations are attributable to correlated genetic and environmental

effects. For example, the widely confirmed association between maternal smoking during pregnancy and child ADHD is suspected to be due to familial or genetic factors that increase the risk for both maternal smoking and child ADHD (Obel et al., 2016; Skoglund et al., 2014). However, similar to genetic risk factors, each environmental factor alone exerts only a small effect, and is not specific to ADHD but rather associated with multiple mental disorders (Faraone et al., 2015). In rare cases, though, severe deprivation in early life can lead to ADHD (Kennedy et al., 2016). While there is considerable overlap in the environmental factors associated with ADHD, ODD, and CD, it has not been sufficiently explored whether individual environmental factors are more strongly associated with one or two of the three externalizing disorders than with the other(s). To summarize, in most patients, a polygenic risk that accumulates with environmental risk factors causes ADHD, ODD, and/or CD (Azeredo et al., 2018).

1.4 The Importance of the Family for Child Development and Child Psychopathology

In childhood and adolescence, the family represents the child's primary environment and is associated with risk and protective factors for child development (Bronfenbrenner, 1986; Claussen et al., 2022). The primary caregivers (hereinafter referred to as parents) bear a special responsibility for the upbringing of their children, shaping everyday family life and equipping their children for later life (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2021; Grusec, 2011). One of the most commonly studied familial factors influencing child development and psychopathology is the quality of the parent-child interaction (Cowan & Pape Cowan, 2015). Studies on the effects of parenting practices have used a large variety of research approaches and assessment methods, and have yielded a strong evidence base for the impact of parenting practices on child development (Grusec, 2011). The present thesis distinguishes between positive and negative parenting practices: Parents who are attentive, responsive, engaged, and empowering to their children exhibit positive parenting practices. In contrast, parents who respond inconsistently or with annoyance to difficult situations, threaten their child, or swear at their child exhibit negative parenting practices. Since the family makes up the child's immediate environment, various further characteristics of families have been studied with regard to child development and child psychopathology. To gain an overview of the different aspects of the family that potentially affect child development and how these familial factors interact with other environmental factors, Bronfenbrenner's ecological systems theory seems especially valuable.

1.4.1 Ecological Systems Theory

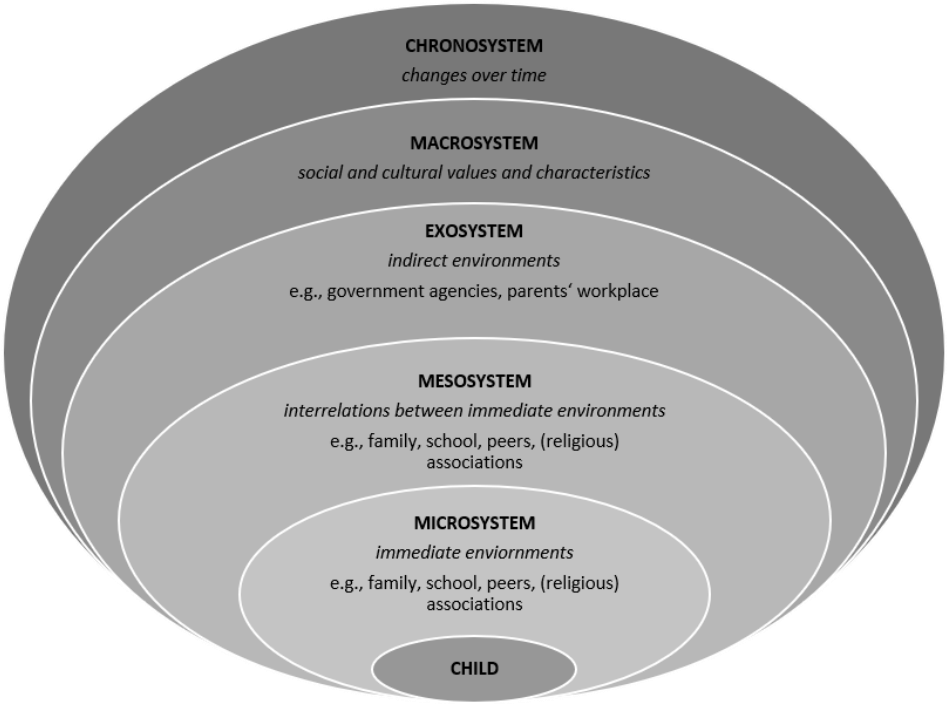
The ecological systems theory describes human development as a mutual adaptation between active, growing individuals and their constantly changing immediate environments (Bronfenbrenner, 1974, 1977, 1979, 1992). Bronfenbrenner described the ecological environment as consisting of the following five systems: micro-, meso-, exo-, macro-, and chronosystem (see Figure 1). First, the microsystem comprises relationships between individuals and their immediate environments, such as parents, siblings, and teachers. Second, the mesosystem is defined as the interrelations between the

immediate actors in an individual's life, such as relationships between parents and teachers or between the individual's friends and family. Third, the exosystem covers social structures that are not in direct contact with the individual but indirectly affect the individual's immediate setting, such as a parent's workplace. Fourth, the macrosystem consists of the features of a particular social group, such as socioeconomic status (SES) or ethnicity (Bronfenbrenner, 1977). Finally, the chronosystem includes all environmental changes – normative (e.g., school enrolment) and non-normative (e.g., parental divorce) events – that occur over the lifetime (Bronfenbrenner, 1986). Since the development of the ecological systems theory to the present day, the holistic approach of this theory has been acknowledged by psychologists, sociologists, and teachers as a valuable framework for studying child development, and the theory is regularly referenced in recent work from various different fields (e.g., Babore et al., 2023; Ferguson et al., 2013; Kelly & Coughlan, 2019; Romano et al., 2015).

There are two central propositions of the ecological systems theory that are particularly meaningful for the present thesis: (a) Multiple, diverse aspects of the child's environment, including the family environment, may be important for child development; (b) Even aspects of the child's environment, including the family environment, that are not in direct contact with the child (e.g., social and cultural values, parental occupational status) sometimes have an indirect influence on the child by affecting systems that are closer to the child (e.g., parenting practices).

Figure 1

Five Systems of the Ecological Systems Theory (own illustration based on Bronfenbrenner, 1974, 1977, 1979, 1992)



1.4.2 Associations of Familial Factors with ADHD, ODD, and CD

The following section presents the state of research on the associations between various familial factors and ADHD, ODD, and CD in children[1]. To facilitate the overview, the findings are grouped according to the following subcategories of familial factors: (a) characteristics and framework of the family (demographic as well as socioeconomic characteristics), (b) mental health of the family members (psychopathologies, quality of life), and (c) intrafamilial interactions and relationships (between the parents as well as between the child and the parents)[2].

In the context of *(a) characteristics and framework of the family*, previous research has examined the associations between family constellation (e.g., living with one parent vs. two parents, number of siblings), parental age, parental educational level, parents' current occupational situation and a diagnosis of ADHD: A meta-analysis by Russell et al. (2016) indicated that children living with single parents are almost twice as likely to have ADHD than their peers in two-parent families. Additionally, parental age appeared to be associated with the risk of child ADHD, with parental age below 20 years showing a 1.5-fold increased risk of ADHD in the offspring (Min et al., 2021). Moreover, meta-analyses and cohort studies indicated that children of parents with a lower educational level and a lower household income are more likely to be diagnosed with ADHD (Choi et al., 2017; Keilow et al., 2020; Russell et al., 2016). Likewise, parental unemployment is related to an increased risk of ADHD (Keilow et al., 2020). The three familial factors mentioned above (education, income, employment) are closely allied to the construct of SES, defined as "the position of a person or group on the socioeconomic scale determined by a combination of social and economic factors, such as income, amount and kind of education, type and prestige of occupation, place of residence, and — in some societies or parts of society — ethnic origin or religious background" (American Psychological Association, n.d.). The aforementioned meta-analysis by Russell et al. (2016) found that a child with low familial SES is twice as likely to have ADHD than a peer with high familial SES. Potential associations of such family characteristics with a diagnosis of ODD or CD have received much less research attention: A meta-analysis reported a small association between lower familial SES and antisocial behavior in children and adolescents (Piotrowska et al., 2015) and one primary study showed an association between lower maternal age at the birth of the child (especially the firstborn) and CD (Wakschlag et al., 2000).

Regarding the *(b) mental health of the family members*, a meta-analysis found that among parents of children with an ADHD diagnosis, 21% also have an ADHD diagnosis, 17% have a diagnosis of depressive disorder, 16% have an anxiety diagnosis, and 14% have an addictive disorder (Cheung &

[1] Note that in this section, most of the research findings are not intended or suitable for drawing conclusions about the direction of the relationships.

[2] There are many ways to group and structure familial factors. Even with the selected subcategories, there are individual factors whose allocation could be discussed.

Theule, 2016). Overall, there were almost three times as many mental disorders among parents of children with ADHD compared to parents of children without ADHD (Cheung & Theule, 2016). This association between a wide variety of parental mental disorders and offspring ADHD was further supported by a nested case-control study using data from the Finnish National Registry (Joelsson et al., 2017). Findings on the links between parental mental health and ODD or CD diagnoses in children have further suggested comparable associations to those for ADHD diagnoses in children (Barker et al., 2012; Marmorstein et al., 2009).

Addressing the third subcategory, *(c) intrafamilial interactions and relationships*, a recent meta-analysis showed that parents of children with ADHD report (slightly but significantly) poorer interparental relationship quality than do parents of healthy children (Weyers et al., 2019). Primary studies have similarly revealed associations between marital quality and ODD and CD diagnoses in offspring (Chaudhury et al., 2020; Harvey et al., 2011). Finally, focusing on parenting, a recent meta-analysis suggested that negative parenting practices are related to higher levels of child externalizing symptoms, whereas positive parenting practices are related to lower levels (Pinquart, 2017). In detail, parental warmth, behavioral control, autonomy granting, and authoritative parenting were associated with lower levels of externalizing behaviors in children. In contrast, harsh control, psychological control, as well as an authoritarian, permissive, and neglectful parenting style were associated with higher levels of externalizing problems in children (Pinquart, 2017). It is undisputed that child abuse or neglect can result in significant harm or injury. Furthermore, (physical, sexual, and emotional) abuse, as well as neglect of a child, are related to a significantly increased risk for psychopathology over the course of development (Zeanah & Humphreys, 2018). For instance, a meta-analysis indicated that individuals with ADHD are twice as likely to have been maltreated during childhood than individuals without ADHD (Clayton et al., 2018). Meta-analyses have also demonstrated that child maltreatment is associated not only with attention problems and hyperactivity but also with aggressive and conduct behaviors (Kim-Cohen et al., 2006; Norman et al., 2012). Furthermore, there is some indication that maltreatment in particular may pose a high risk for developing behavioral problems if a specific genetic predisposition is present (Monoamine Oxidase A genotype; Kim-Cohen et al., 2006).

As early as 1975, Rutter et al. (1975) identified six family risk factors for the onset of mental illness in children and adolescents, combining factors from all three of the aforementioned subcategories: low social class, large family size, foster care placement, paternal criminality, maternal mental disorder, and severe marital discord. Later studies consistently showed that the risk for ADHD and comorbid symptoms increases with the number of family risk factors present (Biederman et al., 1992; Biederman et al., 2002; Østergaard et al., 2016). This accumulation of risk was operationalized as an index of the six factors and subsequently widely used in different versions (Family Adversity Index (FAI); Biederman et al., 1992; Biederman et al., 2002; Rutter et al., 1975).

The methodology of available research focusing on the associations between characteristics in families and ADHD in children can be summarized as follows: (1) various familial factors have already been investigated regarding their association with child ADHD (primary studies); (2) reviews or meta-analyses of the associations with child ADHD are available for some familial factors (secondary studies); (3) only some reviews or meta-analyses provide an overview of a larger group of familial factors; (4) many of the existing reviews or meta-analyses examined familial factors in relation to the presence of a child ADHD diagnosis and thus considered ADHD as a dichotomous variable (present or not); (5) some of the existing reviews or meta-analyses examined familial factors in relation to ADHD symptoms and thus considered ADHD as a continuous variable (e.g., Claussen et al., 2022; Clayton et al., 2018; Connell & Goodman, 2002; Theule et al., 2013); (6) the latter reviews and meta-analyses mainly evaluated studies with healthy (population or control) samples or analyzed studies with healthy and studies with clinical samples together. Finally, to the best of our knowledge, no previous work systematically searched for and quantitatively synthesized findings on the associations of several familial factors and ADHD symptom severity while considering data from clinical samples only (cf. Jendreizik, von Wirth, et al., 2022).

1.5 Aim of the First Study

The first study in this cumulative thesis aimed to review the existing primary studies on the links between multiple familial factors and symptom severity among children and adolescents diagnosed with ADHD (see *Research question 1*). A systematic search was performed and the results of the primary studies were synthesized quantitatively in a meta-analysis (if at least three studies were available) or qualitatively in a supplemental review. The predefined criterion for study inclusion of a clinical ADHD diagnosis of the children and adolescents ensured that the patients studied were representative of patients in routine care in terms of ADHD symptom severity and functional impairments. Finally, identifying significant (continuous) associations between individual familial factors and symptom severity within clinical samples of children and adolescents diagnosed with ADHD is particularly interesting for treatment planning and prognosis, as it highlights potential targets for psychosocial interventions.

Research question 1: Which familial factors are significantly associated with the severity of ADHD symptoms in children and adolescents diagnosed with ADHD (cf. Jendreizik, von Wirth, et al., 2022)?

1.6 Relationships Among Familial Factors (Referring to the Family Stress Model)

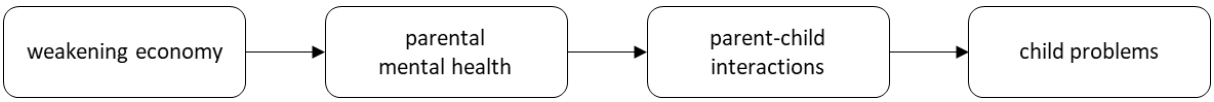
A significant limitation of the literature review conducted within the first study is that while it listed the family characteristics studied with their respective associations with ADHD symptom severity, it did not make any statements about the relationships among these family characteristics. A central assumption of the ecological systems theory (Bronfenbrenner, 1974, 1977, 1979, 1992),

however, is that environmental factors not in direct contact with the child (e.g., societal changes) may influence the child and his/her mental health indirectly, mediated through environmental factors more proximal to the child (e.g., parental mental health and parenting behaviors). Consequently, the relationships among different familial factors and their associations with child symptoms (when several familial factors are considered simultaneously) appeared particularly interesting. For example, one might postulate that a weakening economy negatively affects the mental health of parents, which in turn negatively affects parent-child interactions, ultimately exacerbating the child's problems. From a statistical perspective, these postulated links correspond to a serial indirect effect of an independent variable (weakening economy) on a dependent variable (child problems) via two intervening variables (parental mental health, parent-child interactions, see Figure 2)[3] A model that postulates such associations more explicitly than the ecological systems theory is the family stress model (Conger et al., 1992). This model expressly assumes that a family's economic burden harms the child's mental health by depressing parental mood and impairing parenting behavior (Conger et al., 1992). Several studies have provided evidence to support the assumptions of the family stress model (e.g., Pachter et al., 2006; Rijlaarsdam et al., 2013; Solantaus et al., 2004; Sun et al., 2015). The results of two of these studies, whose methodological approach is most comparable to that of the second study of this thesis, are described in the following. Sun et al. (2015) examined data from 1,420 Chinese families and reported the following findings: Economic burden is indirectly rather than directly associated with externalizing symptoms in children, via parental depression (indirect effect) and via parental depression and negative parenting practices (serial indirect effect). Similarly, an analysis of prospective data from 2,169 Dutch families revealed a significant association between prenatal economic burden and child externalizing symptoms (child's age: 3 years). However, economic burden and child externalizing symptoms were only indirectly associated, insofar as the results revealed serial indirect effects of economic burden on externalizing behaviors in children via more maternal depressive symptoms followed by harsher disciplining (b = .03, SE = .01, β = .05), and via more maternal depressive symptoms followed by more parenting stress (b = .03, SE = .01, β = .05; Rijlaarsdam et al., 2013). The second study of the present cumulative thesis investigated the possible indirect impact of economic and (psycho-)social familial burden (family adversity) on externalizing behaviors in children via parental psychopathology and parenting behaviors (cf. Jendreizik, Hautmann, et al., 2022).

[3] Since the data of some previous studies as well as the data analyzed in the second study of this thesis are cross-sectional, with reference to Kline (2015), the term (serial) indirect effect is used throughout this paper and the term (serial) mediation or mediator is avoided whenever possible.

Figure 2

Hypothetical example of a serial indirect effect of a weakening economy on child problems via parental mental health and parent-child interactions



Note. A serial indirect effect is characterized by one independent variable (here: weakening economy), one dependent variable (here: child problems), and two sequential intervening variables (here: parental mental health and parent-child interactions). A (simple) indirect effect differs from a serial indirect effect in that there is only one intervening variable (e.g., weakening economy → parental mental health → child problems).

1.7 The Moderating Impact of Age and Gender of the Child

Potentially, the described associations between familial factors and child symptoms may be dependent on the age and gender of the child. As school-age ADHD and ODD are less common in girls than in boys, almost all of the research has focused on boys and has neglected girls (Demmer et al., 2017; Faraone et al., 2015; Hinshaw et al., 2022). Clinicians may overlook symptoms and impairments in girls because symptoms manifest less overtly in girls, and girls often use compensatory strategies (Hinshaw et al., 2022). However, research has indicated that the gender and age of the child do not have a significant moderating influence on the relationships of family adversity and parental mental health with externalizing behaviors in children (Biederman et al., 2002; Cheung & Theule, 2016; Connell & Goodman, 2002; Letourneau et al., 2013; Piotrowska et al., 2015). In contrast, the link between parenting behaviors and externalizing behaviors in children did appear to be impacted by the age and gender of children (Granero et al., 2015; Harter, 2008; Javo et al., 2004; Pinquart, 2017). More specifically, research revealed stronger associations between negative parenting behaviors and externalizing behaviors in older compared to younger children (Pinquart, 2017). Although the parental influence was initially thought to diminish as the child grew older, there is increasing evidence that parents are still the central caregivers in adolescence, which is associated with various developmental tasks (Harter, 2008; Pinquart, 2017). Furthermore, stronger associations between negative parenting behaviors and externalizing behaviors in girls than in boys suggest that girls may be more sensitive to negative parenting practices (Granero et al., 2015; Javo et al., 2004).

1.8 Aim of the Second Study

The purpose of the second study of this cumulative thesis was to examine the relationships among selected familial factors and their effects on child ADHD symptoms when considered in one comprehensive model. Data from a large multicenter intervention study for ADHD in school age (Evidence-based, Stepped Care of ADHD in schoolaged children, ESCA school; Döpfner et al., 2017)

were analyzed (cf. Jendreizik, Hautmann, et al., 2022). The familial factors examined in the comprehensive model in the second study of this cumulative thesis were selected in consideration of the findings of the first study. The following familial factors were investigated regarding their associations with child symptom severity: family adversity (characteristics and framework of the family), parental psychopathology (mental health of the family members), and parenting practices (intrafamilial interactions and relationships). Consistent with the ecological systems theory and extending the family stress model, adverse family characteristics were suggested to be linked to more parental psychopathology, more negative parenting behaviors, less positive parenting behaviors, and ultimately more pronounced ADHD and comorbid oppositional symptoms within children. As ODD symptoms are much more common than CD symptoms in children with ADHD, the analyses were limited to comorbid oppositional symptoms (Reale et al., 2017). The second study aimed to validate the postulated interrelationships of the familial factors (see *Research question 2*) and to determine the direct, indirect, and total effects of the familial factors on child externalizing symptoms, separately for ADHD and ODD symptoms (see *Research question 3*). Furthermore, the gender and age of the children were examined as possible moderating influences *(see Research question 4)*.

Research question 2: Are adverse family circumstances associated with more pronounced parental psychopathology, and is parental psychopathology in turn associated with more negative parenting behaviors and less positive parenting behaviors in children diagnosed with ADHD (cf. Jendreizik, Hautmann, et al., 2022)?

Research question 3: Are the familial factors (family adversity, parental psychopathology, positive parenting practices, and negative parenting practices) indirectly or directly related to ADHD symptoms and ODD symptoms in children diagnosed with ADHD (cf. Jendreizik, Hautmann, et al., 2022)?

Research question 4: Are the associations of familial factors (family adversity, parental psychopathology, positive parenting practices, and negative parenting practices) with externalizing symptoms in children moderated by the age or gender of the affected children (cf. Jendreizik, Hautmann, et al., 2022)?

2 Scientific Publications

2.1 Associations of Multiple Familial Factors and Child ADHD Symptom Severity

Jendreizik, L. T., von Wirth, E., & Döpfner, M. (2022). Familial factors associated with symptom severity in children and adolescents with ADHD: a meta-analysis and supplemental review. *Journal of Attention Disorders, 27*(2), 124-144. https://doi.org/10.1177/10870547221132793

The following publication fully corresponds to the published manuscript. Accordingly, the formatting, numbering of tables and figures, and reference list have not been adjusted according to the overall thesis. The supplement of the publication can be found in the appendix.

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Familial Factors Associated With Symptom Severity in Children and Adolescents With ADHD: A Meta-Analysis and Supplemental Review

Lea T. Jendreizik[1], Elena von Wirth[1], and Manfred Döpfner[1]

Abstract

Objective: Both genetic and environmental factors contribute to the development of ADHD, but associations between risk factors and ADHD symptom severity in affected children remain unclear. This systematic review and meta-analysis synthesizes evidence on the association between familial factors and symptom severity in children with ADHD (PROSPERO CRD42020076440). **Method:** PubMed and PsycINFO were searched for eligible studies. **Results:** Forty-three studies ($N = 11,123$ participants) were meta-analyzed. Five additional studies ($N = 2,643$ participants) were considered in the supplemental review. Parenting stress ($r = .25$), negative parenting practices ($r = .19$), broken parental partnership ($r = .19$), critical life events ($r = .17$), parental psychopathologies ($r = .14$–$.16$), socioeconomic status ($r = -.10$), and single-parent family ($r = .10$) were significantly associated with ADHD symptom severity. **Conclusion**: These results suggest that psychosocial familial factors show small but significant associations with symptom severity in children with ADHD. Implications are discussed. (*J. of Att. Dis. 2023; 27(2) 124-144*)

Keywords

ADHD, risk factors, familial factors, psychosocial factors, symptom severity, meta-analysis, review

ADHD is a neurodevelopmental condition characterized by impairing and developmentally inappropriate levels of inattention, hyperactivity, and impulsivity (American Psychiatric Association, 2013), with an estimated worldwide prevalence in children and adolescents of 3.4% (Polanczyk et al., 2015). In terms of the etiology of the disorder, it is assumed that an interaction between polygenic and environmental risk factors plays an important role. Environmental risk factors that are suspected to contribute to the onset of ADHD include exposure to toxins, pregnancy and birth complications, mild traumatic brain injury, as well as psychosocial and familial disadvantages (Faraone et al., 2021).

There is evidence that children from families with low socioeconomic status (SES) are more than twice as likely to have ADHD than their peers from families with high SES (Russell et al., 2016). Lower parental education, lower household income, and parental unemployment have each been found to be associated with an increased likelihood of having ADHD (Choi et al., 2017; Keilow et al., 2020; Russell et al., 2016). In addition, family characteristics such as lower parental age at birth (Min et al., 2021), lower interparental relationship quality (Weyers et al., 2019), and growing up in a single-parent household (Russell et al., 2016) have shown associations with an increased risk of developing ADHD.

Research has also demonstrated that parental psychopathology, especially parental ADHD, is a risk factor for child ADHD (Faraone & Larsson, 2019). Moreover, parents of children with ADHD showed an increased prevalence of depression (17%), anxiety disorder (16%), and addictive disorders (14%, Cheung & Theule, 2016).

Although genetic influences play a major role in the development of ADHD, genetic transmission does not fully explain the association between parental and child ADHD. There is growing evidence that the quality of parenting mediates the relationship between parental psychopathology and child functioning (e.g., Goodman et al., 2020). Parental ADHD symptoms are associated with more negative parenting behaviors, which in turn mediate the association between parent and child ADHD symptoms (Park et al., 2017; Tung et al., 2015).

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Furthermore, a longitudinal adoption study recently revealed that adoptive mother hostility was associated with later child ADHD symptoms, suggesting that environmental family factors influence child ADHD independently of shared genetic factors (Sellers et al., 2020). Similarly, it was reported that parenting stress is substantially associated with child externalizing symptoms (Theule et al., 2013) and (partially) mediates the relationship between parental and child psychopathology (Weijers et al., 2018).

Another psychosocial factor that has been found to be associated with childhood ADHD is exposure to critical life events in childhood. A meta-analysis by Clayton et al. (2018) revealed that individuals with ADHD were up to eight times more likely to have experienced physical abuse, neglect, and psychological abuse compared to individuals without ADHD.

In summary, several familial factors (e.g., SES, parental education, household income, parental unemployment, parental age, interparental relationship, single-parent family, parental psychopathology, parenting behavior, parenting stress, critical life events) have been identified as risk factors for the onset of ADHD. Earlier narrative reviews revealed associations between various environmental factors and ADHD (e.g., Banerjee et al., 2007; Thapar et al., 2013). More recent reviews, published over the past decade, have systematically searched for and meta-analyzed research findings on the associations between environmental risk factors and the risk of ADHD (e.g., Cheung & Theule, 2016; Huang et al., 2018; Russell et al., 2016; Weijers et al., 2018; Weyers et al., 2019). These reviews and meta-analyses, as well as recently published cohort studies (e.g., Keilow et al., 2020), treated ADHD as a dichotomous variable (present or not). Much less work has reported on associations between familial factors and the severity of child ADHD symptoms while treating ADHD as a continuous variable (e.g., Cheung et al., 2018; Connell & Goodman, 2002; Theule et al., 2013). Finally, we are not aware of any work that has systematically searched for and meta-analyzed research findings on the association between multiple familial factors and ADHD symptom severity in clinical samples of children and adolescents with ADHD.

The present systematic review and meta-analysis therefore aims at synthesizing the existing evidence regarding the associations between multiple familial factors and the severity of ADHD symptoms in children and adolescents who fulfill the diagnostic criteria for ADHD. By requiring a clinical diagnosis of ADHD for study inclusion, we ensure that the children studied are representative of patients in routine clinical practice with respect to the range of ADHD symptom severity and existing functional impairment. A systematic analysis of the current evidence on the association between multiple familial factors and ADHD symptom severity will help to identify the most predictive familial risk factors, thereby providing guidance for clinical care and future research. Moreover, the consideration of continuous associations within a clinical sample of children with ADHD seems to be of particular interest for treatment planning and prognosis, as it uncovers possible targets for interventions.

Methods

We conducted the systematic review following the PRISMA guidelines (Moher et al., 2009). The review was registered with PROSPERO (CRD42020076440).

Eligibility Criteria (Inclusion/Exclusion)

We selected studies that met the following criteria: First, participants were children and adolescents with a clinical diagnosis of ADHD ($N \geq 20$; age: 3–18 years) and/or their parents/caregivers. Second, only studies that investigated the association between at least one familial factor and the severity of the child's ADHD symptoms were included. The following factors were not considered to be familial factors: maternal use of nicotine, alcohol, or drugs during pregnancy; parental knowledge of ADHD; parental cognitions (e.g., about the controllability of ADHD behaviors); parental attitudes toward ADHD or ADHD medication; child sleep. We also excluded studies that investigated associations between ADHD symptom severity and events that were considered to be consequences of ADHD (e.g., injuries). Third, ADHD symptom severity was assessed with a dimensional measure (e.g., scores from a clinical interview or rating scale) or with a rating scale that enabled ordinal ranking. According to the diagnostic criteria of the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders [DSM-5], children with the combined ADHD subtype may show more severe ADHD symptomatology (i.e., higher number of diagnostic criteria fulfilled) than children with the predominantly inattentive or predominantly hyperactive-impulsive subtypes. This assumption is supported by empirical results (Graetz et al., 2001). We therefore included studies that reported a comparison between the combined subtype and one or both of the other ADHD subtypes. Fourth, we included both cross-sectional and longitudinal studies. Intervention studies were only included if an association between a familial factor and the child's ADHD symptom severity had been studied prior to the intervention phase. Fifth, studies were required to report a bivariate association measure (e.g., correlation coefficient, odds ratio, Cohen's *d*) or study results that enabled us to calculate a measure of association (e.g., events, mean values). Studies that reported only partial relationships (e.g., using partial correlations) were excluded. Finally, studies published between 01.01.1988 and 16.07.2018 in the English or German language were considered.

Data Sources

The databases PsycINFO (via EBSCOhost) and PubMed were searched for relevant articles. Additional articles were identified through experts on ADHD (i.e., members of the European Network for Hyperkinetic Disorders [EUNETHYDIS]) and citation screening of meta-analyses, reviews, and included studies.

Search Strategy

The full search strategy is provided in Supplement I. "Attention deficit disorder with hyperactivity" was considered as a medical subject heading ("MeSH") in PubMed and as a subject term in PsycINFO. As we were not focusing on the association between familial factors and the occurrence versus non-occurrence of ADHD (categorical perspective), the key term "severity" (all fields) was included. To account for the multiplicity of familial factors, 19 key terms (e.g., psychosocial, environment*, socio-economic, home, famil*, marital, parent*) were used ("all fields"). The search was restricted regarding the date of publication (01.01.1988 to 16.07.2018), language (German or English), and publication type (Journal).

Study Selection

Studies were selected in a two-stage process. After removal of duplicates, titles and abstracts were screened for eligibility independently by the first author and a second reviewer. If at least one reviewer suspected a relevant finding based on the title or abstract (step 1), the full text (step 2) was examined for eligibility by both reviewers. In the case of disagreement, an independent third reviewer was consulted and a consensus was reached.

Data Collection Process

Data extraction was performed by a single reviewer, and the first author checked for completeness and correctness. The following features were extracted from each publication: first author, year of publication, title, country of study, study design (cross-sectional vs. longitudinal), sample size of the total sample and the subsample with ADHD, gender and age, recruitment strategy used (community-based vs. clinically based), diagnostic instrument for the assessment of ADHD, diagnostic criteria for ADHD (DSM vs. International Classification of Diseases [ICD]), the investigated familial factor(s), the measurement of the familial factor(s), the measurement of severity of ADHD symptoms, statistics used (e.g., events, means, correlation or regression), and relevant findings.

Risk of Bias Within Studies

Using a list of eight criteria, the risk of bias for each familial factor in each of the included studies was assessed separately by the first author and an independent reviewer. The criteria catalog was based on the Newcastle-Ottawa Scale (Wells et al., 2000) and was adapted to the requirements of the present study. The full list of criteria applied is provided in Supplement II. The interrater agreement was determined based on percent agreement and (weighted) Cohen's kappa separately for each of the eight criteria, and was classified according to the guidelines of Cicchetti (1994).

Synthesis of Results

The factors examined in the included studies were grouped and titled based on content criteria. If study findings from at least three studies were available for a familial factor, a quantitative synthesis (random effects meta-analysis) was performed. For each familial factor included in the meta-analysis, we report the number of included studies (k), the weighted, averaged correlation coefficient (r) with accompanying 95% confidence interval (CI) and significance level (p), and the heterogeneity of the included studies (I^2). Study findings that could not be included in the meta-analysis are summarized in a supplemental review.

If two studies were based on overlapping samples, the study with the largest sample size was considered. Several longitudinal studies examined associations between familial factors and ADHD symptom severity at multiple, successive measurement time points. In these cases, results of the first measurement time point were included in the meta-analysis. If a correlation coefficient was reported in the publication, it was used in the meta-analysis. In the absence of a correlation coefficient, raw data were preferred over effect size indices (e.g., Cohen's d, odds ratio). Regarding the measurement of ADHD symptom severity, parent judgment was preferred over teacher judgment (if both were reported). Regarding the measurement of the familial factors, data on retrospective and current manifestations (especially parental symptoms, critical life events) were accepted. In the case of odds ratios or events for different levels of a familial factor, we selected either those levels whose contrast matched the examined expressions of the other included studies (e.g., single-parent family vs. family with both biological parents) or the extreme groups (e.g., high vs. low parental education). If ADHD symptom severity was assessed (exclusively) through ADHD subtypes, results for the combined ADHD subtype group were compared with results for either the predominantly inattentive subtype group or the predominantly hyperactive-impulsive subtype group. If results were reported for both the predominantly inattentive subtype and the predominantly hyperactive-impulsive subtype, the two subgroups were combined into a single group.

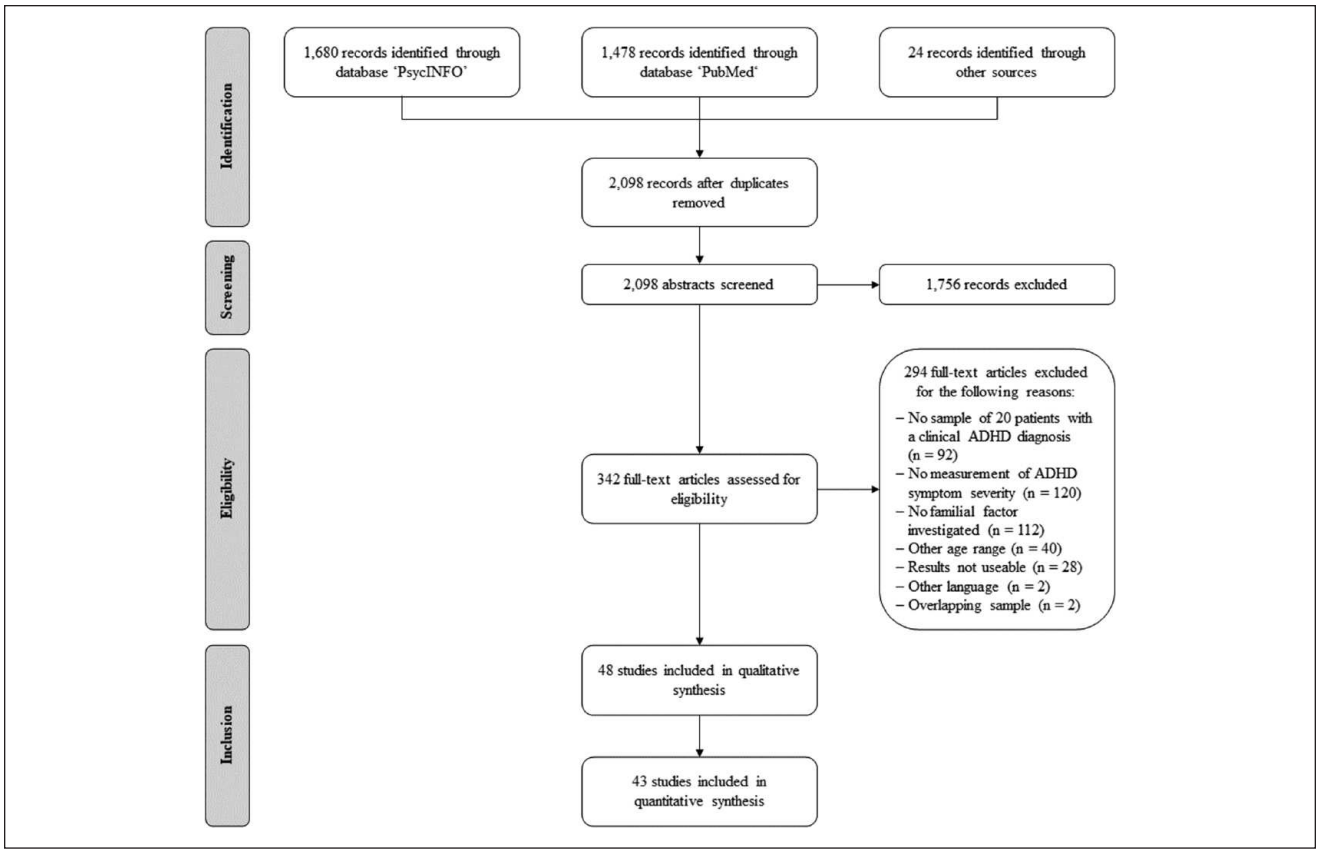

Figure 1. PRISMA flow diagram.

In these cases, raw data (events or means) of the two subgroups were combined by taking into account the respective sample size or standard deviations. If correlation coefficients were reported for two ADHD subscales, two parents, or two indicators of a factor (e.g., parental income and parental education as indicators of SES), a combined correlation coefficient was calculated taking into account the respective intercorrelation. In the absence of a report of the respective correlation, the intercorrelation was estimated to be $r = .05$, following the recommendations of Borenstein et al. (2021).

The random effects meta-analyses were performed using the Comprehensive Meta-Analysis software (CMA; version 3). Effect sizes identified as outliers (confidence interval of the study result and confidence interval of the pooled effect did not overlap) were excluded. Additionally, sensitivity analyses were conducted to examine whether and how effect estimates changed when we excluded (a) studies examining the association between familial factors and ADHD subtypes and (b) studies of insufficient quality (i.e., more than three quality criteria classified as deficient) from the analyses.

Risk of Bias Between Studies

Publication bias was examined by plotting the effect estimate by the standard error separately for each familial factor. The symmetry of the resulting funnel plots was evaluated visually as well as formally using the Egger's regression test (Egger et al., 1997) with a significance level of $p < .10$. Using the trim-and-fill procedure (Duval & Tweedie, 2000), the funnel plots were (where necessary) expanded by imputed studies in order to obtain an effect size estimate that was as unbiased as possible.

Results

Study Selection and Study Characteristics

Forty-three studies with a total of 11,123 participants were included in the meta-analysis. Five additional studies with a total of 2,643 participants were included in the supplemental review. Figure 1 shows the selection process of these studies from the 1,680 results returned by our search in PsycINFO, 1,478 results returned by our search in PubMed, and 24 results identified through other sources.

The interrater agreement regarding the eligibility of studies was moderate for abstracts (percent agreement: 91%, kappa: $\kappa = .58$) and good for full texts (percent agreement: 85%, kappa: $\kappa = .62$). The following familial factors could be evaluated meta-analytically: SES, parental age, single-parent family, broken partnership, number of children, critical life events, parental ADHD, parental affective psychopathologies, parental mental health, parenting stress, parental quality of life, positive parenting practices, negative parenting practices. 119 study findings from 43 studies could be grouped into these 13 factors. In 24 cases, several findings (up to five) from one study were assigned to the same familial factor and were combined into a single effect size. Study findings on the following familial factors could not be meta-analyzed and are summarized in the supplemental review: ethnic group, stepfamily, rank of birth, playing environment and neighborhood, familial ADHD, parental antisocial personality, familial and sibling mental health, maternal social support and self-esteem, further parenting practices and parent-child relationship, and familial risk.

Table 1 depicts the characteristics of studies included in the meta-analysis and supplemental review. A summary of study characteristics is provided in Supplement III.

Risk of Bias Within Studies

The interrater agreement regarding the risk of bias within studies was excellent for seven of the eight criteria (percent agreement $\geq$ 99%, kappa: $\kappa \geq .94$). Interrater agreement for the criteria "missing values" was good (percent agreement = 87%, kappa: $\kappa = .74$). During an exchange between the first author and the independent reviewer, the criteria of "missing values" were further clarified and agreement was reached. Results of the risk of bias assessment are provided in Supplement IV. To summarize, 71% of the included study findings had no more than one criterion rated as deficient, 22% had two quality criteria rated as deficient, and 7% of the included study findings had three or more of the eight quality criteria rated as deficient.

Results of the Meta-Analysis and Supplemental Review

The forest plot in Figure 2 depicts the results of the meta-analysis. We categorize correlation coefficients according to Cohen (1988) as small ($r \geq .10$), medium ($r \geq .30$), and large ($r \geq .50$).

SES. The average correlation between SES and child ADHD symptom severity was $r = -.10$ and significantly different from zero ($k = 11$, 95% CI [−0.14, −0.05], $p < .001$, $I^2 = 26\%$). Lower family SES (e.g., captured by low parental education or low family income) was associated with more severe child ADHD symptoms.

Ethnic group. Due to the wide variation in ethnic groups studied and differences in the ethnic composition of study populations, it was not possible to synthesize the study findings in a meta-analysis. The five studies identified in the systematic search report the following associations: In the baseline assessment of a medication study in six countries (including Puerto Rico and the United States of America [USA]), Tamayo et al. (2008) reported greater ADHD symptomatology in children and adolescents of Latino descent compared with those of Caucasian descent ($M_L = 41.1$, $SD_L = 8.2$, $M_C = 37.8$, $SD_C = 10.0$, $p < .001$). In a US sample, Razani et al. (2015) found no statistically significant differences in the severity of ADHD symptomatology between children and adolescents with Black, Hispanic, or White ethnicity. Only those children and adolescents with an ancestry other than White, Black, or Hispanic showed a slightly increased risk of more severe ADHD (OR = 1.4, 95% CI [1.0, 1.9]). Studies by Schneider et al. (2013), Chronis et al. (2007), and Podolski and Nigg (2001) found no significant associations between a child's ethnic minority status and ADHD symptom severity or ADHD subtype.

Parental age. The averaged correlation between parental age and child ADHD symptom severity was $r = .04$ and not significantly different from zero ($k = 3$, 95% CI [−0.06, 0.13], $p = .45$, $I^2 = 0\%$). None of the included study findings provided evidence of an association between parental age (at birth or time of study) and the severity of childhood ADHD or childhood ADHD subtype.

Single-parent family and stepfamily. The averaged correlation between growing up in a single-parent family and child ADHD symptom severity was $r = .10$ and significantly different from zero ($k = 4$, 95% CI [0.02, 0.18], $p = .02$, $I^2 = 23\%$). Growing up with a single parent was associated with more severe ADHD symptoms in children. It should be noted that only one of the four studies included in the meta-analysis revealed a significant association (Razani et al., 2015). A possible explanation for the inconsistent findings may be that studies included in the meta-analysis failed to differentiate between biological, adoptive, foster and stepparents. There is some evidence that growing up with a stepparent is associated with more severe child ADHD. More specifically, Heckel et al. (2013) found that growing up in a two-parent family with a biological parent and a stepparent was associated with more ADHD symptoms ($M = 76.3$, $SD = 12.9$) than growing up with a single biological parent ($M = 68.7$, $SD = 14.2$, $p = .02$). However, Razani et al. (2015) did not find increased

Table 1. Characteristics of Included Studies.

First author	Year	Country [cc]	*N*	male (%)	Age (*M*)	Familial factor(s)	Measure of familial factor(s)	Measure of symptom severity	Statistic	Meta-Analysis
Socioeconomic status										
Chronis 2007		USA	108	81.5	5.3	(1) Family income	(1) n. i. (logged)	DISC	COR	Yes
Counts	2005	USA	134	69.4	9.7	(1) SES	(1) asked & coded with SEI	ADHD-ST	M	Yes
Faraone	2000	USA	139	n. i.	n. i.	(1) SES	(1) n. i.	ADHD-ST	M	Yes
Freitag	2012	GER	275	83.3	9.7	(1) Socioeconomic status	(1) Occupational status asked, coded (5 categories) and averaged for parents	DCL-HKS	COR	Yes
Graetz	2001	AUS	268	70.5	10.3	(1) Household income	(1) asked (% < §500/week)	ADHD-ST	EV	Yes
						(2) Age parent left school	(2) asked (% < 17 years)			
						(3) Parental employment	(3) asked (% households with one or more employed parents)			
Mulraney	2016	AUS	270	85.9	10.1	(1) Completion of high school	(1) asked (y/n)	ADHD-RS	COR	Yes
Owens	2003	USA/CAN	579	80	RNG 7.0-9.9	(1) Maternal education	(1) asked (6 categories)	SNAP [tp]	COR	Yes
						(2) Public assistance	(2) asked (y/n) °			
Podolski	2001	USA	37	64.3	9.8	(1) SES	(1) SEI	ADHD-ST	M	Yes
Razani	2015	USA	4290	n. i.	RNG 6-18 [ts]	(1) Income	(1) asked (percentage of federal poverty level greater than 400 [ref] vs. less than 200)	asked [r]	OR	Yes
						(2) Maternal education	(2) asked (greater than high school [ref] vs. less than high school)			
Schneider	2013	USA	73	74.0	8.2	(1) SES	(1) n. i.	DBD-RS	COR	Yes
Yang	2007	TWN	182	83.0	8.8	(1) Parents' education	(1) asked, in years	ADHD-ST	M	Yes
Ethnic group										
Chronis	2007	USA	108	81.5	5.3	(2) Race/ethnicity	(2) asked (African American vs. non-Hispanic White or other)	DISC	COR	No
Podolski	2001	USA	37	64.3	9.8	(2) Ethnicity	(2) n. i. (White vs. non-White)	ADHD-ST	EV	No
Razani	2015	USA	4290	n. i.	RNG 6-18 [ts]	(3) Race/ethnicity	(3) asked (non-Hispanic White [ref] vs. Hispanic vs. non-Hispanic Black vs. other)	asked [r]	OR	No
Schneider	2013	USA	73	74.0	8.2	(2) Ethnicity	(2) asked (White vs. ethnic minority)	DBD-RS	COR	No
Tamayo	2008	USA/PRI +	1198	75.8	11.1	(1) Ethnic group	(1) asked (Latinos vs. Caucasians)	ADHD-RS & CRS	M	No
Parental age										
Baldwin	199	USA	30	86.7	9.3	(1) Caregiver's age	(1) asked	CBCL	COR	Yes
Park	2014	KOR	147	80.3	9.0	(1) Maternal age at pregnancy	(1) asked	ADHD-ST	M	Yes
						(2) Paternal age at pregnancy	(2) asked			
Yang	2007	TWN	182	83.0	8.8	(2) Parents' age	(2) asked	ADHD-ST	M	Yes
Single-parent family										
Graetz	2001	AUS	268	70.5	10.3	(4) Family type	(4) asked (two-parent vs. solo-parent family)	ADHD-ST	EV	Yes
Razani	2015	USA	4290	n. i.	RNG 6-18 [ts]	(4) Family structure	(4) Family structure (two parents, biological/adoptive [ref] vs. one parent)	asked [r]	OR	Yes
Schneider	2013	USA	73	74.0	8.2	(3) Parents in home	(3) asked (1 vs. 2)	DBD-RS	COR	Yes
Yang	2007	TWN	182	83.0	8.8	(3) Single-parent family	(3) asked (y/n)	ADHD-ST	EV	Yes
Stepparent family										
Heckel	2013	AUS	479 [h2]	69.7	10.7	(1) Family composition	(1) Study-specific questionnaire (single-parent vs. stepfamily)	CRS	M	No
Razani	2015	USA	4290	n. i.	RNG 6-18 [ts]	(5) Family structure	(5) asked (two parents, biological/adoptive [ref] vs. two parents, stepparent)	asked [r]	OR	No

(continued)

Table 1. (continued)

First author	Year	Country [cc]	*N*	male (%)	Age (*M*)	Familial factor(s)	Measure of familial factor(s)	Measure of symptom severity	Statistic	Meta-Analysis
Broken partnership										
Counts	2005	USA	134	69.4	9.7	(2) Child-rated marital conflict	(2) CPIC	ADHD-ST	M	Yes
Heckel	2009 [sl]	AUS	479	69.7	10.7	(1) Divorce	(1) Study-specific questionnaire (y/n)	CRS	M	Yes
Ramy	2018	EGY	87	66.7	13.1 [ts]	(1) Parental separation	(1) Study-specific questionnaire (y/n)	Mild vs. moderate & severe (CASS)	EV	Yes
Tzang	2009	TWN	109	81.7	9.3	(1) Marital satisfaction	(1) asked (y/n)	ADHD-ST	M	Yes
Number of children										
Ghanizadeh	2015	IRN	441	77.6	9.1	(1) Number of children	(1) asked	CSI	COR	Yes
Graetz	2001	AUS	268	70.5	10.3	(5) Number of children	(5) asked	ADHD-ST	M	Yes
Ramy	2018	EGY	87	66.7	13.1 [ts]	(2) Mean number of sibs	(2) Study-specific questionnaire	Mild vs. moderate & severe (CASS)	M	Yes
Rank of birth										
Ghanizadeh	2015	IRN	441	77.6	9.1	(2) Rank of birth	(2) asked	CSI	COR	No
Playing environment and neighborhood										
Razani	2015	USA	4290	n. i.	RNG 6-18 [ts]	Neighborhood: (6) support (7) amenities (8) disorder	Study-specific questionnaire (6) High vs. low (7) 4/4 vs. 0/4 (8) 0/3 vs. 3/3	asked [r]	OR	No
Taylor	2011	USA	421	79.6	RNG 5-18	Playing environment: Open grass [ref] vs. (1) Deep indoors (2) Built outdoors (3) Big trees and grass	(1) - (3) Photos of play in different settings: Where did your child play in the past week?	asked [t]	D	No
Critical life events										
Counts	2005	USA	134	69.4	9.7	(3) Familial stressful events	(3) Subscale 'life stress' of PSI	ADHD-ST	M	Yes
Daviss	2009	USA	104 [d]	63.5	13.8	(1) Lifetime victimization events (2) Recent negative life events	(1) TESI (2) LEC	ADHD-RS [tp]	COR	Yes
Freitag	2012	GER	275	83.3	9.7	(2) Acute life events in last six months	(2) Semi-structured interview on axis V of the MAS (WHO)	DCL-HKS	COR	Yes
Gul [out]	2018	TUR	100	73.0	8.5	(1) Physical abuse (2) Emotional abuse (3) Sexual abuse (4) Physical neglect (5) Emotional neglect	(1) - (5) ANAQ-C	CRS [tp]	OR	No
Park	2014	KOR	147	80.3	9.0	(3) Primary caretaker other than mother (4) Change in primary caretaker	(3) asked (4) asked (none vs. one plus change)	ADHD-ST	EV	Yes
Park	2017	KOR	55	83.6	9.2	(1) Posttraumatic event	(1) ETISR (y/n)	ADHD-RS	M	Yes
Ramy	2018	EGY	87	66.7	13.1 [ts]	(3) Family circumstances	(3) Study-specific questionnaire (both parents living vs. father, mother or both deceased)	Mild vs. moderate & severe (CASS)	EV	Yes
Schilpzand	2018	AUS	179	69.3	7.3	(1) Trauma exposure	(1) PTSD module of DISC (y/n)	CRS	M	Yes
Sugimoto	2015	JPN	41	90.2	9.5	(1) Child abuse	(1) n. i. (y/n)	ADHD-RS [s]	M	Yes
Tzang	2009	TWN	109	81.7	9.3	(2) Life stress	(2) Subscale 'life stress' of PSI	ADHD-ST	M	Yes
Vitanza	1999	USA	103	100	8.0	(1) Major life events	(1) Life experiences survey	ADHD-RS	COR	Yes

(continued)

Table 1. (continued)

First author	Year	Country [cc]	*N*	male (%)	Age (*M*)	Familial factor(s)	Measure of familial factor(s)	Measure of symptom severity	Statistic	Meta-Analysis
Parental ADHD										
Agha	2013	GBR	570	84.6	10.8	(1) Mother Adult ADHD (2) Father Adult ADHD	(1) + (2) ADHD checklist of DSM-5 (y/n)	CAPA	M	Yes
Counts	2005	USA	134	69.4	9.7	(4) Parental ADHD	(4) DISC (y/n)	ADHD-ST	M	Yes
Freitag	2012	GER	275	83.3	9.7	(3) Parental ADHD	(3) ADHS-SB, WURS & clinical interview	DCL-HKS	M	Yes
López Seco	2015	ESP	73	80.8	11.2	(1) ADHD symptoms mother (2) ADHD symptoms father	(1) + (2) ASRS	ADHD-RS	COR	Yes
Macek	2012	SVN	30	80.0	8.2	(1) ADHD symptoms in childhood mother (2) ADHD symptoms in childhood father (3) Current ADHD symptoms mother (4) Current ADHD symptoms father	(1) + (2) WURS (3) + (4) ADHD checklist of DSM-IV	CBCL	COR	Yes
Ramy	2018	EGY	87	66.7	13.1 [ts]	(4) Family history of ADHD	(4) Study-specific questionnaire (y/n)	Mild vs. moderate & severe (CASS)	EV	Yes
Richards	2014	NLD	T1: 385 [ri]	T1: 83.4	T1: 11.5	(1) Maternal ADHD problems	(1) ADHD-SRQ (T1)	CRS (T1)	COR	Yes
Stadler	2006	GER	68	88.2	10.6	(1) Current maternal ADHD symptoms (2) Current paternal ADHD symptoms (3) Parental history of ADHD	(1) + (2) ADD-Brown-A (3) WURS (both vs. one vs. no parent)	ADD-Brown-C	(1) + (2) COR (3) M	Yes
Takeda	2010	USA	323	76.4	9.9	(1) Parents' ADHD status	(1) (ASRS) neither vs. father vs. mother vs. both positive	K-SADS	M	Yes
Xia	2015	CHN	94	73.3 [x]	8.8 [x]	(1) ADHD symptoms of parents	(1) ASRS	SNAP	COR	Yes
Familial ADHD										
Faraone	2000	USA	139	n. i.	n. i.	(2) ADHD among relatives	(2) K-SADS for siblings, SCID for parents (y/n)	ADHD-ST	EV	No
Lee	2008	CAN	419	80.4	8.6	(1) Familial history of ADHD	(1) asked (y/n)	ADHD-ST	EV	No
Parental affective psychopathology										
Agha	2017	GBR	143	100.0	T1: 10.1 T2: 13.7	(1) Mother depressive symptoms (T1)	(1) HADS	DAWBA (T2)	REG	Yes
Chronis	2007	USA	108	81.5	5.3	(3) Maternal major depressive disorder	(3) SCID (y/n)	DISC	COR	Yes
Harrison	2002	AUS	100	78.0	8.3	(1) Maternal depression	(1) BDI	HSQ	COR	Yes
Owens	2003	USA/CAN	579	80	RNG 7.0-9.9	(3) Parental depression	(3) BDI	SNAP [tp]	COR	Yes
Richards	2014	NLD	T1: 385 [ri]	T1: 83.4	T1: 11.5	(2) Maternal affective problems (T1)	(2) GHQ (T1)	CRS (T1)	COR	Yes
van der Oord	2006	NLD	65	89.2	9.8	(1) Parental depressed mood	(1) CES-D	DBD-RS	COR	Yes
West	1999	AUS	103 [w]	78.6	11	(1) Maternal depression	(1) BDI	ADHD-ST	M	Yes
Xia	2015	CHN	94	73.3 [x]	8.8 [x]	(2) Anxiety symptoms of parents (3) Depressive symptoms of parents	(2) STAI (3) BDI	SNAP	COR	Yes

(continued)

Table 1. (continued)

First author	Year	Country [cc]	*N*	male (%)	Age (*M*)	Familial factor(s)	Measure of familial factor(s)	Measure of symptom severity	Statistic	Meta-Analysis
Parental antisocial personality										
Chronis	2007	USA	108	81.5	5.3	(4) Maternal antisocial personality disorder symptoms	(4) + (5) SCID	DISC	COR	No
						(5) Paternal antisocial personality disorder symptoms	COR			
Parental mental health										
Anastopoulos	1992	USA	104	83.7	8.3	(1) Maternal overall psychopathology	(1) SCL-90 (GSI)	ADHD-RS	COR	Yes
Counts	2005	USA	134	69.4	9.7	(5) Number of maternal lifetime psychiatric disorders	(5) + (6) DIS [c]	ADHD-ST	M	Yes
						(6) Number of paternal lifetime psychiatric disorders				
López Seco	2015	ESP	73	80.8	11.2	(3) Current psychopathology mother	(3) + (4) SCL-90 (y/n)	Symptomatic vs. no symptomatic children (ADHD-RS)	EV	Yes
						(4) Current psychopathology father	(5) + (6) Semi-structured interview (y/n)			
						(5) Psychiatric history mother				
						(6) Psychiatric history father				
Ramy	2018	EGY	87	66.7	13.1 [ts]	(5) Family history of psychiatric illness	(5) Study-specific questionnaire (y/n)	Mild vs. moderate & severe (CASS)	EV	Yes
Razani	2015	USA	4290	n. i.	RNG 6-18 [ts]	(9) Maternal mental health	(9) Maternal mental health (very good [ref] vs. poor)	asked [r]	OR	Yes
Schneider	2013	USA	73	74.0	8.2	(4) Maternal mental health	(4) + (5) BSI (GSI)	DBD-RS	COR	Yes
						(5) Paternal mental health				
Tzang	2009	TWN	109	81.7	9.3	(3) Parental symptoms	(3) SCL-90 (GSI)	ADHD-ST	M	Yes
Vitanza	1999	USA	103	100	8.0	(2) Somatization	(2) - (4) HSCL	ADHD-RS	COR	yes
						(3) Interpersonal sensitivity				
						(4) Depression				
Familial and sibling mental health										
Freitag	2012	GER	275	83.3	9.7	(4) Psychiatric disorders in family	(4) Semi-structured interview on axis V of the MAS (WHO)	DCL-HKS	COR	No
Schilling	2006	GER	24	n. i.	RNG 8-17	(1) Social withdrawal	(1)-(5) CBCL	CRS	COR	No
						(2) Symptoms of anxiety and depression				
						(3) Social problems				
						(4) Problems with attention				
						(5) Symptoms of aggression				
						(6) Hyperactivity of healthy siblings	(6) CRS			
Parenting stress										
Anastopoulos	1992	USA	104	83.7	8.3	(2) Parenting stress	(2) (adj.) PSI [a]	ADHD-RS	COR	Yes
Harrison	2002	AUS	100	78.0	8.3	(2) Parenting stress	(2) PSI (parent domain)	HSQ	COR	Yes
Li	2016	CHN	132	87.1	10.1	(1) Parenting stress	(1) PSI (parent domain)	ADHD-ST	M	Yes
Lin	2002	TWN	100	87.0	9.1	(1) Parenting stress	(1) PSI (parent domain)	ADHD-BPS	COR	Yes
McLaughlin	2006	AUS	150	80.7	8.4	(1) Sense of competence	(1) PSI	CRS	COR	Yes
						(2) Social isolation	(2) PSI			
Podolski	2001	USA	40	64.3	9.8	(3) Parenting stress - mothers	(3) + (4) PSI (parent domain)	ADHD-ST	M	Yes
						(4) Parenting stress - fathers				

(continued)

Table 1. (continued)

First author	Year	Country [cc]	*N*	male (%)	Age (*M*)	Familial factor(s)	Measure of familial factor(s)	Measure of symptom severity	Statistic	Meta-Analysis
Tzang	2009	TWN	109	81.7	9.3	(4) Parenting stress	(4) PSI (parent domain)	ADHD-ST	M	Yes
van der Oord	2006	NLD	65	89.2	9.8	(2) Parenting stress	(2) (adj.) PSI [v]	DBD-RS	COR	Yes
Yang	2007	TWN	182	83.0	8.8	(4) Parenting stress	(4) PSI (parent domain)	ADHD-ST	M	Yes
Parental quality of life										
Cappe	2017	FRA	90	92.2	9.8	(1) (Impaired) quality of life	(1) QoLP	CRS	COR	Yes
Schilling	2006	GER	24	n. i.	RNG 8-17	Parental quality of life (7) mental health (8) physical	(7) + (8) SF-8	CRS	COR	Yes
Xiang	2009	CHN	77	79.2	10.1	(Parental) quality of life (1) physical (2) psychological (3) social (4) environmental	(1) - (4) WHOQOL	SWAN	COR	Yes
Maternal Social Support and Self-Esteem										
Muñoz-Silva	2017	ESP	126	71.4	10.9	(1) (Parental) perceived social support	(1) MPSSS	CRS	COR	No
Vitanza	1999	USA	103	100	8.0	(5) (Parental) self-esteem (6) (Parental) social support	(5) RSE (6) SSQ6	ADHD-RS	COR	No
Positive parenting practices										
Chronis	2007	USA	108	81.5	5.3	(6) Positive parenting (structured task) (7) Positive parenting (play situation)	(6) + (7) Videotaped interaction coded with DPICS	DISC	COR	Yes
Haack	2016	USA	199 [hl]	58.3	8.6	(1) Positive parenting	(1) Study-specific questionnaire based on APQ & PCRQ	CSI	COR	Yes
Ramy	2018	EGY	87	66.7	13.1 [ts]	(6) Family relationships	(6) Study-specific questionnaire (warm vs. non-warm)	Mild vs. moderate & severe (CASS)	EV	Yes
Richards	2014	NLD	T1: 385 [ri]	T1: 83.4	T1: 11.5	(3) Maternal expressed emotion: warmth	(3) Observation & coding with CFI (T1)	CRS (T1)	COR	Yes
Negative parenting practices										
Chronis	2007	USA	108	81.5	5.3	(8) Negative parenting (structured task) (9) Negative parenting (play situation)	(8) + (9) Videotaped interaction coded with DPICS	DISC	COR	Yes
Daviss	2009	USA	104 [d]	63.5	13.8	(3) Current parent-child conflict	(3) CBQ	ADHD-RS [tp]	COR	Yes
Haack	2016	USA	199 [hl]	58.3	8.6	(2) Negative parenting	(2) Study-specific questionnaire based on APQ & PCRQ	CSI	COR	Yes
Mikami [out]	2015	CAN	63	66.7	8.2	(1) Parental negativity	(1) Observation & coding	CSI	COR	No
Podolski	2001	USA	37	64.3	9.8	(5) Maternal satisfaction with parenting performance (6) Paternal satisfaction with parenting performance	(5) + (6) Subscale of PSS	ADHD-ST	M	Yes

(continued)

Table 1. (continued)

First author	Year	Country [cc]	*N*	male (%)	Age (*M*)	Familial factor(s)	Measure of familial factor(s)	Measure of symptom severity	Statistic	Meta-Analysis
Ramy	2018	EGY	87	66.7	13.1 [ts]	(7) Parents' attitude: aggressive (8) Parents' attitude: abusive	(7) + (8) Study-specific questionnaire (y/n)	Mild vs. moderate & severe (CASS)	EV	Yes
Richards	2014	NLD	T1: 385 [rl]	T1: 83.4	T1: 11.5	(4) Maternal expressed emotion: criticism	(4) Observation & coding with CFI (T1)	CRS (T1)	COR	Yes
Further parenting practices and parent-child relationship										
Freitag	2012	GER	275	83.3	9.7	(5) Parenting in last 6 months	(5) Semi-structured interview on axis V of the MAS (WHO)	DCL-HKS	COR	No
Heckel	2013	AUS	479	69.7	10.7	(2) Relationship with mother	(2) Study-specific questionnaire	ADHD-ST	M	No
McLaughlin	2006	AUS	150	80.7	8.4	(3) Parenting practices	(3) PPS	CRS	COR	No
Familial risk										
Freitag	2012	GER	275	83.3	9.7	(6) Familial risk factors	(6) Semi-structured interview on axis V of the MAS (WHO)	DCL-HKS	COR	No
Lee	2008	CAN	419	80.4	8.6	(2) Psychosocial risk	(2) Psychosocial Risk Index [l]	ADHD-ST	M	No

Note. ADD-Brown-A = ADD-Brown Scale for Adults; ADHD-BPS = ADHD Behavioral Problem Scale; ADD-Brown-C = ADD-Brown Scale for Children; ADHD-RS = ADHD Rating Scale (Du Paul); ADHS-SB = German self-rating instrument for ADHD symptoms in adulthood; ADHD-SRQ = Dutch ADHD self-report questionnaire; ADHD-ST = ADHD subtypes; ANAQ-C = Abuse and Neglect Assessment Questionnaire for Children; APQ = Alabama Parenting Questionnaire; ASRS = Adult ADHD Self-Report Scale; BDI = Beck Depression Inventory; BSI = Brief Symptom Inventory; CAPA = Child and Adolescent Psychiatric Assessment; CASS = Conners' Adult Self Report Scale; CBCL = Child Behavior Checklist; CBQ = Conflict Behavior Questionnaire; CES-D = Center for Epidemiologic Studies-Depression; CFI = Camberwell Family Interview; CIRS = Children's Impairment Rating Scale; comb. = combined; COR = correlation; CPIC = Child's Perception of Interparental Conflict Scale; CR = cross-sectional study design (incl. potential intervention periods); CRS = Conners' Rating Scale (various versions); CSI = Child Symptom Inventory; DAWBA = Development and Well-Being Assessment; DBD-RS = Disruptive Behavior Disorders Rating Scale; DCL-HKS = German Hyperkinetic Syndrome Diagnosis Checklist; DIS = Diagnostic Interview Schedule; DISC = Diagnostic Interview Schedule for Children; DPICS = Dyadic Parent–Child Interaction Coding System; DSM = Diagnostic and Statistical Manual of Mental Disorders; ETISR = Early Trauma Inventory Self-Report; EV = events; GHQ = General Health Questionnaire; GSI = General Severity Index; HADS = Hospital Anxiety and Depression Scale; HSQ = Home Situations Questionnaire; K-SADS = Schedule for Affective Disorders and Schizophrenia for School-Age Children; LEC = Life Events Checklist; M = mean; MAS = Multiaxial Classification System for Mental Disorders in Childhood and Adolescence; MPSSS = Multidimensional Perceived Social Support Scale; N = total with ADHD; n. i. = no information available; OR = odds ratio; PCRQ = Parent–Child Relationship Questionnaire; PPS = Parenting Satisfaction Scale; PSI = Parenting Stress Index; PSI-DBD = Parent Structured Interview for Disruptive Behavior Disorders; PSS = Parenting Satisfaction Scale; PTSD = post-traumatic stress disorder; QoLP = scale designed to measure parental quality of life for parents of children with a neurodevelopmental disorder; REG = regression; RNG = range; RSE = Rosenberg Self-esteem Scale; SCID = Structured Clinical Interview for DSM; SCL-90 = Symptom Checklist; SD = standard deviation; SEI = (revised) Duncan Socioeconomic Index; SES = socioeconomic status; SF-8 = SF-8 Health Survey; SNAP = Swanson, Nolan and Pelham Assessment Scale; SSQ6 = Social Support Questionnaire; STAI = State-Trait Anxiety Inventory; SWAN = Strengths and Weaknesses of ADHD symptoms and Normal Behavior Scale; TESI = Trauma Events Screening Inventory; y/n = yes vs. no; WHO = World Health Organization; WHOQOL = World Health Organization Quality of Life Schedule; WURS = Wender-Utah Rating Scale.
[a]Total stress score minus the subscale scores for "distractibility/hyperactivity," "demandingness," "mood," and "parent health"; [c]The screening version of the DIS was used for 13% of cases; [cc]country codes according to ISO 3166-1 alpha3; [d]12 of 104 patients with delayed onset of ADHD; [h1]all children with ADHD subtype predominantly inattentive; [h2]analyses considered based on 68 subjects; [l] sum of the following items: (1) living in subsidized housing, (2) more than 6 people living in the same home, (3) separation from parents before the age of three, (4) single-parent family, (5) mother or father having less than a secondary school education, and (6) aversive parenting practices; [o] yes, if family received welfare, public assistance or supplementary security income; [out] identified as an outlier; [r] "Would you describe [sample child's] illness as mild, moderate, or severe?"; [ref] reference; [ri] only children with combined ADHD subtype; [s] retrospective based on records; [s1] study 1; [t] "how severe would you say your child's ADD or ADHD symptoms are (when not on medication)?"; [tp] teacher & parent rating averaged; [ts] total sample; [v] total stress score minus the subscale scores for "depression" and "distractibility/ hyperactivity"; [w] 80 mothers of 103 children; [x] demographics based on 135 children with ADHD; [+] and four further countries.

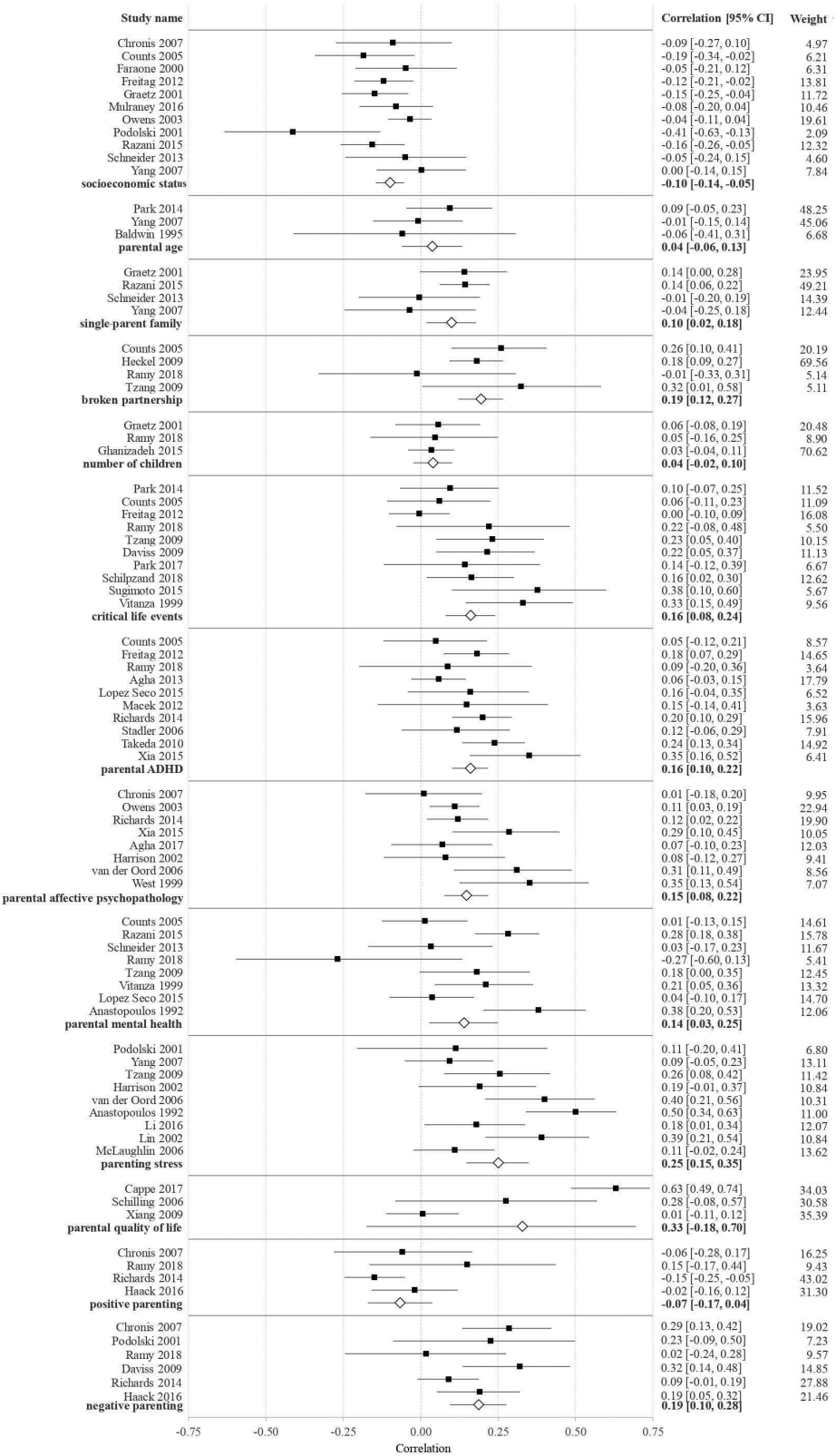

Figure 2. Forest plot of the meta-analysis of 13 familial factors

childhood ADHD symptom severity in children growing up in a two-parent family with a biological or adoptive parent and a stepparent compared to those growing up in a two-parent family with two biological or adoptive parents, suggesting that living with a stepparent does not influence ADHD symptom severity.

Broken partnership. The averaged correlation between a broken interparental partnership and child ADHD symptom severity was $r = .19$ and significantly different from zero ($k = 4$, 95% CI [0.12, 0.27], $p < .001$, $I^2 = 0\%$). Divorce or increased quarrels between the parents were associated with increased ADHD symptoms of the children.

Number of children and rank of birth. The averaged correlation between the number of children in the family and child ADHD symptom severity was $r = .04$ and not significantly different from zero ($k = 3$, 95% CI [−0.02, 0.10], $p = .22$, $I^2 = 0\%$). None of the study findings included in the meta-analysis provided evidence of an association between the number of children in the family and the severity of childhood ADHD or childhood ADHD subtype. Similarly, Ghanizadeh (2015) demonstrated that birth order was not significantly related to ADHD symptom severity.

Playing environment and neighborhood. Our systematic search identified only two studies that examined the playing environment and/or neighborhood in relation to child ADHD symptoms. Taylor and Kuo (2011) found that children and adolescents with ADHD who played in environments with extensive green areas had milder ADHD symptoms than those who played indoors ($d = 0.57$, $p < .001$), in a built-up environment outdoors ($d = 0.64$, $p = .001$), or in an environment with large trees outdoors ($d = 0.33$, $p < .05$). Razani et al. (2015) revealed that growing up in a neighborhood characterized by low levels of social support was associated with a more than fourfold increased risk of higher childhood ADHD symptom severity ($OR = 4.6$, 95% CI [2.8, 7.7]). Likewise, a lack of parks, libraries, or community centers in the neighborhood (amenities) was significantly associated with a slightly increased risk of higher symptom severity ($OR = 1.4$, 95% CI [1.1, 1.8]). In contrast, having garbage or vandalism in the neighborhood (disorder) was not significantly related to ADHD symptom severity.

Critical life events. Eleven studies provided findings pertaining to the factor "critical life events" and were initially eligible for inclusion in the meta-analysis. However, the effect size of one study (Gul & Gurkan, 2018) was identified as an outlier. After omission of this study, the averaged correlation between the experienced critical life events and child ADHD symptom severity was $r = .16$ and significantly different from zero ($k = 10$, 95% CI [0.08, 0.24], $p < .001$, $I^2 = 52\%$). Children with past traumatic experiences or with currently increased (familial) life stress showed increased ADHD symptoms. In contrast, the study by Gul and Gurkan (2018) found no significant association of child ADHD symptom severity with physical abuse, emotional abuse, physical neglect, or emotional neglect. In this study, only sexual abuse was associated with more severe ADHD symptoms ($OR_{IA} = 1.1$, 95% CI [1.0, 1.3]; $OR_{HYP} = 1.1$, 95% CI [1.0, 1.2]).

Parental and familial ADHD. The averaged correlation between parental ADHD and child ADHD symptom severity was $r = .16$ and significantly different from zero ($k = 10$, 95% CI [0.10, 0.22], $p < .001$, $I^2 = 37\%$). More severe ADHD symptoms in the parents were associated with more severe ADHD symptoms in their children. Our systematic search resulted in two additional studies that were not included in the meta-analysis because they investigated ADHD in all family members (including parents and siblings) and not just the parents. These two studies contrasted families of children with the combined subtype of ADHD and families of children with the less severe subtypes, and revealed comparable proportions of family members with ADHD in these two groups (Faraone et al., 2000; Lee et al., 2008). Together, these findings suggest that increases in parental ADHD symptoms are associated with increased child ADHD symptoms, but the number of family members with ADHD is not related to child ADHD.

Parental affective psychopathology. The averaged correlation between parental affective psychopathology and child ADHD symptom severity was $r = .15$ and significantly different from zero ($k = 8$, 95% CI [0.08, 0.22], $p < .001$, $I^2 = 42\%$). More severe parental symptoms of anxiety and depression were consistently associated with more severe ADHD symptoms in children with ADHD.

Parental antisocial personality. Our systematic search resulted in only one study examining the association between parental antisocial personality symptoms and child ADHD symptom severity. No significant associations between these two variables were observed (Chronis et al., 2007).

Parental, familial, and sibling mental health. The averaged correlation between parental mental health and child ADHD symptom severity was $r = .14$ and significantly different from zero ($k = 8$, 95% CI [0.03, 0.25], $p = .02$, $I^2 = 71\%$). More severe parental mental health problems were associated with more severe ADHD symptoms. One additional study was not included in the meta-analysis because it did not focus solely on the mental health of parents, but looked at the mental health of all family members. The study found a small correlation between family psychiatric disorders and child inattention symptoms ($r = .14$, $p = .02$), but not child hyperactivity symptoms (Freitag et al., 2012). Another

study focused on the mental health of siblings of children with ADHD. Schilling et al. (2006) found medium-sized correlation coefficients for the association between ADHD symptom severity in children with ADHD and symptoms of inattention ($r = .46$, $p = .02$), anxiety and depression ($r = .53$, $p = .01$), and social withdrawal ($r = .47$, $p = .02$) in their siblings. Correlations between child ADHD symptomatology and symptoms of hyperactivity, social problems, and aggression in their siblings were not significant. Together, these findings suggest an association between children's ADHD symptom severity and the severity of psychopathology in their family members.

Parenting stress. The averaged correlation between parenting stress and child ADHD symptom severity was $r = .25$ and significantly different from zero ($k = 9$, 95% CI [0.15, 0.35], $p < .001$, $I^2 = 67\%$). More severe parenting stress was consistently associated with more severe ADHD symptoms.

Parental quality of life. The averaged correlation between parental quality of life (QoL) and child ADHD symptom severity was $r = .33$, but not significantly different from zero ($k = 3$, 95% CI [−0.18, 0.70], $p = .20$, $I^2 = 94\%$), possibly due to the heterogeneity in study results. In the included studies, the correlation between parental QoL and child ADHD symptom severity ranged from $r = .63$ (Cappe et al., 2017) to $r = .01$ (Xiang et al., 2009).

Maternal social support and self-esteem. Two research groups investigated the association between mother-perceived social support and child ADHD symptom severity. Muñoz-Silva et al. (2017) found a medium-sized, negative correlation coefficient ($r = -.29$, $p = .001$), suggesting that more social support is associated with less severe child ADHD symptoms. In contrast, Vitanza and Guarnaccia (1999) reported a negligible correlation coefficient, thus calling into question the relationship between maternal self-esteem and child ADHD symptom severity.

Positive parenting practices. The averaged correlation between positive parenting practices and child ADHD symptom severity was $r = -.07$ and not significantly different from zero ($k = 4$, 95% CI [−0.17, 0.04], $p = .21$, $I^2 = 36\%$), suggesting that positive parenting behaviors are not associated with the severity of child ADHD symptoms.

Negative parenting practices. Seven studies provided findings for the factor "negative parenting practices." The effect size of one study (Mikami et al., 2015) was identified as an outlier and thus omitted from the meta-analysis. After this omission, the averaged correlation was $r = .19$ ($k = 6$, 95% CI [0.10, 0.28], $p < .001$, $I^2 = 44\%$). Negative parenting behaviors (e.g., parental expression of displeasure and criticism) were consistently associated with more severe child ADHD symptoms.

Further parenting practices and parent-child relationship. Three study findings could not be assigned to the two factors of positive and negative parenting behaviors. Two studies examining the relationship between parental parenting practices, as measured by the Parenting Practices Scale (McLaughlin & Harrison, 2006) or by axis 5 of the Multiaxial Classification System (MAS, Freitag et al., 2012) and child ADHD symptom severity found no significant associations. Heckel et al. (2013), who investigated the parent-child relationship, reported that mothers of children with predominantly inattentive ADHD rated the quality of their relationship with their children higher (on a self-developed and minimally described measure) than mothers of children with combined ADHD ($p = .001$).

Familial risk. Our systematic search identified two studies that examined the joint appearance of different familial risk factors and their association with child ADHD symptoms. Freitag et al. (2012) identified a small association between the number of familial risk factors detected using axis 5 of the MAS and child inattention symptoms ($r = .16$, $p = .01$), but not child hyperactivity. The study by Lee et al. (2008) found no statistically significant mean differences in psychosocial risk (regarding subsidized housing, cramped living conditions, early separation from parents, single-parent family, low parental education, and aversive parenting practices) between children with ADHD subtypes associated with lower and higher symptomatology.

Risk of Bias Between Studies

The heterogeneity of the articles included in the 13 meta-analyses differed significantly between the familial factors ($I^2 = 0\%$–94%). The heterogeneity of the included studies was estimated to be high ($I^2 > 75\%$) for parental QoL and moderate ($I^2 > 50\%$) for critical life events, parental overall psychopathology, and parenting stress (Higgins et al., 2003). The visual and formal evaluation of the 13 prepared funnel plots (see Supplement V) reached a similar assessment of a possible publication bias. As can be seen in Supplement VI, on the basis of Egger's regression test, a possible publication bias was referred to exclusively for the meta-analysis on critical life events ($p < .10$). Based on the trim-and-fill procedure, studies were imputed for four of the 13 meta-analyses performed. For the familial factors "parental affective psychopathology" and "number of children," the discrepancy between the initial and adapted effect estimate was only minor (one or two studies imputed, $\Delta r \leq .02$); for "negative parenting practices," the discrepancy was medium-sized (one study imputed, $\Delta r \leq .04$) and for "critical life events," the discrepancy was relevant (four

studies imputed, $\Delta r = .07$). In summary, for the familial factor "critical life events," there is significant evidence of an asymmetric funnel plot and a derivable risk of publication bias. In addition, there is evidence, albeit less strong, of asymmetry of the funnel plot for the familial factors "parental affective psychopathology," "number of children," and "negative parenting practices."

Sensitivity Analyses

In the first set of sensitivity analyses, the meta-analyses were repeated excluding studies that were based on a comparison of ADHD subtypes (see also Supplement VII). For two familial factors, none of the included studies were based on a comparison of ADHD subtypes. For four familial factors, the number of studies based on a dimensional measure of ADHD symptom severity was too small to conduct an additional analysis using only these studies. For the remaining seven factors, between 55% and 90% of the originally included studies were considered in a sensitivity analysis. No tendency toward a general increase or decrease in the resulting correlation coefficients was derived. For two familial factors, the sensitivity analysis revealed a minor decrease in the determined correlation ($\Delta r = .02$). For four familial factors, the sensitivity analysis revealed an increase in the determined correlations ($\Delta r \leq .07$). For one familial factor, the estimated effect size remained unchanged. For none of the familial factors was the significance associated with the determined correlation coefficient estimated to be different (significant vs. non-significant) from the original analyses on the basis of the sensitivity analyses.

In the second set of sensitivity analyses, the meta-analyses were repeated excluding those studies that did not demonstrate sufficient methodological quality (see also Supplement VII). These sensitivity analyses were carried out for the following three familial factors: critical life events, parental ADHD, and parental mental health. For a fourth familial factor (parental age), the analysis could not be repeated due to an insufficient number of studies ($k < 3$) of sufficient quality. In the additionally performed analyses, between 88% and 90% of the originally included studies were considered. Unchanged effect estimates were obtained for the familial factors of "parental ADHD," and slightly decreased effect estimates were obtained for critical life events and parental mental health ($\Delta r \leq .03$).

Discussion

There is a broad consensus among scientists and practitioners that various familial conditions influence child development within the framework of reciprocally interacting environmental systems (e.g., Bronfenbrenner, 1992; Dush et al., 2013). To the best of our knowledge, this article presents the first systematic review and meta-analysis on the associations between multiple familial factors and ADHD symptom severity in children and adolescents diagnosed with ADHD.

The meta-analysis revealed significant associations between child ADHD symptom severity and the following familial factors in samples of children with ADHD: SES, single-parent family, broken parental partnership, critical life events, parental ADHD, parental affective psychopathology, parental mental health, parenting stress, and negative parenting practices. The averaged correlations were in the expected direction. The strength of the averaged correlations varied between $r = |.10|$ and $r = |.25|$ and thus has to be rated as small. As a consequence, the proportion of the variance in child ADHD symptom severity that can be explained by the familial factors lay between 1% and 6%.

The results of this meta-analysis are consistent with studies reporting significant associations between the above-mentioned familial factors and the presence of an ADHD diagnosis. Correspondingly, the current findings demonstrate that these familial factors not only represent risk factors for the development of ADHD but are also associated with ADHD symptom severity in children diagnosed with ADHD. In addition, the strength of the correlations identified in the meta-analysis was broadly in line with the findings of previous reviews and meta-analyses that included both clinical and community samples (Clayton et al., 2018; Connell & Goodman, 2002; Goodman et al., 2011, 2020; Russell et al., 2016; Theule et al., 2013; Weijers et al., 2018; Weyers et al., 2019). These works revealed that numerous familial factors show small associations with the occurrence of ADHD, but they failed to identify one or more familial factors that were of prominent importance (Faraone et al., 2021). The present results replicate this pattern: Our analyses demonstrate that a number of factors are associated with ADHD symptom severity in clinical samples, and that no single factor is able to explain a large amount of variance in ADHD symptom severity.

The following familial factors were not significantly associated with ADHD symptom severity in the present meta-analysis: parental QoL, parental age, number of children in family, and positive parenting practices. For "parental QoL," a medium-sized averaged correlation was obtained ($r = .33$) but the calculated probabilities of error did not fall below the specified significance level of 5%. This is likely due to the high heterogeneity of the included studies (> 90%). Interestingly, the strength of correlation between parental QoL and ADHD symptom severity is comparable to the effect size found in a meta-analysis that contrasted parental quality of life in children with and without ADHD (Dey et al., 2019). The factors "parental age," "number of children in family," and "positive parenting practices" can be classified as not (meaningfully) associated with childhood ADHD symptom severity ($r \leq |.07|$). One potential explanation for

this finding is the possible nonlinearity of an underlying relationship. For example, a recent meta-analysis by Min et al. (2021) revealed a nonlinear relationship of parental age with offspring ADHD. Specifically, the highest risk of ADHD in the offspring was found in parents younger than 20 years. This risk decreased with increasing parental age until 31 to 35 years, after which it subsequently increased. It is also possible that nonlinear relationships with ADHD symptom severity may be detected for further variables such as the number of children in the family. Notably, Goodman et al. (2020) found that the associations of positive and negative parenting with overall child functioning did not significantly differ in strength. As such, the greater importance of negative parenting behaviors compared to positive parenting behaviors revealed in the present meta-analysis might be specific to externalizing child behavior problems (Kim & Yoo, 2013; Pinquart, 2017).

The supplemental review provides evidence, on the basis of individual studies, of associations of familial factors with child ADHD symptom severity (e.g., ethnic group, playing environment, mental health of siblings). However, at this time, there is insufficient evidence to support additional indicators of adverse family conditions associated with ADHD symptom severity in children.

The central purpose of this study was to summarize research findings on the associations between multiple familial factors and ADHD symptom severity in children with ADHD in order to complement findings from existing meta-analyses that examined single risk factors or treated ADHD as a dichotomous variable. Based on the nine associations uncovered between familial factors and symptom severity within the group of children with ADHD, inferences for routine clinical care regarding treatment planning and prognosis seem possible.

Strengths and Limitations

In evaluating the reported results, the strengths and limitations of the present work should be considered.

Heterogeneity of the included studies, publication bias, and study quality. For the following three familial factors, a moderate heterogeneity of the included studies should be noted (>50%): critical life events, parental mental health, and parenting stress. In these cases, the findings should be interpreted with caution. For parental QoL, a high heterogeneity of studies was found (>90%). Two common procedures in the presence of substantial heterogeneity in included studies are to examine (a) outliers and (b) theoretical factors (e.g., gender of parent or child) or methodological factors (e.g., source of data or parental diagnosis vs. parental symptoms) as potential moderators. Outliers could not be detected for any of these four factors. With regard to parental QoL, it is important to note that the included studies investigated different facets of the concept of "quality of life," such as physical, psychological, and social. These facets of QoL might be differentially associated with child ADHD symptom severity. Unfortunately, due to the small number of included studies, it was not possible to conduct detailed analyses of the different facets of parental QoL and possible moderators for the other familial factors in the meta-analysis. Indications of a possible publication bias were found for four factors and indications of questionable study quality for three factors (one included study each). However, the sensitivity analyses indicated that the associations persisted even after excluding the studies in question.

Search strategy and inclusion criteria. The salient characteristic of this literature review of only including studies that investigated children and adolescents with a diagnosis of ADHD may be accompanied by a considerable limitation in terms of statistical variance. An alternative would have been to include not only studies with samples of children with a clinical diagnosis of ADHD but also studies with samples of children with an ADHD symptom severity exceeding a predefined cut-off on a parent or teacher rating scale. Due to the wide variety of measurement methods and cut-offs used in the different studies, this option was rejected for reasons of feasibility of the selection process, the homogeneity of the included studies, and the high concordance between the samples studied and patients in routine clinical care. The strong focus of the present work on the symptom severity of children affected by ADHD is reflected in the inclusion of the keyword "severity" in the search strategy. During the development of the search strategy, the use of more specific keywords ("symptom severity"), non-specific keywords ("symptoms") as well as synonymous terms ("intensity") were tested but discarded in light of the criteria of precision and recall. Another feature of the search strategy is that we did not focus on a small number of selected familial factors (e.g., maternal depression) but rather chose the search terms to include as many familial factors as possible. As in any systematic literature search, it is likely that not all relevant literature references could be identified. Furthermore, the decision not to include unpublished literature owing to the questionable methodological quality may have led to an overestimation of the true effect size due to publication bias. However, there is evidence that effect sizes do not differ significantly between published and unpublished studies (e.g., Theule et al., 2013).

Informants of Child ADHD symptom severity. As studies often use parent ratings and rarely use teacher ratings, this work focused more strongly on parent ratings and considered teacher ratings only in the absence of parent ratings. However, given that parents observe the child's symptoms only in specific contexts, their judgment does not reflect the

entire complexity of ADHD. Greater consideration of teacher judgment could complement the picture (Narad et al., 2015) and can be recommended for future studies.

Direction of influence, interaction of familial factors, and gene-environment debate. Based on the predominantly cross-sectional, correlational study designs evaluated for this study, there is no evidence to suggest the direction of influence between familial factors and child ADHD symptom severity. Another significant limitation of the present literature review is that it lists the studied familial factors side by side, without making any statements about the interrelationships among them. In this regard, it might be beneficial to replicate and extend the analysis of the primary data to examine the interactions of familial factors, for example based on structural equation models. Moreover, it should be noted that the conceptualization of familial factors in the present work includes, but is not limited to, genetic transmission. Specifically, the identified relationship between parental and child psychopathology is understood to be caused both by the transmission of genetic material and by environmental processes (e.g., Goodman & Gotlib, 1999). A fundamental challenge in interpreting the associations identified between familial factors such as negative parenting behavior and child symptoms is that shared genes between the children studied and their biological parents may influence both the examined familial factors and the observed child symptoms. A careful application of genetically informed research designs would provide the opportunity to address this fundamental interpretive challenge (Harold et al., 2017).

Implications

Identifying central familial factors for symptom severity in children with ADHD can help guide the evidence-based selection and further development of interventions to manage and potentially prevent severe courses of childhood ADHD. In terms of the strengths of the correlations identified in the present work, the highest correlation coefficients ($r \geq .19$) emerged for parental stress, a dysfunctional interparental relationship, and negative (as opposed to positive) parenting behaviors. Parental psychopathologies and the experience of critical life events showed slightly lower correlations with child ADHD symptom severity ($r = .14$–$.16$). The associations with the socioeconomic position of the family and growing up in a single-parent household were less strong ($r \geq .10$). Consequently, in children and adolescents with ADHD, a standard assessment of parental psychopathology, negative parenting behaviors, experienced critical life events, and perceived parental stress can be recommended. The results of the assessment should inform the selection of intervention modules. It can also be recommended that the commonly used interventions be expanded to include parent-centered interventions to address parental psychopathology, couple-centered interventions to improve the interparental relationship, and family-centered interventions to reduce negative parenting behaviors and parental stress. It would be useful to conduct intervention studies that examine whether improvements in these familial factors lead to improvements in child ADHD.

Conclusion

Despite the above-mentioned limitations, this systematic review and meta-analysis was able to provide an overview of the presence and strength of associations between familial factors and symptom severity in children and adolescents affected by ADHD. A better understanding of which familial factors are associated with severe childhood ADHD provides an opportunity to improve the selection and focus of interventions, to refine existing interventions, and to develop new interventions.

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Data Availability Statement

The corresponding author can provide raw data used for this meta-analysis and supplemental review upon request.

Supplemental Material

Supplemental material for this article is available online.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5*. Author.

Banerjee, T. D., Middleton, F., & Faraone, S. V. (2007). Environmental risk factors for attention-deficit hyperactivity disorder.. *Acta Paediatrica*, *96*(9), 1269–1274.

Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2021). *Introduction to meta-analysis*. John Wiley & Sons.

Bronfenbrenner, U. (1992). *Ecological systems theory*. Jessica Kingsley Publishers.

Cheung, K., Aberdeen, K., Ward, M. A., & Theule, J. (2018). Maternal depression in families of children with ADHD: A meta-analysis. *Journal of Child and Family Studies*, *27*(4), 1015–1028.

Cheung, K., & Theule, J. (2016). Parental psychopathology in families of children with ADHD: A meta-analysis. *Journal of Child and Family Studies*, *25*(12), 3451–3461.

Choi, Y., Shin, J., Cho, K. H., & Park, E.-C. (2017). Change in household income and risk for attention deficit hyperactivity disorder during childhood: A nationwide population-based cohort study. *Journal of Epidemiology*, *27*(2), 56–62.

Cicchetti, D. V. (1994). Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. *Psychological Assessment*, *6*(4), 284–290.

Clayton, K., Lee, J. B., Cheung, K., Theule, J., & Henrikson, B. (2018). Quantifying the relationship between attention-deficit/hyperactivity disorder and experiences of child maltreatment: A meta-analysis. *Child Abuse Review*, *27*(5), 361–377.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2th ed.). Routledge Academic.

Connell, A. M., & Goodman, S. H. (2002). The association between psychopathology in fathers versus mothers and children's internalizing and externalizing behavior problems: A meta-analysis. *Psychological Bulletin*, *128*(5), 746–773.

Dey, M., Paz Castro, R., Haug, S., & Schaub, M. P. (2019). Quality of life of parents of mentally-ill children: A systematic review and meta-analysis. *Epidemiology and Psychiatric Sciences*, *28*(5), 563–577.

Dush, C. M. K., Schmeer, K. K., & Taylor, M. (2013). Chaos as a social determinant of child health: Reciprocal associations? *Social Science & Medicine*, *95*, 69–76.

Duval, S., & Tweedie, R. (2000). Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics*, *56*(2), 455–463.

Egger, M., Davey Smith, G., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ*, *315*(7109), 629–634.

Faraone, S. V., Banaschewski, T., Coghill, D., Zheng, Y., Biederman, J., Bellgrove, M. A., Newcorn, J. H., Gignac, M., Al Saud, N. M., Manor, I., Rohde, L. A., Yang, L., Cortese, S., Almagor, D., Stein, M. A., Albatti, T. H., Aljoudi, H. F., Alqahtani, M. M. J., Asherson, P., ... Wang, Y. (2021). The world federation of ADHD international consensus statement: 208 evidence-based conclusions about the disorder. *Neuroscience and Biobehavioral Reviews*, *128*, 789–818.

Faraone, S. V., & Larsson, H. (2019). Genetics of attention deficit hyperactivity disorder. *Molecular Psychiatry*, *24*(4), 562–575.

Goodman, S. H., & Gotlib, I. H. (1999). Risk for psychopathology in the children of depressed mothers: A developmental model for understanding mechanisms of transmission. *Psychological Review*, *106*(3), 458–490.

Goodman, S. H., Rouse, M. H., Connell, A. M., Broth, M. R., Hall, C. M., & Heyward, D. (2011). Maternal depression and child psychopathology: A meta-analytic review. *Clinical Child and Family Psychology Review*, *14*(1), 1–27.

Goodman, S. H., Simon, H. F. M., Shamblaw, A. L., & Kim, C. Y. (2020). Correction to: Parenting as a mediator of associations between depression in mothers and children's functioning: A systematic review and meta-analysis. *Clinical Child and Family Psychology Review*, *23*(4), 427–460.

Harold, G. T., Leve, L. D., & Sellers, R. (2017). How can genetically informed research help inform the next generation of interparental and parenting interventions? *Child Development*, *88*(2), 446–458.

Higgins, J. P., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *BMJ*, *327*(7414), 557–560.

Huang, L., Wang, Y., Zhang, L., Zheng, Z., Zhu, T., Qu, Y., & Mu, D. (2018). Maternal smoking and attention-deficit/hyperactivity disorder in offspring: A meta-analysis. *Pediatrics*, *141*(1), e20172465.

Keilow, M., Wu, C., & Obel, C. (2020). Cumulative social disadvantage and risk of attention deficit hyperactivity disorder: Results from a nationwide cohort study. *SSM-Population Health*, *10*, 100548.

Kim, D. H., & Yoo, I. Y. (2013). Relationship between attention deficit hyperactive disorder symptoms and perceived parenting practices of school-age children. *Journal of Clinical Nursing*, *22*(7–8), 1133–1139.

Min, X., Li, C., & Yan, Y. (2021). Parental age and the risk of ADHD in offspring: A systematic review and meta-analysis. *International Journal of Environmental Research and Public Health*, *18*(9), 4939.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G.; The PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, *6*(7), e1000097.

Narad, M. E., Garner, A. A., Peugh, J. L., Tamm, L., Antonini, T. N., Kingery, K. M., Simon, J. O., & Epstein, J. N. (2015). Parent-teacher agreement on ADHD symptoms across development. *Psychological Assessment*, *27*(1), 239–248.

Park, J. L., Hudec, K. L., & Johnston, C. (2017). Parental ADHD symptoms and parenting behaviors: A meta-analytic review. *Clinical Psychology Review*, *56*, 25–39.

Pinquart, M. (2017). Associations of parenting dimensions and styles with externalizing problems of children and adolescents: An updated meta-analysis. *Developmental Psychology*, *53*(5), 873–932.

Polanczyk, G. V., Salum, G. A., Sugaya, L. S., Caye, A., & Rohde, L. A. (2015). Annual research review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. *Journal of Child Psychology and Psychiatry*, *56*(3), 345–365.

Russell, A. E., Ford, T., Williams, R., & Russell, G. (2016). The association between socioeconomic disadvantage and attention deficit/hyperactivity disorder (ADHD): A systematic review. *Child Psychiatry and Human Development*, *47*(3), 440–458.

Sellers, R., Harold, G. T., Thapar, A., Neiderhiser, J. M., Ganiban, J. M., Reiss, D., Shaw, D. S., Natsuaki, M. N., & Leve, L. D. (2020). Examining the role of genetic risk and longitudinal transmission processes underlying maternal parenting and psychopathology and children's ADHD symptoms and aggression: Utilizing the advantages of a prospective adoption design. *Behavior Genetics*, *50*(4), 247–262.

Thapar, A., Cooper, M., Eyre, O., & Langley, K. (2013). Practitioner review: what have we learnt about the causes of ADHD? *Journal of Child Psychology and Psychiatry*, *54*(1), 3–16.

Theule, J., Wiener, J., Tannock, R., & Jenkins, J. M. (2013). Parenting stress in families of children with ADHD: A meta-analysis. *Journal of Emotional and Behavioral Disorders*, *21*(1), 3–17.

Tung, I., Brammer, W. A., Li, J. J., & Lee, S. S. (2015). Parenting behavior mediates the intergenerational association of parent and child offspring ADHD symptoms. *Journal of Clinical Child & Adolescent Psychology*, *44*(5), 787–799.

Weijers, D., van Steensel, F. J. A., & Bögels, S. M. (2018). Associations between psychopathology in mothers, fathers and their children: A structural modeling approach. *Journal of Child and Family Studies*, *27*(6), 1992–2003.

Wells, G. A., Shea, B., O'Connell, D., Peterson, J., Welch, V., Losos, M., & Tugwell, P. (2000, July 6). *The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses*. http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp

Weyers, L., Zemp, M., & Alpers, G. W. (2019). Impaired interparental relationships in families of children with attention-deficit/hyperactivity disorder (ADHD). *Zeitschrift für Psychologie*, *227*(1), 31–41.

Studies included in the meta-analysis and supplemental review

Agha, S. S., Zammit, S., Thapar, A., & Langley, K. (2013). Are parental ADHD problems associated with a more severe clinical presentation and greater family adversity in children with ADHD? *European Child & Adolescent Psychiatry*, *22*(6), 369–377.

Agha, S. S., Zammit, S., Thapar, A., & Langley, K. (2017). Maternal psychopathology and offspring clinical outcome: A four-year follow-up of boys with ADHD. *European Child & Adolescent Psychiatry*, *26*(2), 253–262.

Anastopoulos, A. D., Guevremont, D. C., Shelton, T. L., & DuPaul, G. J. (1992). Parenting stress among families of children with attention deficit hyperactivity disorder. *Journal of Abnormal Child Psychology*, *20*(5), 503–520.

Baldwin, K., Brown, R. T., & Milan, M. A. (1995). Predictors of stress in caregivers of attention deficit hyperactivity disordered children. *American Journal of Family Therapy*, *23*(2), 149–160.

Cappe, E., Bolduc, M., Rouge, M. C., Saiag, M. C., & Delorme, R. (2017). Quality of life, psychological characteristics, and adjustment in parents of children with Attention-Deficit/Hyperactivity Disorder. *Quality of Life Research*, *26*(5), 1283–1294.

Chronis, A. M., Lahey, B. B., Pelham, W. E., Jr., Williams, S. H., Baumann, B. L., Kipp, H., Jones, H. A., & Rathouz, P. J. (2007). Maternal depression and early positive parenting predict future conduct problems in young children with attention-deficit/hyperactivity disorder. *Developmental Psychology*, *43*(1), 70–82.

Counts, C. A., Nigg, J. T., Stawicki, J. A., Rappley, M. D., & von Eye, A. (2005). Family adversity in DSM-IV ADHD combined and inattentive subtypes and associated disruptive behavior problems. *Journal of the American Academy of Child & Adolescent Psychiatry*, *44*(7), 690–698.

Daviss, W. B., Diler, R. S., & Birmaher, B. (2009). Associations of lifetime depression with trauma exposure, other environmental adversities, and impairment in adolescents with ADHD. *Journal of Abnormal Child Psychology*, *37*(6), 857–871.

Faraone, S. V., Biederman, J., & Friedman, D. (2000). Validity of DSM-IV subtypes of attention-deficit/hyperactivity disorder: A family study perspective. *Journal of the American Academy of Child & Adolescent Psychiatry*, *39*(3), 300–307.

Freitag, C. M., Hanig, S., Schneider, A., Seitz, C., Palmason, H., Retz, W., & Meyer, J. (2012). Biological and psychosocial environmental risk factors influence symptom severity and psychiatric comorbidity in children with ADHD. *Journal of Neural Transmission*, *119*(1), 81–94.

Ghanizadeh, A. (2015). Conduct behaviors and oppositional defiant behaviors in children and adolescents with ADHD. *Postgraduate Medical Journal*, *127*(3), 289–294.

Graetz, B. W., Sawyer, M. G., Hazell, P. L., Arney, F., & Baghurst, P. (2001). Validity of DSM-IV ADHD subtypes in a nationally representative sample of Australian children and adolescents. *Journal of the American Academy of Child & Adolescent Psychiatry*, *40*(12), 1410–1417.

Gul, H., & Gurkan, C. K. (2018). Child maltreatment and associated parental factors among children with ADHD: A comparative study. *Journal of Attention Disorders*, *22*(13), 1278–1288.

Haack, L. M., Villodas, M. T., McBurnett, K., Hinshaw, S., & Pfiffner, L. J. (2016). Parenting Mediates Symptoms and Impairment in Children With ADHD-Inattentive Type. *Journal of Clinical Child & Adolescent Psychology*, *45*(2), 155–166.

Harrison, C., & Sofronoff, K. (2002). ADHD and parental psychological distress: Role of demographics, child behavioral characteristics, and parental cognitions. *Journal of the American Academy of Child & Adolescent Psychiatry*, *41*(6), 703–711.

Heckel, L., Clarke, A., Barry, R., McCarthy, R., & Selikowitz, M. (2009). The relationship between divorce and the psychological well-being of children with ADHD: differences in age, gender, and subtype. *Emotional and Behavioural Difficulties*, *14*(1), 49–68.

Heckel, L., Clarke, A. R., Barry, R. J., McCarthy, R., & Selikowitz, M. (2013). Child AD/HD severity and psychological functioning in relation to divorce, remarriage, multiple transitions and the quality of family relationships. *Emotional & Behavioural Difficulties*, *18*(4), 353–373.

Lee, S. I., Schachar, R. J., Chen, S. X., Ornstein, T. J., Charach, A., Barr, C., & Ickowicz, A. (2008). Predictive validity of DSM-IV and ICD-10 criteria for ADHD and hyperkinetic disorder. *Journal of Child Psychology & Psychiatry*, *49*(1), 70–78.

Li, Y., Jiang, W. Q., Du, Y. S., & Coghill, D. (2016). Relationships between behavioral symptoms of non-medicated Chinese children with attention deficit hyperactivity disorder and parenting stress: Comparison of different subtypes and comorbidities. *Asia-Pacific Psychiatry*, *8*(2), 127–135.

Lin, Y.-F., & Chung, H.-H. (2002). Parenting stress and parents' willingness to accept treatment in relation to behavioral problems of children with attention-deficit hyperactive disorder. *Journal of Nursing Research*, *10*(1), 43–56.

López Seco, F., Aguado-Gracia, J., Mundo-Cid, P., Acosta-Garcia, S., Marti-Serrano, S., Gaviria, A. M., Vilella, E., & Masana-Marin, A. (2015). Maternal psychiatric history is associated with the symptom severity of ADHD in offspring. *Psychiatry Research, 226*(2–3), 507–512.

Macek, J., Gosar, D., & Tomori, M. (2012). Is there a correlation between ADHD symptom expression between parents and children? *Neuroendocrinology Letters*, *33*(2), 201–206.

McLaughlin, D. P., & Harrison, C. A. (2006). parenting practices of mothers of children with ADHD: The role of maternal and child factors. *Child and Adolescent Mental Health*, *11*(2), 82–88.

Mikami, A. Y., Chong, G. K., Saporito, J. M., & Jiwon Na, J. (2015). Implications of parental affiliate stigma in families of children with ADHD. *Journal of Clinical Child and Adolescent Psychology*, *44*(4), 595–603.

Mulraney, M., Giallo, R., Lycett, K., Mensah, F., & Sciberras, E. (2016). The bidirectional relationship between sleep problems and internalizing and externalizing problems in children with ADHD: a prospective cohort study. *Sleep Medicine*, *17*, 45–51.

Muñoz-Silva, A., Lago-Urbano, R., Sanchez-Garcia, M., & Carmona-Márquez, J. (2017). Child/adolescent's ADHD and parenting stress: The mediating role of family impact and conduct problems. *Frontiers in Psychology*, *8*, 2252.

Owens, E. B., Hinshaw, S. P., Kraemer, H. C., Arnold, L. E., Abikoff, H. B., Cantwell, D. P., Conners, C. K., Elliott, G., Greenhill, L. L., Hechtman, L., Hoza, B., Jensen, P. S., March, J. S., Newcorn, J. H., Pelham, W. E., Severe, J. B., Swanson, J. M., Vitiello, B., Wells, K. C., & Wigal, T. (2003). Which treatment for whom for ADHD? Moderators of treatment response in the MTA. *Journal of Consulting and Clinical Psychology*, *71*(3), 540–552.

Park, S., Cho, S. C., Kim, J. W., Shin, M. S., Yoo, H. J., Oh, S. M., Han, D. H., Cheong, J. H., & Kim, B. N. (2014). Differential perinatal risk factors in children with attention-deficit/hyperactivity disorder by subtype. *Psychiatry Research*, *219*(3), 609–616.

Park, S., Kim, B. N., Kim, J. W., Shin, M. S., Yoo, H. J., & Cho, S. C. (2017). Interactions Between Early Trauma and Catechol-O-Methyltransferase Genes on Inhibitory Deficits in Children With ADHD. *Journal of Attention Disorders*, *21*(3), 183–189.

Podolski, C.-L., & Nigg, J. T. (2001). Parent stress and coping in relation to child ADHD severity and associated child disruptive behavior problems. *Journal of Clinical Child Psychology*, *30*(4), 503–513.

Ramy, H., El Sheikh, M., Sultan, M., Bassim, R., Eid, M., Ali, R., & El Missiry, M. (2018). Risk factors influencing severity of attention deficit hyperactivity disorder in a sample of preparatory school students in Cairo. *Clinical Child Psychology & Psychiatry*, *23*(4), 542–555.

Razani, N., Hilton, J. F., Halpern-Felsher, B. L., Okumura, M. J., Morrell, H. E., & Yen, I. H. (2015). Neighborhood Characteristics and ADHD: Results of a National Study. *Journal of Attention Disorders*, *19*(9), 731–740.

Richards, J. S., Arias Vásquez, A., Rommelse, N. N. J., Oosterlaan, J., Hoekstra, P. J., Franke, B., Hartman, C. A., & Buitelaar, J. K. (2014). A follow-up study of maternal expressed emotion toward children with attention-deficit/hyperactivity disorder (ADHD): Relation with severity and persistence of ADHD and comorbidity. *Journal of the American Academy of Child & Adolescent Psychiatry*, *53*(3), 311–319.

Schilling, V., Petermann, F., & Hampel, P. (2006). Psychosocial situation in families of children with ADHD. *Zeitschrift für Psychiatrie, Psychologie und Psychotherapie*, *54*(4), 293–301.

Schilpzand, E. J., Sciberras, E., Alisic, E., Efron, D., Hazell, P., Jongeling, B., Anderson, V., & Nicholson, J. M. (2018). Trauma exposure in children with and without ADHD: Prevalence and functional impairment in a community-based study of 6–8-year-old Australian children. *European Child & Adolescent Psychiatry*, *27*(6), 811–819.

Schneider, B. W., Gerdes, A. C., Haack, L. M., & Lawton, K. E. (2013). Predicting Treatment Dropout in Parent Training Interventions for Families of School-Aged Children With ADHD. *Child & Family Behavior Therapy*, *35*(2), 144–169.

Stadler, C., Holtmann, M., Claus, D., Büttner, G., Berger, N., Maier, J., Poustka, F., & Schmeck, K. (2006). Familiäre Muster bei Störungen von Aufmerksamkeit und Impulskontrolle. Familial patterns in disorders of attention and impulsive control. *Praxis der Kinderpsychologie und Kinderpsychiatrie*, *55*(5), 350–362.

Sugimoto, A., Suzuki, Y., Endo, T., Matsumoto, K., Sugiyama, T., & Someya, T. (2015). Efficacy of atomoxetine for symptoms of attention-deficit/hyperactivity disorder in children with a history of child abuse. *Journal of Child & Adolescent Psychopharmacology*, *25*(3), 269–271.

Takeda, T., Stotesbery, K., Power, T., Ambrosini, P. J., Berrettini, W., Hakonarson, H., & Elia, J. (2010). Parental ADHD status and its association with proband ADHD subtype and severity. *The Journal of Pediatrics*, *157*(6), 995–1000.

Tamayo, J. M., Pumariega, A., Rothe, E. M., Kelsey, D., Allen, A. J., Velez-Borras, J., Williams, D., Anderson, S. G., & Durell, T. M. (2008). Latino versus Caucasian response to atomoxetine in attention-deficit/hyperactivity disorder. *Journal of Child & Adolescent Psychopharmacology*, *18*(1), 44–53.

Taylor, A. F., & Kuo, F. E. (2011). Could exposure to everyday green spaces help treat ADHD? Evidence from children's play settings. *Journal of Applied Psychology*, *3*(3), 281–303.

Tzang, R. F., Chang, Y. C., & Liu, S. I. (2009). The association between children's ADHD subtype and parenting stress and parental symptoms. *International Journal of Psychiatry in Clinical Practice*, *13*(4), 318–325.

van der Oord, S., Prins, P. J., Oosterlaan, J., & Emmelkamp, P. M. (2006). The association between parenting stress, depressed mood and informant agreement in ADHD and ODD. *Behaviour Research and Therapy*, *44*(11), 1585–1595.

Vitanza, S. A., & Guarnaccia, C. A. (1999). A model of psychological distress for mothers of children with attention-deficit hyperactivity disorder. *Journal of Child and Family Studies*, *8*(1), 27–45.

West, J., Houghton, S., Douglas, G., Wall, M., & Whiting, K. (1999). Levels of self-reported depression among mothers of children with Attention-Deficit/Hyperactivity Disorder. *Journal of Attention Disorders*, *3*(3), 135–140.

Xia, W., Shen, L., & Zhang, J. (2015). Comorbid anxiety and depression in school-aged children with attention deficit hyperactivity disorder (ADHD) and self-reported symptoms of ADHD, anxiety, and depression among parents of school-aged children with and without ADHD. *Shanghai Archives of Psychiatry*, *27*(6), 356–367.

Xiang, Y.-T., Luk, E. S. L., & Lai, K. Y. C. (2009). Quality of life in parents of children with attention-deficit-hyperactivity disorder in Hong Kong. *Australian and New Zealand Journal of Psychiatry*, *43*(8), 731–738.

Yang, P., Jong, Y.-J., Hsu, H.-Y., & Tsai, J.-H. (2007). Psychiatric features and parenting stress profiles of subtypes of attention-deficit/hyperactivity disorder: results from a clinically referred Taiwanese sample. *Journal of Developmental & Behavioral Pediatrics*, *28*(5), 369–375.

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2.2 Direct and Indirect Effects of Familial Factors on Child Externalizing Symptoms

Jendreizik, L. T., Hautmann, C., von Wirth, E., Dose, C., Thöne, A.-K., Treier, A.-K., Banaschewski, T., Becker, K., Brandeis, D., Geissler, J., Hebebrand, J., Hohmann, S., Holtmann, M., Huss, M., Jans, T., Kaiser, A., Millenet, S., Poustka, L., Schneider, P., & Döpfner, M. (2022). The importance of familial risk factors in children with ADHD: direct and indirect effects of family adversity, parental psychopathology and parenting practices on externalizing symptoms. *Child and Adolescent Psychiatry and Mental Health, 16*(1), Article 96. https://doi.org/10.1186/s13034-022-00529-z

The following publication fully corresponds to the published manuscript. Accordingly, the formatting, numbering of tables and figures, and reference list have not been adjusted according to the overall thesis. The supplement of the publication can be found in the appendix.

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RESEARCH

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The importance of familial risk factors in children with ADHD: direct and indirect effects of family adversity, parental psychopathology and parenting practices on externalizing symptoms

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Abstract

Background: Children experiencing unfavorable family circumstances have an increased risk of developing externalizing symptoms. The present study examines the direct, indirect and total effects of family adversity, parental psychopathology, and positive and negative parenting practices on symptoms of attention-deficit/hyperactivity disorder (ADHD) and oppositional defiant disorder (ODD) in children with ADHD.

Methods: Data from 555 children ($M = 8.9$ years old, 80.5% boys) who participated in a multicenter study on the treatment of ADHD (ESCAschool) were analyzed using structural equation modeling (SEM).

Results: The SEM analyses revealed that (a) family adversity and parental psychopathology are associated with both child ADHD and ODD symptoms while negative parenting practices are only related to child ODD symptoms; (b) family adversity is only indirectly associated with child ADHD and ODD symptoms, via parental psychopathology and negative parenting practices; (c) the detrimental effect of negative parenting practices on child ADHD and ODD symptoms is stronger in girls than in boys (multi-sample SEM); (d) there are no significant associations between positive parenting practices and child ADHD or ODD symptoms.

Conclusions: Family adversity, parental psychopathology, and negative parenting practices should be routinely assessed by clinicians and considered in treatment planning.

Trial registration (18th December 2015): German Clinical Trials Register (DRKS) DRKS00008973.

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Keywords: Attention-deficit/hyperactivity disorder, Oppositional defiant disorder, Family adversity, Parental mental health, Parenting, Structural equation modeling

Background

Externalizing disorders, including attention-deficit/hyperactivity disorder (ADHD) and oppositional defiant disorder (ODD), are among the most prevalent mental disorders in childhood and adolescence. ADHD is characterized by impairing and developmentally inappropriate levels of inattention, hyperactivity and impulsivity [1], and has an estimated worldwide prevalence of 3.4% in children and adolescents [45]. ODD is marked by irritable mood, defiant and disobedient behavior towards authority figures and vindictiveness [1], affecting about 3.6% of children and adolescents worldwide [45]. Both disorders are significantly more common in boys than in girls [16, 58]. Approximately half of children and adolescents diagnosed with ADHD are also affected by ODD [15, 33].

It is assumed that genetic and environmental risk factors accumulate to cause both of these externalizing disorders [2, 21]. The heritability of ADHD is estimated to be higher (about 74%) than that of ODD (about 61% [14, 22]). Most of the environmental risk factors that have been found to be associated with the onset of ADHD exert their influence during the prenatal and early postnatal period (e.g., exposure to toxins, extreme deprivation or traumatic brain injury early in life [10, 34, 54]. Environmental risk factors that exert their influence later in childhood and adolescence (e.g., socioeconomic status or parenting behaviors) have been found to be linked to the severity of ADHD symptoms and oppositional, aggressive, and nonsocial behaviors [9, 46, 50].

Back in 1975, Rutter and colleagues examined the associations between adverse family circumstances and psychological disorders in children and adolescents. They identified six family-related risk factors that were associated with the rate of child psychiatric disorders (i.e., severe marital discord, low social class, large family size, paternal criminality, maternal mental disorder, and foster placement) and revealed that the aggregate of these factors, rather than the presence of any single factor, was linked to psychopathology in the child [51]. Subsequently, Biederman et al. [4, 5] demonstrated that regardless of a child's gender, the risk of developing ADHD and comorbid symptoms increased with an increasing number of family risk factors. Subsequent research yielded further support for a small but significant association between family adversity and child externalizing symptoms [36, 44].

Another field of environmental research focuses on the relationship between parental and child psychopathology, with studies reporting significant positive associations between child externalizing symptoms and parental symptoms of ADHD, depression, anxiety, and aggression [11, 13]. Besides genetic factors, several other processes that may be involved in the intergenerational transmission of psychopathology have been discussed [13, 23]. Among these, parenting behavior has been shown to be directly associated with child externalizing behaviors [43] and to mediate the association between parental psychopathology and child externalizing behaviors [3, 6, 24].

Bronfenbrenner's ecological systems theory [7] describes environmental factors which are relevant for child development, looking not only at the child and his or her immediate surroundings (microsystem) but also at larger systems of the child's environment (meso-, exo-, macro- and chronosystem). Based on this theory, the effects of family adversity (exosystem) on the child and his or her mental health can be thought to be mediated by familial factors that are more proximal to the child, such as parental psychopathology and parenting practices (microsystem). In line with this, the family stress model [12] postulates a theoretical process that links economic pressure in the family, via depressed parental mood and impaired parenting, to problematic adolescent adjustment. Several studies provided further evidence that family financial burden exacerbates child symptoms through increased depressive symptoms of the parents and a negative influence on parenting behavior [41, 47, 53, 56]. Extending the assumptions of the family stress model [12], we postulate that such an indirect effect is not specific to economic pressure in the family or depressive symptoms of parents. Rather, we hypothesize that both economic and psychosocial adversities in the family (family adversity) indirectly impact on child externalizing symptoms via parental psychopathology and parenting practices.

Previous studies examining possible moderating influences of child age and gender on the association between familial risk factors and externalizing symptoms in school-aged children yielded different findings depending on the particular familial risk factor investigated. While the associations of family adversity and parental psychopathology with child externalizing symptoms appear to be broadly independent of child age and gender [4, 11, 13, 36, 44], the association between parenting practices and child externalizing symptoms seems to vary as a function of child age and gender. According to a recent meta-analysis, parenting behaviors are more strongly related to

child externalizing symptoms in older children than in younger children [43]. In addition, there is some evidence that girls may be more strongly influenced by negative parenting behaviors than boys (e.g., [27]).

To the best of our knowledge, the effects of family adversity, parental psychopathology, and parenting practices on child symptoms of ADHD and ODD have not yet been examined together within one comprehensive model, possibly because suitable methods for analysis require large sample sizes. The objectives of this study are to (a) determine direct, indirect, serial indirect and total effects of familial factors (i.e., family adversity, parental psychopathology, positive and negative parenting practices) on child ADHD and ODD symptoms and (b) investigate possible moderating effects of child age and gender in a large sample of children aged between 6 and 12 years with a diagnosis of ADHD.

Methods

Participants and procedure

This study used data drawn from the ESCAschool study (Evidence-based, Stepped Care of ADHD in school-aged children; [18]), a multicenter trial encompassing nine study sites in Germany (Cologne, Essen, Göttingen, Hamm, Mainz, Mannheim, Marburg, Tübingen, Würzburg). ESCAschool is part of the research consortium ESCAlife and investigated a stepped care approach for school-aged children with ADHD, involving individualized treatment strategies based on behavioral and pharmacological interventions. Participants were mainly recruited via the outpatient units of the participating study sites. The children included in ESCAschool (a) met the criteria for an ADHD diagnosis according to the *Diagnostic and Statistical Manual of Mental Disorders* (DSM, 5th ed.; [1]), (b) were between 6 and 12 years old, and (c) had an IQ score above 80. For the present study, we analyzed baseline data (i.e., before the start of the study treatment) of 555 children who were screened for the ESCAschool study and met all inclusion and exclusion criteria. More detailed information on the background, procedures, and inclusion and exclusion criteria for ESCAschool can be found in the published study protocol [18]. All parents and all children provided written informed consent to participate in the study. Ethics approval was provided by the local ethics committees for each participating center separately.

Measures

The following measures were collected from clinicians and parents at the baseline assessment.

Family adversity (FAI)

Family adversity was measured using a modified version of the Family Adversity Index (FAI) originally developed by Rutter and colleagues [51]. The modified version, adapted from the German Mannheim Parent Interview [20], includes the following items: low parental education, crowded housing conditions, parental conflicts, parental delinquency, and parental mental disorder. Each item is coded dichotomously by a clinician (0 = *no*, 1 = *yes*) based on an interview with at least one parent. The five item scores are then summed together to form the index (value range: 0–5). Crowded housing conditions were defined as having less than one room per person. Parental conflicts were assumed in the case of single-parent families or if there were significant disputes between the parents. Parental delinquency was indicated if at least one parent had been sentenced to jail or penalized with a fine, or if a parent's driving license had been revoked for at least 6 months. Finally, a parental mental disorder was coded if either parent had been diagnosed with a mental disorder during their lifetime.

Parental psychopathology (pPSYC)

Parental ADHD (pADHD) was measured using the German ADHD self-report questionnaire (ADHS-Selbstbeurteilungsbogen [ADHS-SB]; [48]), which was adapted to DSM-5 criteria for the purpose of the present study. Parents rated each of the 18 symptom items on a 4-point Likert scale ranging from 0 (*not present*) to 3 (*severe*), with higher scores indicating higher symptoms of parental inattention, impulsivity, and hyperactivity. The scores for all 18 items were summed together to form the total symptom score. In the present sample, the total symptom scale showed a high internal consistency ($\alpha = 0.91$).

Parental symptoms of depression, anxiety and stress (pDAS) were assessed using the German short version (DASS-21; [40]) of the Depression Anxiety and Stress Scales (DASS; [37]). Parents rated each of the 21 items on a 4-point Likert scale ranging from 0 (*never*) to 3 (*very often*), with higher scores indicating a greater severity of parental symptoms. In the present study, a sum score was formed by considering all 21 items. In the present sample, the scale showed a high internal consistency ($\alpha = 0.91$).

Parental aggression (pAGG) was assessed using the Aggression Questionnaire (AQ-12) by Bryant and Smith [8] in its German version [25]. The questionnaire consists of 12 items measuring physical aggression, verbal aggression, anger and animosity. Parents rated each item on a 6-point Likert scale ranging from 1 (*very atypical*) to 6 (*very typical*), with higher scores indicating more parental aggression. The scores on the 12 items were summed together to form the total symptom score. In the present

sample, the total scale showed a good internal consistency (α = 0.86).

Parenting practices (pPAR, nPAR)

Positive parenting (pPAR) was measured using the German Questionnaire on Parenting Behavior (Fragebogen zum Erziehungsverhalten [FZEV]; [39]), which was developed on the basis of various English-language instruments (e.g., [55]). The scale consists of 13 items assessing positive, reinforcing and encouraging parenting behavior. Parents rated each item on a 4-point Likert scale ranging from 0 (*never*) to 3 (*very often*), with higher scores indicating a more frequent use of positive parenting practices. The scale value was formed by averaging the respective item scores. In the present sample, the scale demonstrated a good internal consistency (α = 0.85).

Negative parenting (nPAR) was measured using a short version of the Negative-Inept Parenting Scale (NIP) from the Assessment of Positive and Negative Parenting (FPNE; [30],, which was developed on the basis of the Management of Children's Behavior Scale (MCBS, [42]). The scale used in the present study consists of 10 items, which measure inconsistent, impulsive and rigid parenting behavior. Parents rated each item on a 4-point Likert scale ranging from 0 (*never*) to 3 (*very often*), with higher scores indicating a more frequent use of negative parenting practices. The scale value was formed by averaging the respective item scores. In the present sample, the 10-item scale showed an acceptable internal consistency (α = 0.74).

Child ADHD and child ODD (cADHD, cODD)

Child symptoms of ADHD and ODD were each assessed independently by a clinician and by the parents. For the assessment of ADHD symptoms, the clinician used the 18 items of the German Diagnostic Checklist for ADHD (DCL-ADHS, DISYPS-III; [17], which reflect the criteria for ADHD according to the DSM-5 and the 10th edition of the *International Statistical Classification of Diseases and Related Health Problems* (10th ed.; [59]). For the assessment of oppositional symptoms, the clinician used the eight ODD items from the German Diagnostic Checklist for Oppositional Defiant and Conduct Disorder (CD) (DCL-SSV, DISYPS-III; [17]), which reflect the criteria for ODD according to the DSM-5 and ICD-10. The symptoms were explored using a German semi-structured clinical interview for ADHD, ODD and CD symptoms, which was conducted with at least one parent (ILF-EXTERNAL, DISYPS-ILF, [26]). Clinicians rated each item on a 4-point Likert scale ranging from 0 (*age-typical/not at all*) to 3 (*very much*, with higher scores indicating more pronounced child ADHD and ODD symptoms. The two scale values (ADHD, ODD were formed by averaging the respective item scores. In the present sample, the scales showed a good internal consistency (ADHD: α = 0.82; ODD: α = 0.83). Furthermore, a high interrater reliability has been reported, with an intraclass correlation of 0.91 (ADHD) and 0.94 (ODD) [57].

The parents assessed the children's ADHD and ODD symptoms using the German-language rating scales for ADHD (FBB-ADHS) and for ODD and CD (FBB-SSV, DISYPS-III; [17]), which are based on the DSM-5 and ICD-10. More specifically, parents rated 20 ADHD items (nine items on inattention, 11 items on hyperactivity) and eight ODD items on a 4-point Likert scale ranging from 0 (*not at all*) to 3 (*markedly*), with higher scores indicating more severe symptoms. Again, the two scale values (ADHD, ODD) were formed by averaging the respective item scores. In the present sample, the scales showed a good internal consistency, with a Cronbach's alpha of 0.89 for each scale.

Statistical analysis

In a first step, missing values, descriptive statistics and bivariate correlations were investigated. Analyses were performed using SPSS 27.0. To examine missing values, Little's (1988) missing completely at random (MCAR) test was performed. Key variables were examined for deviations from normality based on skewness and kurtosis. It was checked whether the intercorrelations of potential indicators of latent factors were positive and sufficiently strong ($r \geq 0.50$) for the formation of latent factors. Child demographic variables (child age and gender) were tested for significant bivariate correlations with the familial variables (FAI, pADHD, pDAS, pAGG, pPAR, nPAR) and child symptoms (cADHD, cODD).

Within the main analyses, a confirmatory factor analysis (CFA) was performed and a structural equation model were tested: First, a *CFA* was conducted to assess the validity of the measurement models for the three latent factors parental psychopathology (pPSYC), child ADHD (cADHD), and child ODD (cODD). For the latent factor parental psychopathology (pPSYC), we used parental ADHD (pADHD), parental depression, anxiety and stress (pDAS), and parental aggression (pAGG) as indicators. For the two latent factors child ADHD (cADHD) and child ODD (cODD), corresponding clinician ratings (DCL-ADHS, DCL-SSV) and parent ratings (FBB-ADHS, FBB-SSV) were used as indicators and the error variances of the two indicators from one informant (clinician, parent) were allowed to covary. All three latent factors (pPSYC, cADHD, cODD) were allowed to covary. Second, an *(initial) structural*

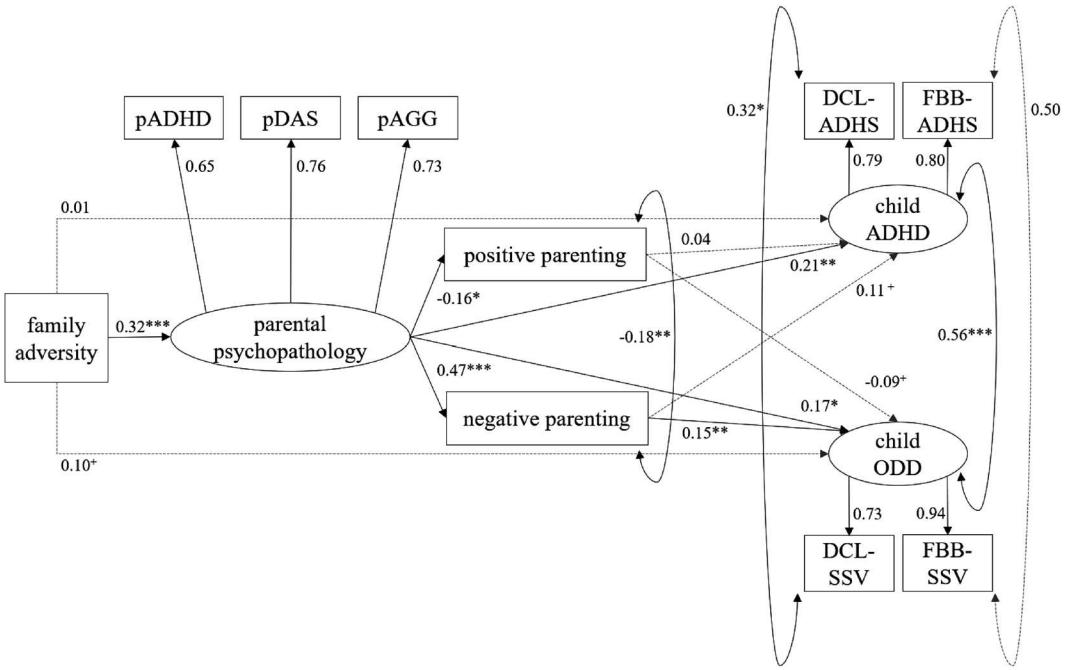

Fig. 1 Structural equation model (SEM 2). Structural equation model depicting factor loadings, covariances and standardized path coefficients. Solid lines indicate significant paths, $p < .05$. The SEM 2 shown differs from SEM 1 by the added error covariance between positive and negative parenting practices. DCL-ADHS = clinician-rated child attention-deficit/hyperactivity disorder, DCL-SSV = clinician-rated child oppositional defiant disorder, FBB-ADHS = parent-rated child attention-deficit/hyperactivity disorder, FBB-SSV = parent-rated child oppositional defiant disorder, pADHD = parental attention-deficit/hyperactivity disorder (ADHS-SB), pAGG = parental aggression (AQ 12), pDAS = parental depression, anxiety and stress (DASS21). $^{+}p < .10$, $*p < .05$, $**p < .01$, $***p < .001$

equation model (SEM 1) was checked for model fit. For SEM 1, we considered direct pathways from family adversity to parental psychopathology (FAI → pPSYC), from parental psychopathology to positive as well as negative parenting practices (pPSYC → pPAR/nPAR), and from all familial factors to child ADHD and child ODD (FAI/pPSYC/pPAR/nPAR → cADHD/cODD). Accordingly, the factors family adversity, parental psychopathology, (positive and negative) parenting practices, and child (ADHD and ODD) symptoms are arranged serially within SEM 1, and the positive and negative parenting practices and child ADHD and ODD symptoms are each arranged in parallel (see also Fig. 1). Consequently, SEM 1 enabled the determination of the direct effects of all familial factors on child ADHD and ODD symptoms (FAI/pPSYC/pPAR/nPAR → cADHD/cODD) as well as the indirect effects of family adversity (FAI) and parental psychopathology (pPSYC) on child ADHD and ODD symptoms (FAI → pPSYC → cADHD/cODD; pPSYC → pPAR/nPAR → cADHD/cODD), the serial indirect effects of family adversity (FAI) on child ADHD and ODD symptoms (FAI → pPSYC → pPAR/nPAR → cADHD/cODD), and the total effects of family adversity (FAI) and parental psychopathology (pPSYC) on child ADHD and ODD symptoms. Modification indices and theoretical considerations were used to examine reasonable adjustments to the SEM 1, and the model fit of the resulting model (i.e., SEM 2) was tested for its superiority over SEM 1.

Multi-sample SEMs were examined to reveal potentially moderating effects of (a) child age (split based on median age) and (b) gender. As a prerequisite, measurement invariance was tested beforehand. Configural invariance requires that the model configuration is identical in both groups (i.e., the same items belong to the same factors). Weak invariance additionally requires equal factor loadings in the groups and strong invariance additionally requires that the item intercepts are the same in the groups [35]. The total effects of family adversity and parental psychopathology on child symptoms and the direct effects of positive and negative parenting practices on child symptoms were determined for each of the two groups and compared using χ^2 difference test.

Structural equation models were tested using the lavaan package (version 0.6–8; [49]) in R (version 4.1.0). For the SEM models, all variables were z-transformed and full information likelihood was used to handle

missing values. As some variables were not normally distributed, a scaled test statistic was used (asymptotically equal to the Yuan-Bentler test statistic). Model fit was evaluated based on the comparative fix index (CFI), the standardized root mean square residual (SRMR), and the root mean square error of approximation (RMSEA). The model fit was considered acceptable if CFI $\geq$ 0.95, SRMR $\leq$ 0.08 and RMSEA $\leq$ 0.07 and good if CFI $\geq$ 0.95 and SRMR and RMSEA $\leq$ 0.05 [31, 35]. The χ^2 test statistic was also inspected, although this index tends to increase along with the sample size and can therefore only be interpreted to a limited extent [35]. The direct, indirect, serial indirect and total effects of family adversity, parental psychopathology, and (positive and negative) parenting practices on child ADHD and ODD symptoms were determined, and bootstrapping with 1000 replications was used to obtain confidence intervals and standard errors of the estimated effects. Nested models were compared using the χ^2 difference test, and non-nested models were compared using the Akaike information criterion (AIC) and the Bayesian information criterion (BIC).

Results

Study sample and descriptive statistics

The 555 children had a mean age of 8.9 years ($SD = 1.5$) and 80.5% were male. In total, 275 children (49.5%) had a combined type ADHD diagnosis, 222 children (40.0%) had a predominantly inattentive type ADHD diagnosis, and 58 children (10.5%) had a predominantly hyperactive-impulsive type ADHD diagnosis. About one-third ($n = 189$, 34.1 %) received medication for the treatment of ADHD. The following comorbid diagnoses were present in the study sample: ODD ($n = 214$, 38.6%), anxiety disorder ($n = 41$, 7.3%), CD ($n = 37$, 6.7%), tic disorder ($n = 32$, 5.8%), depressive disorder ($n = 18$, 3.2%), and obsessive-compulsive disorder ($n = 2$, 0.4%). The participating parent was either the biological mother (87.2%), the biological father (7.4%), or another caregiver (5.4%). Little`s MCAR test was non-significant, which was in line with the assumption that the data were missing at random ($\chi^2(217) = 232.94$ $p = 0.22$). Descriptive statistics and bivariate correlations for the key and demographic variables are shown in Table 1.

Table 1 Descriptive Statistics and Bivariate Correlations for Key and Demographic Variables

	1. FAI	2. pADHD	3. pDAS	4. pAGG	5. pPAR	6. nPAR	7. cADHD (C)	8. cADHD (P)	9. cODD (C)	10. cODD (P)
1. FAI	1									
2. pADHD	0.20**	1								
3. pDAS	0.28**	0.50**	1							
4. pAGG	0.21**	0.48**	0.53**	1						
5. pPAR	0.03	− 0.04	− 0.13**	− 0.19**	1					
6. nPAR	0.11*	0.23**	0.36**	0.40**	− 0.23**	1				
7. cADHD (C)	0.06	0.17**	0.16**	0.12**	− 0.04	0.15**	1			
8. cADHD (P)	0.10*	0.16**	0.19**	0.10*	0.03	0.18**	0.63**	1		
9. cODD (C)	0.15**	0.14**	0.19**	0.13**	− 0.12**	0.20**	0.47**	0.33**	1	
10. cODD (P)	0.17**	0.16**	0.22**	0.16**	− 0.15**	0.25**	0.44**	0.54**	0.69**	1
Child gender (0 = b, 1 = g)	0.02	− 0.01	− 0.03	− 0.04	0.08	− 0.03	− 0.13**	− 0.07	− 0.11**	− 0.12**
Child age	− 0.05	− 0.07	− 0.05	− 0.02	− 0.14**	0.02	− 0.02	− 0.04	0.03	0.05
n	549	524	518	521	517	509	555	495	544	528
Missings in %	1.08	5.59	6.66	6.12	6.84	8.29	0	10.81	1.98	4.86
M (SD)	0.76 (0.85)	8.97 (8.58)	10.92 (8.44)	25.70 (9.22)	1.87 (0.38)	2.00 (0.39)	1.88 (0.47)	1.81 (0.53)	1.17 (0.65)	1.40 (0.71)
Min	0.00	0.00	0.00	12.00	0.77	1.10	0.72	0.20	0.00	0.00
Max	5.00	49.00	45.00	64.00	3.00	3.20	3.00	3.00	3.00	3.00
Skew	1.07	1.74	1.28	0.99	0.11	0.27	− 0.04	− 0.20	0.34	0.05
Kurtosis	1.21	3.52	1.89	1.22	− 0.19	0.09	− 0.70	− 0.48	− 0.28	− 0.74

b = boys, cADHD (C) = clinician-rated childattention-deficit/hyperactivity disorder (DCL-ADHS), cADHD (P) = parent-ratedchild attention-deficit/hyperactivity disorder (FBB-ADHS), cODD (C) =clinician-rated child oppositional defiant disorder (DCL-SSV), cODD (P) = parent-rated child oppositional defiantdisorder (FBB-SSV), FAI = Family Adversity Index, g = girls, nPAR = negativeparenting (FPNE), pADHD = parental attention-deficit/hyperactivity disorder (ADHS-SB),pDAS = parental depression, anxiety and stress (DASS21), pPAR = positiveparenting (FZEV)

* $p < 0.05$, ** $p < 0.01$

Table 2 Model fit parameters for CFA, SEM 1, SEM 2, and the alternative model

Model	χ^2 (*df*)	*p*	CFI	SRMR	RMSEA	AIC	BIC	$\Delta\chi^2$ (*df*)	*p*
CFA	5.21 (9)	0.82	1.00	0.01	< 0.001				
SEM 1	46.85 (24)	0.003	0.98	0.03	0.04				
SEM 2	32.51 (23)	0.09	0.99	0.02	0.03	13,570.21	13,751.60	14.16 (1)[a]	< 0.001
Alternative model	110.27 (23)	< 0.001	0.93	0.08	0.09	13,655.55	13,836.94		

In the CFA model the validity of the measurement models of the three latent factors parental psychopathology (pPSYC), child ADHD (cADHD), and child ODD (cODD) was assessed. In SEM 1, direct and indirect effects of family adversity (FAI), parental psychopathology (pPSYC), positive parenting (pPAR), and negative parenting (nPAR) on child ADHD and ODD symptoms were examined (FAI → pPSYC → pPAR/nPAR → cADHD/cODD). In SEM 2, SEM 1 was extended to include the error covariance of positive and negative parenting. The alternative model contained the following alternative arrangement of the familial factors, with otherwise unchanged paths: pPSYC → FAI → pPAR/nPAR → cADHD/cODD

AIC = Akaike information criterion, BIC = Bayesian information criterion, CFA = confirmatory factor analysis, CFI = comparative fix index, RMSEA = root mean square error of approximation, SRMR = standardized root mean square residual

[a] reference model = SEM 1

Model testing

The CFA resulted in a good model fit and confirmed the validity of the measurement models of the three latent factors parental psychopathology (pPSYC), child ADHD (cADHD), and child ODD (cODD, see Table 2). All factor loadings were of adequate strength and were significantly related to the respective latent factor ($\beta > 0.68$). We found a good model fit of the initial SEM (SEM 1) with direct pathways from family adversity to parental psychopathology, from parental psychopathology to positive as well as negative parenting practices, and from all familial factors to child ADHD and child ODD (see Table 2). Nevertheless, the modification indices (MI) suggested an extension of the model to include the error covariance between positive and negative parenting (MI > 10.00). Since this statistically based recommendation was also

Table 3 Direct, Indirect and Total Effects of Familial Variables on Child Symptoms (SEM 2)

Effect	Path	*b* [95% CI]	*SE*	*β*	*p*
Total	**Family adversity (FAI) → child ADHD (cADHD)**	0.07 [− 0.01, 0.16]	0.04	0.09	0.08
Direct	FAI → cADHD [b]	0.01 [− 0.08, 0.10]	0.04	0.01	0.85
Indirect	FAI → parental psychopathology (pPSYC) → cADHD	0.05 [0.01, 0.10]	0.02	0.07	0.01
Serial indirect	FAI → pPSYC → positive parenting (pPAR) → cADHD	− 0.00 [− 0.01, 0.00]	0.00	− 0.00	0.49
Serial indirect	FAI → pPSYC → negative parenting (nPAR) → cADHD	0.01 [− 0.00, 0.03]	0.01	0.02	0.09
Total	**Parental psychopathology (pPSYC) → child ADHD (cADHD)**	0.31 [0.15, 0.46]	0.08	0.25	< 0.001
Direct	pPSYC → cADHD	0.25 [0.07, 0.42]	0.09	0.21	0.005
Indirect	pPSYC → positive parenting (pPAR) → cADHD	− 0.01 [− 0.04, 0.02]	0.01	− 0.01	0.51
Indirect	pPSYC → negative parenting (nPAR) → cADHD	0.06 [− 0.01, 0.14]	0.04	0.05	0.09
Direct	**Positive parenting (pPAR) → child ADHD (cADHD)** [a]	0.04 [− 0.06, 0.11]	0.04	0.04	0.44
Direct	**Negative parenting (nPAR) → child ADHD (cADHD)**	0.09 [− 0.01, 0.18]	0.05	0.11	0.07
Total	**Family adversity (FAI) → child ODD (cODD)**	0.14 [0.06, 0.22]	0.04	0.19	0.001
Direct	FAI → cODD [b]	0.08 [0.00, 0.17]	0.04	0.10	0.07
Indirect	FAI → parental psychopathology (pPSYC) → cODD	0.04 [0.01, 0.08]	0.02	0.06	0.04
Serial indirect	FAI → pPSYC → positive parenting (pPAR) → cODD	0.00 [0.00, 0.01]	0.00	0.01	0.18
Serial indirect	FAI → pPSYC → negative parenting (nPAR) → cODD	0.02 [0.01, 0.03]	0.01	0.02	0.005
Total	**Parental psychopathology (pPSYC) → child ODD (cODD)**	0.29 [0.15, 0.44]	0.07	0.26	< 0.001
Direct	pPSYC → cODD	0.20 [0.04, 0.35]	0.08	0.17	0.02
Indirect	pPSYC → positive parenting (pPAR) → cODD	0.02 [0.00, 0.05]	0.01	0.02	0.19
Indirect	pPSYC → negative parenting (nPAR) → cODD	0.08 [0.02, 0.15]	0.03	0.07	0.02
Direct	**Positive parenting (pPAR) → child ODD (cODD)** [a]	− 0.07 [− 0.16, 0.00]	0.04	− 0.09	0.09
Direct	**Negative parenting (nPAR) → child ODD (cODD)**	0.11 [0.03, 0.20]	0.04	0.15	0.008

Total and direct effects (bold text) of familial factors on child ADHD and child ODD symptoms were compared using χ^2 difference test

[a] Corresponding effects differed significantly for child ADHD and child ODD based on χ2 difference test ($\chi^2_{diff}(1) = 7.23$, $p = 0.007$)

theoretically justifiable, the initial model was extended to include the suggested error covariance (SEM 2). As shown in Table 2, the superiority of the resulting model fit was confirmed by the result of the χ^2 difference test. The coefficients of the postulated paths among the familial factors (FAI → pPSYC, pPSYC → pPAR/nPAR) each reached significance (see Fig. 1). In SEM 2, the explained variance (by all familial factors) in child ADHD was $R^2 = 7.5\%$ and the explained variance in child ODD was $R^2 = 12.6\%$.

Effects of familial factors on child externalizing symptoms

The direct, indirect and total effects of the four familial factors on child ADHD and ODD symptoms were determined in the extended SEM 2 model (see Table 3). First, considering the total effects of family adversity and parental psychopathology on *child ADHD symptoms*, as well as the direct effects of positive and negative parenting practices on child ADHD symptoms, only the total effect of parental psychopathology on child ADHD symptoms reached significance ($b = 0.31$, $SE = 0.08$, $\beta = 0.25$, $p < 0.001$). While the total effect of family adversity and the direct effect of negative parenting practices on child ADHD symptoms showed a trend for significance (FAI: $p = 0.08$; nPAR: $p = 0.07$), the direct effect of positive parenting practices did not. Second, considering the indirect and direct effects of family adversity and parental psychopathology on child ADHD symptoms, a significant indirect effect of family adversity on child ADHD symptoms via parental psychopathology was detected ($b = 0.05$, $SE = 0.02$, $\beta = 0.07$, $p = 0.01$), and a trend for a significant serial indirect effect of family adversity on child symptoms via parental psychopathology and negative parenting practices ($p = 0.09$). In contrast, the direct effect of family adversity on child ADHD symptoms was not significant. The direct effect of parental psychopathology on child ADHD symptoms was significant ($b = 0.25$, $SE = 0.09$, $\beta = 0.21$, $p = 0.005$) and the indirect effect of parental psychopathology on child ADHD symptoms via negative parenting practices showed a trend for significance ($p = 0.09$). Overall, an (exclusively indirect) effect of family adversity on child ADHD symptoms (FAI → pPSYC → cADHD) and a (direct) effect of parental psychopathology on child ADHD symptoms (pPSYC → cADHD) were revealed.

Third, considering the total effects of family adversity and parental psychopathology, as well as the direct effects of positive and negative parenting practices on *child ODD symptoms*, the following three familial factors exerted a significant effect: family adversity (total effect: $b = 0.14$, $SE = 0.04$, $\beta = 0.19$, $p = 0.001$), parental psychopathology (total effect: $b = 0.29$, $SE = 0.07$, $\beta = 0.26$, $p < 0.001$), and negative parenting practices (direct effect: $b = 0.11$, $SE = 0.04$, $\beta = 0.15$, $p = 0.008$). The total effect of the fourth familial factor, positive parenting practices, only showed a trend for significance ($p = 0.09$). Fourth, we considered the indirect and direct effects of family adversity and parental psychopathology on child ODD symptoms. The analyses revealed a significant indirect effect of family adversity on child ODD symptoms via parental psychopathology ($b = 0.04$, $SE = 0.02$, $\beta = 0.06$, $p = 0.04$) and a serial indirect effect of family adversity on child ODD symptoms via parental psychopathology and negative parenting practices ($b = 0.02$, $SE = 0.01$, $\beta = 0.02$, $p = 0.005$). In contrast, the direct effect of family adversity on child ODD symptoms was not significant. Finally, parental psychopathology had both a direct effect on child ODD symptoms ($b = 0.20$, $SE = 0.08$, $\beta = 0.17$, $p = 0.02$) and an indirect effect on child ODD symptoms via negative parenting practices ($b = 0.08$, $SE = 0.03$, $\beta = 0.07$, $p = 0.02$). In summary, the analyses revealed an (exclusively indirect) effect of family adversity on child ODD symptoms (FAI → pPSYC → cODD; FAI → pPSYC → nPAR → cODD), a (direct and indirect) effect of parental psychopathology on child ODD symptoms (pPSYC → cODD; pPSYC → nPAR → cODD) and a (direct) effect of negative parenting practices on child ODD symptoms (nPAR → cODD).

When comparing the total (family adversity, parental psychopathology) or direct (positive and negative parenting practices) effects of the familial factors on child ADHD and child ODD symptoms (by comparing the model fits of the nested models with freely varying and equated path coefficients using χ2 difference test), only positive parenting practices had a significantly different effect on child ADHD and child ODD symptoms ($\chi^2_{diff}(1) = 7.23$, $p = 0.007$).

An extension to model SEM 2, adding two additional pathways (FAI → pPAR/nPAR), provided the opportunity to examine even more potential indirect effects of the familial factors. However, the extended model did not provide a better model fit ($\chi^2(21) = 27.95$, $p = 0.14$, CFI = 1.00, SRMR = 0.02, RMSEA = 0.03; $\chi^2_{diff}(2) = 4.76$, $p = 0.09$), and the total, direct, and indirect effects described above remained largely unchanged (for details see Additional file 1: Table A1).

Moderating effects of child age and gender

Descriptive statistics and measurement invariance

Descriptive statistics and bivariate correlations are shown in the Additional file 1 (Tables A2 and A3) separately for younger and older children and for boys and girls. Configural as well as weak measurement invariance based on SEM 2 was shown across younger and older children but not across boys and girls. Specifically, for girls,

the estimation of SEM 2 resulted in negative variances. Potential reasons for the estimation problems might have been the small sample size of girls ($n=108$), the examination of a complex statistical model, and only two indicators for two of the three latent factors (cADHD, cODD) [35]. However, to nevertheless examine the moderating effect of gender, SEM 2 was simplified, and instead of the two latent factors (cADHD and cODD) with two indicators each (DCL-ADHS, FBB-ADHS; DCL-SSV, FBB-SSV), we calculated two separate SEMs with two manifest factors each. Specifically, one multi-sample SEM with clinician-rated child symptoms (DCL-ADHS, DCL-SSV) and one with parent-rated child symptoms (FBB-ADHS, FBB-SSV) were performed to examine the moderating influences of gender. As a result of the simplification of the model, configural and weak measurement invariance based on SEM 2 was shown across boys and girls (see Additional file 1: Table A4).

Effects of familial factors on child externalizing symptoms for younger and older children

For younger children only parental psychopathology (total effect: $b=0.36$, $SE=0.10$, $\beta=0.35$, $p<0.001$) and for older children none of the familial factors had a significant (total or direct) effect on *child ADHD symptoms*. However, for younger children family adversity showed a trend for a significant (total) effect ($p<0.10$) and for older children negative parenting practices showed a trend for a significant (direct) effect on child ADHD symptoms ($p=0.06$). The explained variance in child ADHD was $R^2=14.9\%$ for younger children and $R^2=3.6\%$ for older children. In both age groups, family adversity (younger children: $b=0.13$, $SE=0.06$, $\beta=0.19$, $p=0.03$; older children: $b=0.12$, $SE=0.05$, $\beta=0.17$, $p=0.02$) and parental psychopathology (younger children: $b=0.30$, $SE=0.11$, $\beta=0.30$, $p=0.006$; older children: $b=0.25$, $SE=0.12$, $\beta=0.21$, $p=0.03$) had significant (total) effects on *child ODD symptoms*. In addition, in both age groups negative parenting practices showed a trend for a significant (direct) effect on child ODD symptoms (younger children: $p<0.10$; older children: $p=0.07$). The explained variance in child ODD symptoms was $R^2=13.7\%$ for younger children and $R^2=10.7\%$ for older children. The direct effect of positive parenting did not reach significance in either age group or for either symptom domain (child ADHD, child ODD). None of the (total or direct) effects differed significantly between younger and older children. Further details are provided in Additional file 1 (Table A5).

Effects of familial factors on child externalizing symptoms for boys and girls

Due to the estimation problems of the SEM 2 in the group of girls and the calculation of two multi-sample SEMs for the moderator gender, separate estimates of direct and total effects resulted for the clinician rating and parent rating of child ADHD and ODD symptoms.

For boys, parental psychopathology (clinician rating: $b=0.33$, $SE=0.08$, $\beta=0.23$, $p<0.001$; parent rating: $b=0.32$, $SE=0.10$, $\beta=0.22$, $p=0.001$) and family adversity (only parent rating: $b=0.11$, $SE=0.05$, $\beta=0.11$, $p=0.04$) had a significant (total) effect on *child ADHD symptoms*. Additionally, negative parenting practices showed a trend for a significant (direct) effect on child ADHD symptoms for boys (only parent rating: $p=0.09$). For girls, only negative parenting (only clinician rating: $b=0.33$, $SE=0.14$, $\beta=0.35$, $p=0.02$) had a significant (direct) effect on child ADHD symptoms. The explained variance in child ADHD symptoms was $R^2=5.0\%$ (clinician rating) or $R^2=6.3\%$ (parent rating) for boys and $R^2=9.7\%$ (clinician rating) or $R^2=3.4\%$ (parent rating) for girls. For boys, family adversity (clinician rating: $b=0.16$, $SE=0.05$, $\beta=0.16$, $p=0.001$; parent rating: $b=0.22$, $SE=0.05$, $\beta=0.21$, $p<0.001$) and parental psychopathology (clinician rating: $b=0.27$, $SE=0.09$, $\beta=0.19$, $p=0.001$; parent rating: $b=0.39$, $SE=0.10$, $\beta=0.27$, $p<0.001$) had a significant (total) effect on *child ODD symptoms*. Additionally, positive parenting practices showed a trend for a significant (direct) effect on child ODD symptoms for boys (clinician rating: $p=0.07$; parent rating: $p=0.08$). For girls, only negative parenting practices (clinician rating: $b=0.47$, $SE=0.12$, $\beta=0.52$, $p<0.001$; parent rating: $b=0.42$, $SE=0.14$, $\beta=0.45$, $p=0.002$) had a significant (direct) effect on child ODD symptoms. The explained variance in child ODD symptoms was $R^2=6.6\%$ (clinician rating) or $R^2=12.4\%$ (parent rating) for boys and $R^2=22.2\%$ (clinician rating) or $R^2=15.7\%$ (parent rating) for girls. The direct effects of negative parenting on child ADHD (only clinician rating) and child ODD (clinician and parent rating) showed significantly different path coefficients for boys and girls (by comparing the model fits of the nested models with freely varying and equated path coefficients using $\chi 2$ difference test). Further details are provided in Additional file 1 (Tables A6 and A7).

Alternative arrangement of familial factors

To further test the plausibility of SEM 2, we examined an alternative arrangement of the familial factors. Specifically, instead of modeling a direct pathway from family adversity to parental psychopathology (FAI → pPSYC) and from parental psychopathology to (positive and negative) parenting practices (pPSYC → pPAR/nPAR), a

direct pathway from parental psychopathology to family adversity (pPSYC → FAI) and from family adversity to (positive and negative) parenting practices (FAI → pPAR/nPAR) was provided within this alternative model. All other postulated pathways remained unchanged. As can be seen in Table 2, the model fit of the alternative model was not acceptable and both the AIC and the BIC suggested a superiority of the SEM 2 over the alternative model.

Discussion

To the best of our knowledge, this is the first study to examine effects of family adversity, parental psychopathology, and parenting practices on ADHD and ODD symptoms together within one comprehensive model in a large sample of children with ADHD. The analyses performed supported a model inspired by Bronfenbrenner's ecological systems theory [7], in which the familial factors were ordered according to their proximity to the child. In the present study, family adversity was associated with a more pronounced parental psychopathology, which was in turn associated with more negative and fewer positive parenting practices. This finding is also in line with the assumptions of the family stress model [12]. More specifically, our results support the assumption that family adversity (e.g., low parental education, marital conflicts, parental delinquency, crowded housing conditions) is associated with increased psychopathological symptoms of the parents, which in turn have a negative impact on their parenting behavior. The strengths of the associations among these familial factors in the present study are comparable with previous study findings based on the family stress model [41, 47, 56].

Effects of familial factors on child externalizing symptoms

Two of the four familial factors revealed significant effects on child ADHD symptoms: family adversity (indirect: FAI → pPSYC → cADHD) and parental psychopathology (total, direct). Three of the four familial factors revealed significant effects on child ODD symptoms: family adversity (total; indirect: FAI → pPSYC → cODD; serial indirect: FAI → pPSYC → nPAR → cODD), parental psychopathology (total; direct; indirect: pPSYC → nPAR → cODD), and negative parenting practices (direct). Accordingly, adverse family circumstances and psychopathological symptoms of parents were associated with more severe ADHD and ODD symptoms in children. In addition, inconsistent, impulsive, and rigid parenting behaviors (negative parenting practices) were related to more severe ODD symptoms in children. In contrast, positive, reinforcing and encouraging parenting behavior (positive parenting practices) was not associated with less severe externalizing symptoms in children. The effects of family adversity, parental psychopathology, and negative parenting practices on child externalizing symptoms were small and broadly in line with previous study findings [11, 13, 36, 43, 44]. The finding that negative parenting practices have more impact on children's externalizing behaviors than do positive parenting practices is also consistent with previous study findings [19, 28, 32, 43].

Neither ADHD symptoms nor ODD symptoms in children were directly related to family adversity. However, indirect effects of family adversity via parental psychopathology and serial indirect effects via parental psychopathology and negative parenting practices emerged. About 12.6% of the variance in child ODD and 7.5% of the variance in child ADHD symptoms was explained by the familial factors studied. The higher proportion of explained variance in child ODD symptoms compared to child ADHD symptoms in the presented SEM may be attributable to the fact that a greater number of the examined familial factors were associated with child ODD symptoms than with child ADHD symptoms. While it is necessary to take into account some statistical features in this regard (see: limitations and further studies), this finding is consistent with previous evidence suggesting less importance of genetic risk factors and a greater importance of environmental risk factors for ODD symptoms compared with ADHD symptoms [14].

Moderating effects of child age and gender

The (total or direct) effects of the familial factors did not significantly differ between younger and older children, but did significantly differ between boys and girls. Inconsistent, impulsive and rigid parenting behaviors (negative parenting practices) were more strongly associated with child ADHD and ODD symptoms in girls than in boys. This finding is consistent with previous research (e.g., [27]), although conflicting evidence has also been reported [43]. More research is needed to clarify whether girls indeed show a greater sensitivity to negative parenting behaviors than do boys. Interestingly, the largest amount of explained variance in child symptoms was found for (clinician-rated) ODD symptoms in girls ($R^2 = 22.2\%$) and the smallest for (latent factor) ADHD symptoms in older children ($R^2 = 3.6\%$). Accordingly, it can be assumed that especially for ADHD symptoms in later childhood and adolescence, factors other than those studied here could be decisive for symptom severity.

Limitations and recommendations for further studies

The findings of the present study should be interpreted in the context of several limitations. First, the data analyzed

are cross-sectional. Unlike longitudinal data, cross-sectional data are not suitable for drawing conclusions about the direction of influence. However, an alternative model that changed the direction of the prediction of familial factors such that parental psychopathology preceded family adversity, parenting practices, and finally child externalizing symptoms resulted in an unacceptable model fit. Therefore, the reverse direction of influence can be considered unlikely. Nevertheless, some studies suggest a bidirectional rather than unidirectional relationship between child symptoms and family variables, especially parenting practices (e.g., [52]).

Second, the data collection was restricted to clinician and parent ratings of child symptoms. The consideration of several informants, such as clinicians, parents, teachers, and the child him/herself (from early adolescence), is central to a valid assessment of externalizing symptomatology in all relevant life domains. Future studies should additionally obtain a teacher's rating to provide as complete a picture as possible [38]. Although teacher ratings were requested and collected in the ESCAschool study, the number of available teacher ratings was considered too low (56%) for inclusion as a third indicator of child externalizing symptoms. Moreover, in view of evidence of a low correspondence between parental self-report and observational measures of parenting practices [29], in future studies, it would be valuable to include observations of parenting in order to rule out the suggestion that the purported associations between parental psychopathology and parenting practices may be purely attributable to same-informant effects.

Third, the Family Adversity Index, which is a tried and tested tool to assess adverse family circumstances [4], offers few concrete hints for deriving clinical implications. As the determination of individual risk factors may be more relevant to inform prevention and intervention approaches, future studies should examine individual risk factors (e.g., marital conflicts) instead of employing an index of family adversity. However, it should be critically noted that it may, in fact, be the combined presence of multiple, nonspecific, familial risk factors, rather than the presence of single, specific risk factors, that is associated with child symptom severity.

Fourth, the comparison of the impact of the familial factors on child ADHD and child ODD symptoms may be limited. Stronger associations between the investigated familial factors and child symptoms, and a correspondingly higher explained variance in child symptoms, were found for ODD symptoms than for ADHD symptoms in the present study. From a statistical perspective, it should be noted that all of the children had an ADHD diagnosis whereas only about 40% had an additional, comorbid ODD diagnosis. Moreover, in the present sample, the symptom expression was higher and the variance in symptoms was lower for ADHD symptoms than for the comorbid ODD symptoms. Therefore, it cannot be ruled out that the higher explained variance in the child symptoms for ODD than for ADHD was attributable to the smaller variances in ADHD symptoms.

Fifth, the findings on moderating effects by gender should be interpreted with caution. Even though the obvious estimation problems in the group of girls was circumvented by simplifying the SEM, the sample size must be considered to be small in relation to the complexity of the model studied [35]. Accordingly, the presented findings on moderating effects by gender should only be evaluated in terms of warranting further investigations.

Summary and clinical implications

The present study provides evidence that (a) family adversity and parental psychopathology are associated with both child ADHD and ODD symptoms while negative parenting practices are only related to child ODD symptoms; (b) family adversity is only indirectly associated with child ADHD and ODD symptoms, via parental psychopathology and negative parenting practices; (c) the detrimental effect of negative parenting practices on child ADHD and ODD symptoms is stronger in girls than in boys; (d) there are no significant associations between positive parenting practices and child ADHD or ODD symptoms.

Understanding how familial factors are (directly and indirectly) related to child symptoms can inform the development and selection of effective interventions for children. Based on the present study, which provides evidence that children in adverse family circumstances and with psychologically impaired parents appear to be at increased risk for higher ADHD symptom severity and comorbid ODD symptoms, we recommend that these areas be routinely examined as part of the diagnostic process. In addition, to prevent ODD symptoms in children, and especially in girls, a detailed examination of parenting practices seems appropriate. Interventions addressing the parent–child interaction should presumably focus specifically on reducing negative parenting practices.

Conclusions

Child development takes place in continuous interaction with the child's direct (e.g., parent) and extended (e.g., familial, socioeconomic status) environment. It is important to consider that not only the direct parent–child interaction, but also more general environmental factors have a (sometimes indirect) impact on the child. For an etiological understanding of externalizing symptoms in

children, especially ODD symptoms, clinicians should routinely consider familial factors such as adverse family circumstances, parental psychopathology, and (negative) parenting practices, and address them through appropriate interventions.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13034-022-00529-z.

Additional file 1. Importance of familial risk factors in ADHD_Table A1 to Table A7.

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Availability of data and materials
The dataset can be obtained from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
This study was performed in line with the principles of the Declaration of Helsinki. Ethics approval was provided by the local ethics committees for each participating center.

Consent for publication
Informed consent was obtained from all patients and their parents or guardians included in the study.

Competing interests
CD received royalties from Hogrefe as an author of self-help books for parents and teachers of preschool- and school-age children with ADHD. A-KTh receives royalties from Hogrefe for the publication of a diagnostic instrument (DISYPS-ILF). TB served in an advisory or consultancy role for ADHS digital, Infectopharm, Lundbeck, Medice, Neurim Pharmaceuticals, Oberberg GmbH, Roche, and Takeda. He received conference support or speaker's fees from Medice and Takeda. He received royalties from Hogrefe, Kohlhammer, CIP Medien, Oxford University Press. KB receives or has received research grants from the German Research Foundation (DFG), German Federal Ministry for Education and Research (BMBF), Philipps-University Marburg, Federal Joint Committee (G-BA), German Ministry for Health, University Hospital Giessen and Marburg and Rhön Klinikum. Additionally, she receives royalties from Thieme. JG has received a research grant from the Bavarian State Ministry of Family, Labor and Social Affairs. She receives royalties from Hogrefe for the publication of an ADHD treatment manual. MHo served in an advisory role for Shire, Takeda and Medice and received conference attendance support or was paid for public speaking by Medice, Shire and Takeda. He received research support from the German Ministry of Education and Research (BMBF). He receives royalties as Editor-in-Chief of the German Journal for Child and Adolescent Psychiatry and for textbooks from Hogrefe. MHu has served as a member of the advisory boards of Eli Lilly and Co., Engelhardt Arzneimittel, Janssen-Cilag, Medice, Novartis, Shire, and Steiner Arzneimittel within the past five years; served as a consultant to Engelhardt Arzneimittel, Medice, and Steiner Arzneimittel; received honoraria from Eli Lilly and Co., Engelhardt Arzneimittel, Janssen-Cilag, Medice, Novartis, and Shire; and received unrestricted grants for investigator-initiated trials from Eli Lilly and Co., Medice, Engelhardt Arzneimittel, and Steiner Arzneimittel. LP served in an advisory or consultancy role for Takeda, Roche, and Infectopharm. She has received speaker's fees from Takeda, Medice and Infectophar and royalties from Hogrefe, Kohlhammer, and Schattauer. MD is supervisor and lecturer and received income as head of the School of Child and Adolescent Behavior Therapy at the University of Cologne and royalties from treatment manuals, books, and psychological tests published by Guilford, Hogrefe, Enke, Beltz, and Huber. He received consulting income and research support from Medice, Shire, and eyelevel. All other authors (LTJ, CH, EvW, A-KTr, DB, JH, SH, TJ, AK, SM, PS) declare no conflict of interest.

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References

1. American Psychiatric Association. Diagnostic and statistical manual of mental disorders, 5th ed; 2013. https://doi.org/10.1176/appi.books.9780890425596
2. Azeredo A, Moreira D, Barbosa F. ADHD, CD, and ODD: systematic review of genetic and environmental risk factors. Res Dev Disabil. 2018;82:10–9. https://doi.org/10.1016/j.ridd.2017.12.010.
3. Bellina M, Grazioli S, Garzitto M, Mauri M, Rosi E, Molteni M, Brambilla P, Nobile M. Relationship between parenting measures and parents

and child psychopathological symptoms: a cross-sectional study. BMC Psychiatry. 2020;20(1):1–11. https://doi.org/10.1186/s12888-020-02778-8.
4. Biederman J, Faraone SV, Monuteaux MC. Differential effect of environmental adversity by gender: Rutter's index of adversity in a group of boys and girls with and without ADHD. Am J Psychiatry. 2002;159(9):1556–62. https://doi.org/10.1176/appi.ajp.159.9.1556.
5. Biederman J, Milberger S, Faraone SV, Kiely K, Guite J, Mick E, Ablon S, Warburton R, Reed E. Family-environment risk factors for attention-deficit hyperactivity disorder: a test of Rutter's indicators of adversity. Arch Gen Psychiatry. 1995;52(6):464–70. https://doi.org/10.1001/archpsyc.1995.03950180050007.
6. Breaux RP, Brown HR, Harvey EA. Mediators and moderators of the relation between parental ADHD symptomatology and the early development of child ADHD and ODD symptoms. J Abnorm Child Psychol. 2017;45(3):443–56. https://doi.org/10.1007/s10802-016-0213-1.
7. Bronfenbrenner U. Ecological systems theory. In: Vasta R, editor. Six theories of child development: revised formulations and current issues. Jessica Kingsley Publishers; 1992. p. 187–249.
8. Bryant FB, Smith BD. Refining the architecture of aggression: a measurement model for the Buss–Perry Aggression Questionnaire. J Res Pers. 2001;35(2):138–67. https://doi.org/10.1006/jrpe.2000.2302.
9. Burke JD, Loeber R, Birmaher B. Oppositional defiant disorder and conduct disorder: a review of the past 10 years, part II. J Am Acad Child Adolesc Psychiatry. 2002;41(11):1275–93. https://doi.org/10.1097/00004583-200211000-00009.
10. Chen M-H, Pan T-L, Wang P-W, Hsu J-W, Huang K-L, Su T-P, Li C-T, Lin W-C, Tsai S-J, Chen T-J, Bai Y-M. Prenatal exposure to acetaminophen and the risk of attention-deficit/hyperactivity disorder: a nationwide study in Taiwan. J Clin Psychiatry. 2019;80(5):15264.
11. Cheung K, Theule J. Parental psychopathology in families of children with ADHD: a meta-analysis. J Child Fam Stud. 2016;25(12):3451–61. https://doi.org/10.1007/s10826-016-0499-1.
12. Conger RD, Conger KJ, Elder GH Jr, Lorenz FO, Simons RL, Whitbeck LB. A family process model of economic hardship and adjustment of early adolescent boys. Child Dev. 1992;63(3):526–41. https://doi.org/10.1111/j.1467-8624.1992.tb01644.x.
13. Connell AM, Goodman SH. The association between psychopathology in fathers versus mothers and children's internalizing and externalizing behavior problems: a meta-analysis. Psychol Bull. 2002;128(5):746–73. https://doi.org/10.1037/0033-2909.128.5.746.
14. Coolidge FL, Thede LL, Young SE. Heritability and the comorbidity of attention deficit hyperactivity disorder with behavioral disorders and executive function deficits: a preliminary investigation. Dev Neuropsychol. 2000;17(3):273–87. https://doi.org/10.1207/S15326942DN1703_1.
15. Cuffe SP, Visser SN, Holbrook JR, Danielson ML, Geryk LL, Wolraich ML, McKeown RE. ADHD and psychiatric comorbidity: functional outcomes in a school-based sample of children. J Atten Disord. 2020;24(9):1345–54. https://doi.org/10.1177/1087054715613437.
16. Demmer DH, Hooley M, Sheen J, McGillivray JA, Lum JA. Sex differences in the prevalence of oppositional defiant disorder during middle childhood: a meta-analysis. J Abnorm Child Psychol. 2017;45(2):313–25. https://doi.org/10.1007/s10802-016-0170-8.
17. Döpfner M, Görtz-Dorten A. DISYPS-III: Diagnostik-System für psychische Störungen nach ICD-10 und DSM-5 für Kinder und Jugendliche-III: Manual. Hogrefe; 2017.
18. Döpfner M, Hautmann C, Dose C, Banaschewski T, Becker K, Brandeis D, Holtmann M, Jans T, Jenkner C, Millenet S, Renner T, Romanos M, von Wirth E. ESCAschool study: trial protocol of an adaptive treatment approach for school-age children with ADHD including two randomised trials. BMC Psychiatry. 2017;17(1):1–14. https://doi.org/10.1186/s12888-017-1433-9.
19. Dose C, Hautmann C, Bürger M, Schürmann S, Döpfner M. Negative parenting behaviour as a mediator of the effects of telephone-assisted self-help for parents of pharmacologically treated children with attention-deficit/hyperactivity disorder. Eur Child Adolesc Psychiatry. 2021;30(6):861–75. https://doi.org/10.1007/s00787-020-01565-w.
20. Esser G, Blanz B, Geisel B, Laucht M. Mannheimer Elterninterview. Mannheim, Germany: Beltz; 1989.
21. Faraone SV, Banaschewski T, Coghill D, Zheng Y, Biederman J, Bellgrove MA, Newcorn JH, Gignac M, Al Saud NM, Manor I, Rohde LA, Cortese S, Almagor D, Stein MA, Albatti TH, Aljoudi HF, Alqahtani MMJ, Asherson P, Atwoli L, Wang Y. The world federation of ADHD international consensus statement: 208 evidence-based conclusions about the disorder. Neurosci Biobehav Rev. 2021;128:789–818. https://doi.org/10.1016/j.neubiorev.2021.01.022.
22. Faraone SV, Larsson H. Genetics of attention deficit hyperactivity disorder. Mol Psychiatry. 2019;24(4):562–75. https://doi.org/10.1038/s41380-018-0070-0.
23. Goodman SH, Gotlib IH. Risk for psychopathology in the children of depressed mothers: a developmental model for understanding mechanisms of transmission. Psychol Rev. 1999;106(3):458–90. https://doi.org/10.1037/0033-295X.106.3.458.
24. Goodman SH, Simon HF, Shamblaw AL, Kim CY. Parenting as a mediator of associations between depression in mothers and children's functioning: a systematic review and meta-analysis. Clin Child Fam Psychol Rev. 2020;23(4):427–60. https://doi.org/10.1007/s10567-020-00322-4.
25. Görtz-Dorten A. Fragebogen zum Umgang mit Ärger (FB-Ä). Unpublished. University of Cologne: Department of Child and Adolescent Psychiatry, Psychosomatics and Psychotherapy; 2013.
26. Görtz-Dorten A, Thöne A-K, Döpfner M. Interview-Leitfäden zum Diagnostik-System für psychische Störungen nach DSM-5 für Kinder-und Jugendliche (DISYPS-ILF). Hogrefe; 2022.
27. Granero R, Louwaars L, Ezpeleta L. Socioeconomic status and oppositional defiant disorder in preschoolers: parenting practices and executive functioning as mediating variables. Front Psychol. 2015;6:1412. https://doi.org/10.3389/fpsyg.2015.01412.
28. Hanisch C, Hautmann C, Plück J, Eichelberger I, Döpfner M. The prevention program for externalizing problem behavior (PEP) improves child behavior by reducing negative parenting: analysis of mediating processes in a randomized controlled trial. J Child Psychol Psychiatry. 2014;55(5):473–84. https://doi.org/10.1111/jcpp.12177.
29. Hendriks A, Van der Giessen D, Stams G, Overbeek G. The association between parent-reported and observed parenting: a multi-level meta-analysis. Psychol Assess. 2018;30(5):621. https://doi.org/10.1037/pas0000500.
30. Holas V, Thöne A-K, Dose C, Görtz-Dorten A, Hautmann C, Imort S, Jendreizik LT, Plück J, Treier A-K, Banaschewski T, Döpfner M, on behalf of the ADOPT and the ESCA consortia. Psychometric properties of a parent rating scale for the assessment of positive and negative parenting. [Manuscript in preparation]; 2022.
31. Hooper D, Coughlan J, Mullen MR. Structural equation modelling: guidelines for determining model fit. Electron J Bus Res Methods. 2008;6(1):53–60.
32. Jendreizik LT, von Wirth E, Döpfner M. Familial factors associated with symptom severity in children and adolescents with ADHD: a meta-analysis and supplemental review. J Atten Disord. 2022; 10870547221132793.
33. Jensen PS, Hinshaw SP, Kraemer HC, Lenora N, Newcorn JH, Abikoff HB, March JS, Arnold LE, Cantwell DP, Conners CK, Elliott GR, Greenhill LL, Hechtman L, Hoza B, Pelham WE, Severe JB, Swanson JM, Wells KC, Wigal T, Vitiello B. ADHD comorbidity findings from the MTA study: comparing comorbid subgroups. J Am Acad Child Adolesc Psychiatry. 2001;40(2):147–58. https://doi.org/10.1097/00004583-200102000-00009.
34. Kennedy M, Kreppner J, Knights N, Kumsta R, Maughan B, Golm D, Rutter M, Schlotz W, Sonuga-Barke EJ. Early severe institutional deprivation is associated with a persistent variant of adult attention-deficit/hyperactivity disorder: clinical presentation, developmental continuities and life circumstances in the English and Romanian Adoptees study. J Child Psychol Psychiatry. 2016;57(10):1113–25. https://doi.org/10.1111/jcpp.12576.
35. Kline RB. Principles and practice of structural equation modeling. Guilford publications; 2015.
36. Letourneau NL, Duffett-Leger L, Levac L, Watson B, Young-Morris C. Socioeconomic status and child development: a meta-analysis. J Emot Behav Disord. 2013;21(3):211–24. https://doi.org/10.1177/1063426611421007.
37. Lovibond PF, Lovibond SH. The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. Behav Res Ther. 1995;33(3):335–43. https://doi.org/10.1016/0005-7967(94)00075-U.
38. Narad ME, Garner AA, Peugh JL, Tamm L, Antonini TN, Kingery KM, Simon JO, Epstein JN. Parent–teacher agreement on ADHD symptoms across development. Psychol Assess. 2015;27(1):239–48. https://doi.org/10.1037/a0037864.

39. Naumann S, Bertram H, Kuschel A, Heinrichs N, Hahlweg K, Döpfner M. Der Erziehungsfragebogen (EFB). Diagnostica. 2010;56(3):144–57. https://doi.org/10.1026/0012-1924/a000018.
40. Nilges P, Essau C. Die depressions-angst-stress-Skalen: Der DASS–ein Screeningverfahren nicht nur für Schmerzpatienten. Schmerz. 2015;29:649–57. https://doi.org/10.1007/s00482-015-0019-z.
41. Pachter LM, Auinger P, Palmer R, Weitzman M. Do parenting and the home environment, maternal depression, neighborhood, and chronic poverty affect child behavioral problems differently in different racial-ethnic groups? Pediatrics. 2006;117(4):1329–38. https://doi.org/10.1542/peds.2005-1784.
42. Perepletchikova F, Kazdin AE. Assessment of parenting practices related to conduct problems: development and validation of the Management of Children's Behavior Scale. J Child Fam Stud. 2004;13(4):385–403.
43. Pinquart M. Associations of parenting dimensions and styles with externalizing problems of children and adolescents: an updated meta-analysis. Dev Psychol. 2017;53(5):873–932. https://doi.org/10.1037/dev0000295.
44. Piotrowska PJ, Stride CB, Croft SE, Rowe R. Socioeconomic status and anti-social behaviour among children and adolescents: a systematic review and meta-analysis. Clin Psychol Rev. 2015;35:47–55. https://doi.org/10.1016/j.cpr.2014.11.003.
45. Polanczyk GV, Salum GA, Sugaya LS, Caye A, Rohde LA. Annual research review: a meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. J Child Psychol Psychiatry. 2015;56(3):345–65. https://doi.org/10.1111/jcpp.12381
46. Rey JM, Walter G, Plapp JM, Denshire E. Family environment in attention deficit hyperactivity, oppositional defiant and conduct disorders. Aust N Z J Psychiatry. 2000;34(3):453–7. https://doi.org/10.1080/j.1440-1614.2000.00735.x.
47. Rijlaarsdam J, Stevens GW, Van Der Ende J, Hofman A, Jaddoe VW, Mackenbach JP, Verhulst FC, Tiemeier H. Economic disadvantage and young children's emotional and behavioral problems: mechanisms of risk. J Abnorm Child Psychol. 2013;41(1):125–37. https://doi.org/10.1007/s10802-012-9655-2.
48. Rösler M, Retz-Junginger P, Retz W, Stieglitz R. Homburger ADHS-Skalen für Erwachsene. Hogrefe; 2008.
49. Rosseel Y. Lavaan: An R package for structural equation modeling and more. Version 0.5–12 (BETA). J Stat Softw. 2012;48(2):1–36. https://doi.org/10.18637/jss.v048.i02
50. Rowe R, Maughan B, Pickles A, Costello EJ, Angold A. The relationship between DSM-IV oppositional defiant disorder and conduct disorder: findings from the Great Smoky Mountains Study. J Child Psychol Psychiatry. 2002;43(3):365–73. https://doi.org/10.1111/1469-7610.00027.
51. Rutter M, Cox A, Tupling C, Berger M, Yule W. Attainment and adjustment in two geographical areas: I—the prevalence of psychiatric disorder. Br J Psychiatry. 1975;126(6):493–509. https://doi.org/10.1192/bjp.126.6.493.
52. Shaffer A, Lindhiem O, Kolko DJ, Trentacosta CJ. Bidirectional relations between parenting practices and child externalizing behavior: a cross-lagged panel analysis in the context of a psychosocial treatment and 3-year follow-up. J Abnorm Child Psychol. 2013;41(2):199–210. https://doi.org/10.1007/s10802-012-9670-3.
53. Solantaus T, Leinonen J, Punamäki R-L. Children's mental health in times of economic recession: replication and extension of the family economic stress model in Finland. Dev Psychol. 2004;40(3):412–29. https://doi.org/10.1037/0012-1649.40.3.412.
54. Stojanovski S, Felsky D, Viviano JD, Shahab S, Bangali R, Burton CL, Devenyi GA, O'Donnell LJ, Szatmari P, Chakravarty MM, Ameis S, Schachar R, Voineskos AN, Wheeler AL. Polygenic risk and neural substrates of attention-deficit/hyperactivity disorder symptoms in youths with a history of mild traumatic brain injury. Biol Psychiat. 2019;85(5):408–16. https://doi.org/10.1016/j.biopsych.2018.06.024.
55. Strayhorn JM, Weidman CS. A parent practices scale and its relation to parent and child mental health. J Am Acad Child Adolesc Psychiatry. 1988;27(5):613–8. https://doi.org/10.1097/00004583-198809000-00016.
56. Sun W, Li D, Zhang W, Bao Z, Wang Y. Family material hardship and Chinese adolescents' problem behaviors: a moderated mediation analysis. PLoS ONE. 2015;10(5): e0128024. https://doi.org/10.1371/journal.pone.0128024.
57. Thöne A-K, Görtz-Dorten A, Altenberger P, Dose C, Geldermann N, Hautmann C, Jendreizik LT, Treier A-K, von Wirth E, Banaschewski T, Brandeis D, Millenet S, Hohmann S, Becker K, Ketter J, Hebebrand J, Wenning J, Holtmann M, Legenbauer T, Döpfner M. Toward a dimensional assessment of externalizing disorders in children: reliability and validity of a semi-structured parent interview. Front Psychol. 2020;11:1840. https://doi.org/10.3389/fpsyg.2020.01840.
58. Willcutt EG. The prevalence of DSM-IV attention-deficit/hyperactivity disorder: a meta-analytic review. Neurotherapeutics. 2012;9(3):490–9. https://doi.org/10.1007/s13311-012-0135-8.
59. World Health Organization. International statistical classification of diseases and related health problems, 10th ed.; 2016. https://icd.who.int/browse10/2016/en

Publisher's Note

3 Discussion

This cumulative dissertation highlighted the family, as children's immediate environment, and explored its relevance to children's externalizing behaviors. Focusing on children and adolescents with an ADHD diagnosis, associations of family characteristics with ADHD symptom severity and comorbid oppositional symptoms in children were examined (cf. Jendreizik, Hautmann, et al., 2022; Jendreizik, von Wirth, et al., 2022). The first study of the present thesis reviewed primary studies concerning the relationship between multiple familial factors and the severity of symptoms in children and adolescents affected by child ADHD (cf. Jendreizik, von Wirth, et al., 2022). The second study considered four familial factors within one statistical model, exploring relationships among these factors. Furthermore, the direct and indirect effects of the familial factors on ADHD and comorbid oppositional symptoms were examined in a large clinical sample of children with ADHD (cf. Jendreizik, Hautmann, et al., 2022). The research questions of the two studies are of particular clinical relevance since the familial factors investigated appear to be at least partially modifiable through psychosocial interventions (cf. Jendreizik, Hautmann, et al., 2022; Jendreizik, von Wirth, et al., 2022).

3.1 Summary and Interpretation of Results

The findings of the two studies of this cumulative thesis are summarized and discussed along with the research questions presented in the introduction.

Research question 1: Which familial factors are significantly associated with the severity of ADHD symptoms in children and adolescents diagnosed with ADHD (cf. Jendreizik, von Wirth, et al., 2022)?

The meta-analysis performed within the first study revealed significant correlations between several familial factors and child ADHD symptom severity (Jendreizik, von Wirth, et al., 2022). Significant associations were found for each of the three subcategories of familial factors introduced: (a) characteristics and framework of the family: broken parental partnership, SES, single-parent family; (b) mental health of the family members: parental ADHD, parental affective psychopathology, parental mental health; (c) intrafamilial interactions and relationships: parenting stress, negative parenting practices, critical life events (Jendreizik, von Wirth, et al., 2022)[4]. The directions of the correlations were consistently in the expected direction, the strengths of the correlations were small ($r < .30$), and the variance explained by the respective factor varied between 1% and 6% (Jendreizik, von Wirth, et al., 2022). In conclusion, multiple familial factors, rather than one single familial factor or factors in one subcategory of familial factors, appear to be associated with child symptom severity (Jendreizik, von Wirth, et al., 2022). Moreover, for each of the three subcategories of familial factors, some factors were not significantly associated with ADHD symptom severity in children: (a) characteristics and

[4] There are many ways to group and structure familial factors. Even with the selected subcategories, there are individual factors whose allocation could be discussed.

framework of the family: parental age, number of children in the family; (b) mental health of the family members: parental QoL; and (c) intrafamilial interactions and relationships: positive parenting practices (Jendreizik, von Wirth, et al., 2022). In summary, nine of the 13 meta-analytically evaluated familial factors (including adverse family circumstances, parental psychopathologies, and negative parenting practices) were significantly associated with child ADHD symptom severity. However, no single factor explained a large amount of variance in ADHD symptom severity (Jendreizik, von Wirth, et al., 2022). The supplementary review provided no robust evidence that family characteristics that could not be meta-analytically evaluated due to a small number of included studies are crucial for symptom severity among children and adolescents affected by ADHD (Jendreizik, von Wirth, et al., 2022).

In addition to the first study, the second study also reported bivariate associations between several familial factors and child ADHD symptoms. Specifically, both studies examined bivariate correlations of positive and negative parenting behaviors, parental psychopathology, and adverse family characteristics with symptom severity in children and adolescents affected by ADHD (Jendreizik, Hautmann, et al., 2022; Jendreizik, von Wirth, et al., 2022). In the following, the findings of the two studies are reviewed in terms of consistencies or inconsistencies. Consistently, both studies found no significant bivariate correlations between positive parenting behaviors and child ADHD symptoms ($p \geq .21$; Jendreizik, Hautmann, et al., 2022; Jendreizik, von Wirth, et al., 2022). In contrast, both studies showed significant small bivariate associations between negative parenting behaviors and child ADHD symptoms (Jendreizik, Hautmann, et al., 2022: [clinician-rated] $r = .15$; [parent-rated] $r = .18$; Jendreizik, von Wirth, et al., 2022: $r = .19$). Furthermore, both studies revealed small but significant bivariate associations between (different types of) parental psychopathology and child ADHD symptoms (Jendreizik, Hautmann, et al., 2022: $r = .10$ - $.19$; Jendreizik, von Wirth, et al., 2022: $r = .14$ - $.16$). Although a comparison of the results of the two studies in terms of adverse family characteristics seems problematic due to the markedly different operationalizations (individual familial factors vs. index), they do appear to be broadly comparable: The first study meta-analytically evaluated five potentially adverse family characteristics and detected small but significant associations with child ADHD symptom severity for three of the five studied factors ($r = |.10|$ -.19; Jendreizik, von Wirth, et al., 2022). The second study revealed a small but significant bivariate association between family adversity and child ADHD symptoms when assessed by parents ($r = .10$) but not when assessed by clinicians (Jendreizik, Hautmann, et al., 2022). In summary, the two studies showed consistent findings for the following familial factors: Parental psychopathology and negative (but not positive) parenting practices were associated with ADHD symptom severity in children and adolescents with an ADHD diagnosis. The results regarding the associations between adverse family characteristics and ADHD symptoms are only roughly comparable for the two studies and are more ambiguous.

In 2022, the U.S. Centers for Disease Control and Prevention also reviewed primary studies on the relationship between multiple family characteristics and ADHD in children (Claussen et al., 2022). When comparing this meta-analysis with the first study of the present thesis (cf. Claussen et al., 2022; Jendreizik, von Wirth, et al., 2022), three important discrepancies concerning the methodology stand out: First, in contrast to the first study of this cumulative thesis, which evaluated only clinical samples of children with ADHD (Jendreizik, von Wirth, et al., 2022), Claussen et al. (2022) studied community samples, risk-associated samples, and samples affected by adverse family circumstances (e.g., children affected by maltreatment). Second, Claussen et al. (2022) considered longitudinal and retrospective studies instead of cross-sectional studies (cf. Jendreizik, von Wirth, et al., 2022). Third, Claussen et al. (2022) examined familial factors of the subcategories (a) characteristics and framework of the family and (c) intrafamilial interactions and relationships, but did not include the subcategory (b) mental health of the family members. Regarding outcomes, Claussen et al. (2022) provided separate information for ADHD diagnoses (dichotomous effect size) and ADHD symptoms (continuous effect size) where possible. In the following discussion, however, only the continuous effect sizes reported are addressed. In terms of (a) characteristics and framework of the family, Claussen et al. (2022) reported a small positive correlation between parental divorce and ADHD symptoms (r = .11). Although the operationalizations differ between the two reviews, the two related correlation coefficients in our review can be considered comparable in terms of the direction, size, and significance of effects (single-parent family: r = .10; broken parental partnership: r = .19). Interestingly, Claussen et al. (2022) reported a small positive correlation for a further familial factor, for which we were unable to include studies in our review: parental incarceration (r = .10). With respect to (b) intrafamilial interactions and relationships, the findings of the two reviews diverge: While Claussen et al. (2022) reported a significant negative association between positive parenting practices and ADHD symptoms (r = -.14), our analyses resulted in a non-significant correlation coefficient. For negative parenting behaviors, by contrast, both reviews revealed significant correlations, which are also comparable regarding direction and size (both r = .19). In terms of the relationship between child maltreatment or critical life events and ADHD symptoms, both reviews found a significant positive association. However, the size of the correlation differed slightly, with a moderate coefficient in the review by Claussen et al. (2022; r = .30) and a small coefficient in our review (r = .16; Jendreizik, von Wirth, et al., 2022). Regarding the familial factors positive parenting behaviors and maltreatment or critical life events, it should be considered that the confidence intervals of the correlations identified by the two working groups overlap in each case. Moreover, it should be noted that the varying strengths of the correlation coefficients for the association between positive parenting behaviors and ADHD symptoms, and the association between maltreatment or critical life events experiences and ADHD symptoms, may be due to the differing characteristics of the primary studies evaluated (study design and study sample). Thus, it is conceivable

that the associations between maltreatment or critical life events experiences and ADHD symptoms are more prominent within, for example, a school class (community sample) than within a group of children with ADHD (clinical sample). Consequently, it might be assumed that the children in the community sample have considerably fewer risk factors for ADHD than those in the clinical sample, and that the aggregate of many (genetic, biological, and psychosocial) risk factors within the children in the clinical sample blurred the observed association between maltreatment or critical life events experiences and ADHD symptoms. Finally, of course, different operationalizations of the familial factors may lead to the varying strengths of the correlation coefficients.

Research question 2: Are adverse family circumstances associated with more pronounced parental psychopathology, and is parental psychopathology in turn associated with more negative parenting behaviors and less positive parenting behaviors in children diagnosed with ADHD (cf. Jendreizik, Hautmann, et al., 2022)?

In line with the ecological systems theory (Bronfenbrenner, 1992) and the family stress model (Conger et al., 1992), the model proposed in the second study arranged the familial factors by their proximity to the child (cf. Jendreizik, Hautmann, et al., 2022). The proposed model showed a good model fit. In contrast, the alternative model consisting of the familial factors with a different sequence resulted in an unacceptable model fit (Jendreizik, Hautmann, et al., 2022). The interrelationships of the familial factors were in line with expectation: Family adversity was positively associated with parental mental health problems, which were in turn associated with a higher rate of negative and a lower rate of positive parenting behaviors (Jendreizik, Hautmann, et al., 2022). The strengths of the relationships were broadly comparable to the findings of previous studies examining the postulates of the family stress model (Pachter et al., 2006; Rijlaarsdam et al., 2013; Sun et al., 2015) and were rated as small to moderate (β = .16 - .47; Jendreizik, Hautmann, et al., 2022).

Research question 3: Are the familial factors (family adversity, parental psychopathology, positive parenting practices, and negative parenting practices) indirectly or directly related to ADHD symptoms and ODD symptoms in children diagnosed with ADHD (cf. Jendreizik, Hautmann, et al., 2022)?

Based on the SEM analyses conducted within the second study, family adversity was indirectly rather than directly linked to more pronounced externalizing behaviors in children diagnosed with ADHD. Parental psychopathology was directly associated with higher levels of both ADHD and ODD symptoms and indirectly related to higher levels of ODD symptoms in children. Negative parenting practices were directly related to more ODD symptoms but not to more ADHD symptoms in children (Jendreizik, Hautmann, et al., 2022). The respective directions of the identified effects were consistent with theoretical assumptions. The indirect impact of family adversity on child externalizing behaviors can be described as follows: Adverse family characteristics were related to more pronounced parental

mental health problems, which were in turn linked to more pronounced ADHD and ODD symptoms in children. Additionally, the potential serial indirect effect of adverse family characteristics on child symptoms of ODD can be described as follows: Family adversity was related to parental mental health problems, which were related to a higher rate of negative parenting behaviors, and ultimately more child symptoms of ODD. Viewed from another perspective, two out of the four familial factors (family adversity, parental psychopathology) significantly impacted ADHD symptoms (Jendreizik, Hautmann, et al., 2022). Three out of the four familial factors (family adversity, parental psychopathology, negative parenting practices) showed a considerable impact on child symptoms of ODD (Jendreizik, Hautmann, et al., 2022). About 12.6 % of the variance in comorbid oppositional symptoms, and 7.5 % of the variance in ADHD symptoms in children, was explained by the four familial factors. Interestingly, a higher rate of positive parenting behaviors was not related to less pronounced externalizing behaviors among children (Jendreizik, Hautmann, et al., 2022).

The following section discusses the substantive meaning, possible causation, and implications of the relationships among familial factors and the effects of familial factors on externalizing behaviors in children found in the second study. However, it should be noted in the following discussion that the study design does not allow for firm conclusions about the direction of the relationships (for more information: see: 3.2). Therefore, the direction of relationships was hypothesized and discussed on a theoretical basis. Consistent with the ecological systems theory (Bronfenbrenner, 1974, 1977, 1979, 1992) and extending the family stress model (Conger et al., 1992), parents who experienced economic or (psycho-)social adversity (e.g., raising a child alone, having a conflict-laden parental relationship, or having experiences with breaking the law) reported more pronounced mental health problems (Jendreizik, Hautmann, et al., 2022). It can be assumed that this association is true for both internalizing (e.g., depressive and anxiety symptoms and increased stress) and externalizing (e.g., inner restlessness, distractibility, irritability, argumentativeness, or aggression) parental symptoms (Jendreizik, Hautmann, et al., 2022; Silva et al., 2016). Furthermore, children's externalizing symptoms were increased with a higher extent of parental mental health problems (Jendreizik, Hautmann, et al., 2022). It can be assumed that the parental experience of economic or (psycho-)social stress or mental health problems is associated with impaired parenting. Thus, parents with limited financial and psychosocial resources or with mental health problems may be more likely to respond ineffectively or inconsistently to their child (Cheung & Theule, 2016; Chronis-Tuscano et al., 2017). Notably, in families with economic and psychosocial burdens, parents may have less time to spend with their children on average, as they have to work more and thus have fewer opportunities to carry out relationship-building activities with their children (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2021; Heinrich, 2014). In families affected by unemployment, the parent-child relationship may deteriorate due to severe parental psychosocial stress and loss of psychosocial resources (e.g., loss of

social contacts and leisure activities; Heinrich, 2014). Furthermore, parents with mental health problems may have a limited ability to perceive and respond sensitively to their children's immediate needs (Cheung & Theule, 2016; Chronis-Tuscano et al., 2017), thereby reinforcing externalizing behaviors in children. Additionally, it can be assumed that families with limited financial resources have less money to pay, for instance, for sporting activities or other leisure activities that allow for physical activity and stabilization of self-esteem in children (Grima et al., 2017). It is also conceivable, on the other hand, that the child's externalizing symptoms may condition or exacerbate parental overwhelm, reinforcing negative parenting behaviors or daily parental feelings of failure and thus also parental psychological symptoms (e.g., parental depression; for more information see: 3.2). In fact, two exciting findings were noted in the two studies: First, negative parenting behaviors were associated with more externalizing, especially comorbid oppositional behaviors, but positive parenting behaviors were not associated with fewer externalizing behaviors in children (Jendreizik, Hautmann, et al., 2022; Jendreizik, von Wirth, et al., 2022). Although the overall evidence base is somewhat inconclusive, previous studies from our research group have yielded corresponding findings. Specifically, in these intervention studies, changes in negative, but not positive, parenting practices were associated with symptom reduction (Dose et al., 2021; Hanisch et al., 2014; Pinquart, 2017). Accordingly, one might conclude that positive parenting behaviors are necessary but insufficient to deal with clinically significant oppositional symptoms in children. Instead, refraining from negative parenting behaviors appears to be relevant for reducing comorbid oppositional behaviors in children. Second, familial factors were more strongly related to ODD symptoms than to ADHD symptoms in children (Jendreizik, Hautmann, et al., 2022). Previous research reported corresponding results in this regard, but further evidence is needed (Azeredo et al., 2018; Coolidge et al., 2000). One possible conclusion from this finding is a greater importance of the child's environment, including the family environment, and a lesser importance of genes for ODD symptoms compared to ADHD symptoms (cf. Jendreizik, Hautmann, et al., 2022).

In the following section, based on the results of the first and second study, statements will be made as to which therapeutic and governmental support services could be offered to families. The first study pointed out that nine familial factors (including adverse family circumstances, parental mental health, and negative parenting behaviors) are significantly associated with child ADHD symptom severity (Jendreizik, von Wirth, et al., 2022). The second study supported the findings that family adversity, parental psychopathology, and negative parenting practices are linked to externalizing symptoms in children (Jendreizik, Hautmann, et al., 2022). Accordingly, the following recommendations can be made for therapeutic practice: Family characteristics should be part of a detailed diagnostic assessment, and interventions should be tailored to the individual family's needs. In detail, it seems valuable to expand child-centered interventions to parent-centered interventions to

manage parental mental health problems, couple-centered interventions to improve the relationship between parents, and family-centered interventions to reduce negative parenting behaviors (Dose et al., 2021; Hanisch et al., 2014; Jendreizik, von Wirth, et al., 2022). Undisputedly, moreover, socially organized support to enable (in particular) families with limited financial and psychosocial resources to cope with raising children and prevent child psychopathologies is both sensible and morally necessary. This could include, for example, financial support and relief for families, the expansion of all-day care including personnel qualification opportunities, the expansion of preventive, supportive services, and easier access to intervention services (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2021). Although the findings of the present thesis provide preliminary indications for prevention and intervention approaches, further research is required for the formulation of more specific recommendations. Based on the results of the second study, it appears that parental mental health problems are directly related to child ADHD symptoms and both directly and indirectly (via parenting practices) related to child ODD symptoms (Jendreizik, Hautmann, et al., 2022). Therefore, when treating children with ADHD, a thorough assessment of parental mental health before the start of treatment seems clearly recommendable. If deemed necessary, the parents could then be provided with (pharmacological or psychotherapeutic) treatment for their mental health problems. A consequent reduction in parental symptoms would be expected to be accompanied by a decrease in child symptoms. As such, this parental treatment could occur instead of or in addition to the child's treatment in order to optimize the treatment effects for both parties. In a review examining the associations of parental ADHD with treatment outcomes for children with ADHD, Chronis-Tuscano et al. (2017) reported that parental ADHD is associated with worse outcomes following psychosocial and pharmacological treatment of the child, and that treatment of parental ADHD has positive effects on parenting. Moreover, the authors pointed out that for parents with clinical ADHD, changes in the duration, pace, and delivery format of psychotherapeutic interventions could lead to clinical benefits (Chronis-Tuscano et al., 2017). In line with this, a first study found that treatments targeting parental psychopathology, here maternal depression, yield additional benefits for children with ADHD compared to usual care approaches (Chronis-Tuscano et al., 2013). Another study, which examined the potential of supplemental multimodal therapy for parental ADHD to improve the effectiveness of parent-child training for children with ADHD, yielded mixed results: While the response after combined treatment (maternal treatment & parent-child training) was independent of the intensity of maternal treatment, greater improvements in (mother-rated) disruptive behaviors was found with more intensive maternal treatment prior to the initiation of parent-child training (Hautmann et al., 2018; Jans et al., 2015). To date, however, there is a lack of randomized controlled trials comparing treatment outcomes between a combined parent and child treatment approach for child ADHD and a parent or a child treatment alone. Results are eagerly awaited from a SMART (Sequential Multiple

Randomization Trial; Chronis-Tuscano et al., 2016) study that is investigating the combination of parental and child ADHD treatment for mothers with ADHD and their young children with elevated ADHD symptoms.

Research question 4: Are the associations of familial factors (family adversity, parental psychopathology, positive parenting practices, and negative parenting practices) with externalizing symptoms in children moderated by the age or gender of the affected children (cf. Jendreizik, Hautmann, et al., 2022)?

Based on the multi-sample SEMs performed within the second study, no significantly different (total or direct) effects on child externalizing symptoms were found for family adversity, parental psychopathology, and parenting practices in the age-based subsamples (Jendreizik, Hautmann, et al., 2022). It should be noted, however, that all of the children studied were between six and 12 years old. Therefore, it would be informative to examine the moderating effects of children's age in a study sample encompassing a wider age range (e.g., 3 - 18 years). For example, it would be interesting to investigate the potentially differing importance of (positive and negative) parenting behaviors at preschool age and during adolescence.

Furthermore, the second study found no significant differences between boys and girls regarding (total, direct) effects of family adversity and parental psychopathology on externalizing symptoms, but did reveal such effects for negative parenting practices (Jendreizik, Hautmann, et al., 2022). Specifically, the association between inconsistent, impulsive and rigid parenting practices and child externalizing symptoms was stronger in girls than in boys. As such, the study supported previous findings that negative parenting practices might have a weaker impact on externalizing behaviors in boys than in girls (Granero et al., 2015; Javo et al., 2004). However, as other research reported no moderating effect or a stronger association in boys than in girls, further investigation is essential in order to interpret this finding (Pinquart, 2017; Tung et al., 2012).

3.2 Limitations

Some limitations should be considered when interpreting the presented findings. First, one of the main limitations of both studies is that (almost exclusively) cross-sectional data were analyzed (cf. Jendreizik, Hautmann, et al., 2022; Jendreizik, von Wirth, et al., 2022). Of the 48 primary studies whose findings were synthesized in the first study, only one had a longitudinal design and contributed longitudinal data to the meta-analysis and supplemental review. All other synthesized primary studies had a cross-sectional or longitudinal design, but only cross-sectional data were considered. Consequently, no statements regarding the direction of the relationships can be derived from the bivariate correlations determined in the first study (Jendreizik, von Wirth, et al., 2022). The second study analyzed data from the initial phase of a multicenter intervention study for school-aged children with ADHD. Accordingly, both the familial factors (family adversity, parental psychopathology,

parenting practices) and symptoms (ADHD, ODD) of the 555 children with ADHD were recorded before treatment started. Therefore, no definitive conclusions can be drawn regarding the direction of the association in the second study either (Jendreizik, Hautmann, et al., 2022). Greater certainty about the direction of the relationship can be obtained primarily through the use of a longitudinal study design (Kline, 2015). Nevertheless, to find further indications about the direction of the associations, the second study contrasted the postulated model (family adversity, parental psychopathology, parenting practices, child symptoms) with an alternative model encompassing a different order of familial factors (parental psychopathology, family adversity, parenting practices, child symptoms; cf. Jendreizik, Hautmann, et al., 2022). Even though this alternative model showed an unacceptable model fit and was thus clearly inferior to the postulated initial model, the assumed direction of the relationships remains to be determined (Jendreizik, Hautmann, et al., 2022). Specifically, for example, raising a child with high physical agitation, a tendency toward chaos, and oppositional behavior may require increased parental support. As a consequence of this, parents may be more often exhausted or overwhelmed, their mental health may be more impaired, more parental conflicts may occur, parents may divorce, and it might even be the case that parental working hours have to be reduced to ensure the child's care. The attentive reader will have noticed that the direction of the latter description of the associations (child mental health → parenting & parental mental health → family circumstances) differs from the direction of descriptions in the previous section (family circumstances → parental mental health → parenting → child mental health; see also: 3.1). In summary, while the association was confirmed, the direction of the influence remains unclear. Furthermore, it is possible that other familial factors, which were not examined, mediate the reported relationships or that the relationships among familial factors are bidirectional rather than unidirectional. In particular, some studies suggest that maternal depression and parenting behaviors or parenting behaviors and child symptoms influence each other reciprocally rather than unilaterally (Patterson et al., 2004; Pinquart, 2017; Shaffer et al., 2013).

Second, a considerable limitation of both studies in the current thesis is the intense focus on (biological) parents as informants. In particular, in common with the literature in the area of developmental psychopathology (Parent et al., 2017), the two studies mainly consider ratings from mothers and only a very limited number of ratings from fathers or other caregivers (cf. Jendreizik, Hautmann, et al., 2022; Jendreizik, von Wirth, et al., 2022). Moreover, the assessment of both familial factors and child symptoms by parents entails two limitations: On the one hand, it is still unclear to what extent parents are suitable as exclusive informants for ADHD symptom presentations in different settings (e.g., home, school, peer contact). For example, research has shown low to moderate agreement between parent and teacher ratings (De Los Reyes et al., 2015; Narad et al., 2015). The current debate is whether the informants themselves are the source of these discrepancies, leading to

the assumption of reporter bias, or whether the discrepancies reflect different symptom presentations in different settings (e.g., at home, in school) and thus provide valuable information for diagnostic purposes (De Los Reyes et al., 2015; Narad et al., 2015). To recall, the first study almost exclusively considered parent ratings of child ADHD symptom severity (cf. Jendreizik, von Wirth, et al., 2022). Correspondingly, associations between familial factors and teacher-rated severity of ADHD symptoms, for example, which might reflect symptom severity in the school context, were not investigated. In the second study, both parents and clinicians were used as informants to assess children's externalizing symptoms (cf. Jendreizik, Hautmann, et al., 2022), meaning that again, teachers' assessments were lacking. Unfortunately, the initial plan to include all three ratings (clinician, parent, teacher) as indicators of the two latent factors of child symptoms (ADHD, ODD) in the second study had to be discarded due to the small number of participating teachers (56%; Jendreizik, Hautmann, et al., 2022). Moreover, in the second study, the clinician assessed the child's symptoms primarily using a semi-structured clinical interview with parents (cf. Jendreizik, Hautmann, et al., 2022). Therefore, it must also be assumed that the externalizing symptoms assessed by the clinician broadly reflect symptoms at home and the perception and evaluation of the parents. In sum, the assessment of ADHD symptoms in different settings and with the help of different informants seems valuable and necessary to inform both diagnosis and suitable interventions (De Los Reyes et al., 2015; Deutsche Gesellschaft für Kinder- und Jugendpsychiatrie, Psychosomatik und Psychotherapie, 2016; Deutsche Gesellschaft für Kinder- und Jugendpsychiatrie, Psychosomatik und Psychotherapie et al., 2017). An exclusive reliance on parents as informants is also problematic because the associations found between familial factors and child symptoms could be due to same-informant effects. Future studies should counteract such a potential overestimation of possible associations by using a variety of informants as well as direct observation (e.g., parenting behaviors) or objective recording of variables (e.g., income via salary record; De Los Reyes et al., 2015).

Third, it is open to discussion whether it is more useful to investigate individual, concrete unfavorable family characteristics (cf. Jendreizik, von Wirth, et al., 2022: broken parental partnership, SES, single-parent family, parental age, number of children) or broader (economic and psychosocial) disadvantage (cf. Jendreizik, Hautmann, et al., 2022: family adversity index). On the one hand, demonstrating an association of an individual familial factor with externalizing symptoms is helpful for deriving what type of support a family requires as well as possible interventions. On the other hand, regarding child psychopathology in general and externalizing symptoms in particular, there is increasing evidence that it is not one individual familial factor that has a specific association, but rather the aggregation of various familial factors that is linked to externalizing symptoms in children (Biederman et al., 1992; Biederman et al., 2002; Jendreizik, Hautmann, et al., 2022). However, it should be kept in mind that in models examining various familial factors simultaneously, the inclusion of an

index of familial adversity appears problematic, as a clear delineation from other familial factors is complicated by the breadth of the index. Specifically, a significant limitation of the second study is that the investigated family adversity index encompasses the presence of a parental mental disorder (as one of five indicators) and thus has a substantive overlap with the latent factor of parental psychopathology also investigated (cf. Jendreizik, Hautmann, et al., 2022).

Fourth, the present thesis only depicts an excerpt of various familial factors that might be examined. Although the first study conducted a broad systematic search and included a wide range of familial factors, some factors also associated with families had to be excluded, such as maternal use of nicotine, alcohol, or drugs during pregnancy, parental knowledge of ADHD, parental cognitions (e.g., about the controllability of ADHD behaviors), and parental attitudes toward ADHD or ADHD medication (cf. Jendreizik, von Wirth, et al., 2022). Although the association between these factors and symptom severity in children is undoubtedly also of interest, it seemed necessary to limit the number of factors included in order to ensure the feasibility of the review. As a result, the literature review reported associations between mainly psychosocial characteristics of families and child ADHD symptoms, and neglected biological and cognitive psychological characteristics of families. The second study even exclusively examined the associations of a few selected familial factors with child externalizing symptoms (cf. Jendreizik, Hautmann, et al., 2022), which was necessary because the model complexity is limited by the sample size (Kline, 2015). Additionally, the number of missing values, the psychometric properties of the measures, and possible overlaps and associations between the factors were considered when selecting factors. Finally, of course, even among the ESCAschool data, there would have been further familial factors that would have been interesting to investigate (e.g., critical life events).

Furthermore, the two studies of the cumulative dissertation have specific limitations, which have already been addressed in the respective publications (cf. Jendreizik, Hautmann, et al., 2022; Jendreizik, von Wirth, et al., 2022). In summary, for the first study (meta-analysis and supplemental review), the interpretation of findings should take into account the search strategy used, the inclusion and exclusion criteria formulated, the heterogeneity of the included studies, a possible publication bias, and the quality of the included studies (Jendreizik, von Wirth, et al., 2022). In the second study, the interpretation of the results should consider the small size of the study sample (especially of girls) with the high model complexity, as well as the different symptom expressions and variances of symptoms of ADHD and ODD (Jendreizik, Hautmann, et al., 2022). Moreover, it should be noted that the relationships between familial factors, such as parental psychopathology, and child psychopathology revealed in this thesis are understood as caused by genetic transmission, environmental processes, and their interaction (e.g., Goodman & Gotlib, 1999). Further investigation of causation was not possible due to the lack of genetic information in the two studies.

3.3 Strengths

In addition to the limitations, the two studies of this cumulative thesis have various strengths that are worthy of mention. The analytical procedures of the two studies represented two different, current, and sophisticated methodological approaches (meta-analysis, SEM) and were applied independently by the PhD candidate with only limited support (cf. Jendreizik, Hautmann, et al., 2022; Jendreizik, von Wirth, et al., 2022). The successful publication in peer-reviewed journals relevant to the field underpins the methodological quality and relevance of the topic and research questions. The meta-analysis provides researchers and practitioners with a broad overview of relevant family characteristics regarding the severity of symptoms in children and adolescents affected by child ADHD and identifies potential targets for psychosocial interventions (cf. Jendreizik, von Wirth, et al., 2022). Guidelines for reporting systematic reviews (PRISMA; Moher et al., 2009) were applied, and the methodological approach was of high quality (e.g., two assessors for study selection and study quality). SEM analyses were conducted in a large sample of school-aged children (6 - 12 years of age) with a clinical ADHD diagnosis. The quality of the clinical diagnosis is exceptionally high, as it was made by study staff based on a semi-structured clinical interview at the beginning of the study. The large sample of 555 children allowed for the investigation of a complex model with three manifest factors (family adversity, positive parenting practices, negative parenting practices) and three latent factors (parental psychopathology, child ADHD, child ODD ; cf. Jendreizik, Hautmann, et al., 2022). In sum, this cumulative thesis presented two studies that combined high methodological quality and high practical relevance for children and adolescents with ADHD.

3.4 Further Planned Analyses

The ESCAschool study resulted in a large amount of data, the analysis of which is of great interest. Beyond the planned primary analyses (Döpfner et al., 2017), the PhD candidate intends to conduct additional investigations of the relationships between familial factors and child symptoms. First, the SEM analyses of the second study could be partially or fully repeated using longitudinal data from the ESCAschool study (measurement time points at baseline, after step 1, after step 2, after follow-up; see Döpfner et al., 2017). Following the approach postulated by Kazdin (2007), negative parenting practices, for example, could be examined as a possible mediator of behavioral therapy interventions. It would also be conceivable to combine the data from the parallel sub-trials of ESCAlife (ESCApreschool, ESCAschool, ESCAadol) and examine related analyses across a more comprehensive age range (3 - 17 years). Within the ESCAschool study, it would also be interesting to investigate the associations between experienced critical life events and externalizing symptoms or to examine the impact of the familial factors studied on child internalizing symptoms or functional impairment. In addition, it may be illuminating to conduct related analyses in other clinical samples from the externalizing domain (e.g., children with affective dysregulation). Finally, applying another

methodological approach, it would be exciting to visually and statistically link a wide variety of adverse family circumstances (e.g., low parental education, single-parent family, parental conflicts, parental incarceration) with child externalizing symptoms or child functional impairment within the framework of network analysis (for an introduction see Borsboom & Cramer, 2013).

3.5 Conclusions

The family, as the immediate environment of children, encompasses risk and protective factors for child development. In addition to the immediate environments of the child, factors more distant from the child (e.g., societal factors) may have a (sometimes indirect) influence on the child. For example, a psychosocial or economic family burden can negatively affect parental mental health and interactions between parents and children. When treating children and adolescents with a potential diagnosis of ADHD, a standard assessment of several family characteristics can be recommended and used to inform the selection of psychosocial interventions (Jendreizik, Hautmann, et al., 2022; Jendreizik, von Wirth, et al., 2022). It may be recommendable to supplement the widely used child-centered interventions with parent-centered interventions, couple-centered interventions and/or family-centered interventions, which address parental mental health problems, interparental relationships, and negative parenting practices. To test the assumption that child symptoms may be reduced by modifying familial factors, research involving an individualized selection and a combination of interventions would be valuable.

4 References

Agarwal, R., Goldenberg, M., Perry, R., & IsHak, W. W. (2012). The quality of life of adults with attention deficit hyperactivity disorder: a systematic review. *Innovations in Clinical Neuroscience*, *9*(5-6), 10-21.

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th ed., text rev.). https://doi.org/10.1176/appi.books.9780890425787

American Psychological Association. (n.d.). Socioeconomic status. In *APA dictionary of psychology*. Retrieved October 10, 2022, from https://dictionary.apa.org/socioeconomic-status

Azeredo, A., Moreira, D., & Barbosa, F. (2018). ADHD, CD, and ODD: Systematic review of genetic and environmental risk factors. *Research in Developmental Disabilities*, *82*, 10-19. https://doi.org/10.1016/j.ridd.2017.12.010

Babore, A., Trumello, C., Lombardi, L., Candelori, C., Chirumbolo, A., Cattelino, E., Baiocco, R., Bramanti, S. M., Viceconti, M. L., & Pignataro, S. (2023). Mothers' and children's mental health during the COVID-19 pandemic lockdown: the mediating role of parenting stress. *Child Psychiatry & Human Development*, *54*, 134-146. https://doi.org/10.1007/s10578-021-01230-6

Barker, E. D., Copeland, W., Maughan, B., Jaffee, S. R., & Uher, R. (2012). Relative impact of maternal depression and associated risk factors on offspring psychopathology. *The British Journal of Psychiatry*, *200*(2), 124-129. https://doi.org/10.1192/bjp.bp.111.092346

Bertelsen, E. N., Larsen, J. T., Petersen, L., Christensen, J., & Dalsgaard, S. (2016). Childhood epilepsy, febrile seizures, and subsequent risk of ADHD. *Pediatrics*, *138*(2), Article e20154654. https://doi.org/10.1542/peds.2015-4654

Biederman, J., Faraone, S. V., Keenan, K., Benjamin, J., Krifcher, B., Moore, C., Sprich-Buckminster, S., Ugaglia, K., Jellinek, M. S., Steingard, R., Spencer, T., Norman, D., Kolodny, R., Kraus, I., Perrin, J., Keller, M., & Tsuang, M. T. (1992). Further evidence for family-genetic risk factors in attention deficit hyperactivity disorder: Patterns of comorbidity in probands and relatives in psychiatrically and pediatrically referred samples. *Archives of General Psychiatry*, *49*(9), 728-738. https://doi.org/10.1001/archpsyc.1992.01820090056010

Biederman, J., Faraone, S. V., & Monuteaux, M. C. (2002). Differential effect of environmental adversity by gender: Rutter's index of adversity in a group of boys and girls with and without ADHD. *American Journal of Psychiatry*, *159*(9), 1556-1562. https://doi.org/10.1176/appi.ajp.159.9.1556

Borsboom, D., & Cramer, A. O. (2013). Network analysis: an integrative approach to the structure of psychopathology. *Annual Review of Clinical Psychology*, *9*(1), 91-121. https://doi.org/10.1146/annurev-clinpsy-050212-185608

Breslau, J., Miller, E., Chung, W.-J. J., & Schweitzer, J. B. (2011). Childhood and adolescent onset psychiatric disorders, substance use, and failure to graduate high school on time. *Journal of Psychiatric Research*, *45*(3), 295-301. https://doi.org/10.1016/j.jpsychires.2010.06.014

Brikell, I., Ghirardi, L., D'Onofrio, B. M., Dunn, D. W., Almqvist, C., Dalsgaard, S., Kuja-Halkola, R., & Larsson, H. (2018). Familial liability to epilepsy and attention-deficit/hyperactivity disorder: a nationwide cohort study. *Biological Psychiatry*, *83*(2), 173-180. https://doi.org/10.1016/j.biopsych.2017.08.006

Brikell, I., Larsson, H., Lu, Y., Pettersson, E., Chen, Q., Kuja-Halkola, R., Karlsson, R., Lahey, B. B., Lichtenstein, P., & Martin, J. (2020). The contribution of common genetic risk variants for ADHD to a general factor of childhood psychopathology. *Molecular Psychiatry*, *25*(8), 1809-1821. https://doi.org/10.1038/s41380-018-0109-2

Bronfenbrenner, U. (1974). Developmental research, public policy, and the ecology of childhood. *Child Development*, *45*(1), 1-5. https://doi.org/10.2307/1127743

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American Psychologist*, *32*(7), 513-531. https://doi.org/10.1037/0003-066X.32.7.513

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press. https://doi.org/10.2307/j.ctv26071r6

Bronfenbrenner, U. (1986). Ecology of the family as a context for human development: Research perspectives. *Developmental Psychology*, *22*(6), 723-742. https://doi.org/10.1037/0012-1649.22.6.723

Bronfenbrenner, U. (1992). Ecological systems theory. In R. Vasta (Ed.), *Six Theories of Child Development: Revised Formulations and Current Issues* (pp. 187-249). Jessica Kingsley Publishers.

Bundesministerium für Familie, Senioren, Frauen und Jugend. (2021). *Eltern sein in Deutschland*. https://www.bmfsfj.de/bmfsfj/service/publikationen/eltern-sein-in-deutschland-174068

Chang, Z., Lichtenstein, P., D'Onofrio, B. M., Sjölander, A., & Larsson, H. (2014). Serious transport accidents in adults with attention-deficit/hyperactivity disorder and the effect of medication: a population-based study. *JAMA Psychiatry*, *71*(3), 319-325. https://doi.org/10.1001/jamapsychiatry.2013.4174

Chaudhury, P., Bhattacharya, B., & Saha, P. K. (2020). Parent–Child Relationship and Marital Quality of Parents of Conduct or Oppositional Defiant Disorder and Unaffected Individuals: A Comparative Study. *Psychological Studies*, *65*(2), 124-136. https://doi.org/10.1007/s12646-019-00543-w

Chen, M.-H., Pan, T.-L., Hsu, J.-W., Huang, K.-L., Su, T.-P., Li, C.-T., Lin, W.-C., Tsai, S.-J., Chang, W.-H., Chen, T.-J., & Bai, Y.-M. (2018). Risk of type 2 diabetes in adolescents and young adults with

attention-deficit/hyperactivity disorder: a nationwide longitudinal study. *The Journal of Clinical Psychiatry*, *79*(3), Article 17m11607. https://doi.org/10.4088/jcp.17m11607

Chen, W., Zhou, K., Sham, P., Franke, B., Kuntsi, J., Campbell, D., Fleischman, K., Knight, J., Andreou, P., Arnold, R., Altfink, M., Boer, F., Boholst, M. J., Buschgens, C., Butler, L., Christiansen, H., Fliers, E., Howe-Forbes, R., Gabriëls, I., Heise, A., . . . Asherson, P. (2008). DSM-IV combined type ADHD shows familial association with sibling trait scores: A sampling strategy for QTL linkage. *American Journal of Medical Genetics Part B (Neuropsychiatric Genetics)*, *147*(8), 1450-1460. https://doi.org/10.1002/ajmg.b.30672

Cheung, K., & Theule, J. (2016). Parental psychopathology in families of children with ADHD: A meta-analysis. *Journal of Child and Family Studies*, *25*(12), 3451-3461. https://doi.org/10.1007/s10826-016-0499-1

Choi, Y., Shin, J., Cho, K. H., & Park, E.-C. (2017). Change in household income and risk for attention deficit hyperactivity disorder during childhood: A nationwide population-based cohort study. *Journal of Epidemiology*, *27*(2), 56-62. https://doi.org/10.1016/j.je.2016.09.004

Chou, I.-C., Chang, Y.-T., Chin, Z.-N., Muo, C.-H., Sung, F.-C., Kuo, H.-T., Tsai, C.-H., & Kao, C.-H. (2013). Correlation between epilepsy and attention deficit hyperactivity disorder: a population-based cohort study. *PLoS One*, *8*(3), Article e57926. https://doi.org/10.1371/journal.pone.0057926

Chronis-Tuscano, A., Clarke, T. L., O'Brien, K. A., Raggi, V. L., Diaz, Y., Mintz, A. D., Rooney, M. E., Knight, L. A., Seymour, K. E., Thomas, S. R., Seeley, J., Kosty, D., & Lewinsohn, P. (2013). Development and preliminary evaluation of an integrated treatment targeting parenting and depressive symptoms in mothers of children with attention-deficit/hyperactivity disorder. *Journal of Consulting and Clinical Psychology*, *81*(5), 918-925. https://doi.org/10.1037/a0032112

Chronis-Tuscano, A., Wang, C. H., Strickland, J., Almirall, D., & Stein, M. A. (2016). Personalized treatment of mothers with ADHD and their young at-risk children: A SMART pilot. *Journal of Clinical Child & Adolescent Psychology*, *45*(4), 510-521. https://doi.org/10.1080/15374416.2015.1102069

Chronis-Tuscano, A., Wang, C. H., Woods, K. E., Strickland, J., & Stein, M. A. (2017). Parent ADHD and evidence-based treatment for their children: review and directions for future research. *Journal of Abnormal Child Psychology*, *45*(3), 501-517. https://doi.org/10.1007/s10802-016-0238-5

Claussen, A. H., Holbrook, J. R., Hutchins, H. J., Robinson, L. R., Bloomfield, J., Meng, L., Bitsko, R. H., O'Masta, B., Cerles, A., Maher, B., Rush, M., & Kaminski, J. W. (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*, 1-23. https://doi.org/10.1007/s11121-022-01358-4

Clayton, K., Lee, J. B., Cheung, K., Theule, J., & Henrikson, B. (2018). Quantifying the relationship between attention-deficit/hyperactivity disorder and experiences of child maltreatment: A meta-analysis. *Child Abuse Review*, *27*(5), 361-377. https://doi.org/10.1002/car.2530

Conger, R. D., Conger, K. J., Elder Jr, G. H., Lorenz, F. O., Simons, R. L., & Whitbeck, L. B. (1992). A family process model of economic hardship and adjustment of early adolescent boys. *Child Development*, *63*(3), 526-541. https://doi.org/10.1111/j.1467-8624.1992.tb01644.x

Connell, A. M., & Goodman, S. H. (2002). The association between psychopathology in fathers versus mothers and children's internalizing and externalizing behavior problems: a meta-analysis. *Psychological Bulletin*, *128*(5), 746-773. https://doi.org/10.1037/0033-2909.128.5.746

Coolidge, F. L., Thede, L. L., & Young, S. E. (2000). Heritability and the comorbidity of attention deficit hyperactivity disorder with behavioral disorders and executive function deficits: A preliminary investigation. *Developmental Neuropsychology*, *17*(3), 273-287. https://doi.org/10.1207/S15326942DN1703_1

Cortese, S., Sun, S., Zhang, J., Sharma, E., Chang, Z., Kuja-Halkola, R., Almqvist, C., Larsson, H., & Faraone, S. V. (2018). Association between attention deficit hyperactivity disorder and asthma: a systematic review and meta-analysis and a Swedish population-based study. *The Lancet Psychiatry*, *5*(9), 717-726. https://doi.org/10.1016/S2215-0366(18)30224-4

Cowan, P. A., & Pape Cowan, C. (2015). Developmental psychopathology from family systems and family risk factors perspectives: Implications for family research, practice, and policy. In *Developmental Psychopathology, Volume One, Theory and Method* (pp. 530-587). https://doi.org/10.1002/9780470939383.ch14

Cuffe, S. P., Visser, S. N., Holbrook, J. R., Danielson, M. L., Geryk, L. L., Wolraich, M. L., & McKeown, R. E. (2020). ADHD and psychiatric comorbidity: Functional outcomes in a school-based sample of children. *Journal of Attention Disorders*, *24*(9), 1345-1354. https://doi.org/10.1177/1087054715613437

Dalsgaard, S., Østergaard, S. D., Leckman, J. F., Mortensen, P. B., & Pedersen, M. G. (2015). Mortality in children, adolescents, and adults with attention deficit hyperactivity disorder: a nationwide cohort study. *The Lancet*, *385*(9983), 2190-2196. https://doi.org/10.1016/S0140-6736(14)61684-6

Danckaerts, M., Sonuga-Barke, E. J., Banaschewski, T., Buitelaar, J., Döpfner, M., Hollis, C., Santosh, P., Rothenberger, A., Sergeant, J., Steinhausen, H.-C., Taylor, E., Zuddas, A., & Coghill, D. (2010). The quality of life of children with attention deficit/hyperactivity disorder: a

systematic review. *European Child & Adolescent Psychiatry*, *19*(2), 83-105. https://doi.org/10.1007/s00787-009-0046-3

De Los Reyes, A., Augenstein, T. M., Wang, M., Thomas, S. A., Drabick, D. A., Burgers, D. E., & Rabinowitz, J. (2015). The validity of the multi-informant approach to assessing child and adolescent mental health. *Psychological Bulletin*, *141*(4), 858-900. https://doi.org/10.1037/a0038498

Demmer, D. H., Hooley, M., Sheen, J., McGillivray, J. A., & Lum, J. A. (2017). Sex differences in the prevalence of oppositional defiant disorder during middle childhood: a meta-analysis. *Journal of Abnormal Child Psychology*, *45*(2), 313-325. https://doi.org/10.1007/s10802-016-0170-8

Demontis, D., Walters, R. K., Martin, J., Mattheisen, M., Als, T. D., Agerbo, E., Baldursson, G., Belliveau, R., Bybjerg-Grauholm, J., & Bækvad-Hansen, M. (2019). Discovery of the first genome-wide significant risk loci for attention deficit/hyperactivity disorder. *Nature Genetics*, *51*(1), 63-75. https://doi.org/10.1038/s41588-018-0269-7

Demontis, D., Walters, R. K., Rajagopal, V. M., Waldman, I. D., Grove, J., Als, T. D., Dalsgaard, S., Ribasés, M., Bybjerg-Grauholm, J., Bækvad-Hansen, M., Werge, T., Nordentoft, M., Mors, O., ADHD Working Group of the Psychiatric Genomics Consortium (PGC), Cormand, B., Hougaard, D. M., Neale, B. M., Franke, B., Faraone, S. V., & Børglum, A. D. (2021). Risk variants and polygenic architecture of disruptive behavior disorders in the context of attention-deficit/hyperactivity disorder. *Nature Communications*, *12*(1), Article 576. https://doi.org/10.1038/s41467-020-20443-2

Deutsche Gesellschaft für Kinder- und Jugendpsychiatrie, Psychosomatik und Psychotherapie. (2016). *Langfassung der evidenz- und konsensbasierten Leitlinie (S3) Störungen des Sozialverhaltens: Empfehlungen zur Versorgung und Behandlung* https://register.awmf.org/assets/guidelines/028-020l_S3_Stoerungen_des_Sozialverhaltens_2018-09_1.pdf

Deutsche Gesellschaft für Kinder- und Jugendpsychiatrie, Psychosomatik und Psychotherapie, Deutsche Gesellschaft für Psychiatrie und Psychotherapie, Psychosomatik und Nervenheilkunde, & Deutsche Gesellschaft für Sozialpäiatrie, und Jugendmedizin. (2017). *Langfassung der interdisziplinären evidenz- und konsensbasierten (S3) Leitlinie Aufmerksamkeitsdefizit- / Hyperaktivitätsstörung (ADHS) im Kindes-, Jugend- und Erwachsenenalter*. https://register.awmf.org/assets/guidelines/028-045l_S3_ADHS_2018-06.pdf

Döpfner, M., & Banaschewski, T. (2022). Klassifikation von Aufmerksamkeitsdefizit-/Hyperaktivitätsstörungen in der ICD-11. *Zeitschrift für Kinder-und Jugendpsychiatrie und Psychotherapie*, *50*(1), 51-53. https://doi.org/10.1024/1422-4917/a000854

Döpfner, M., Hautmann, C., Dose, C., Banaschewski, T., Becker, K., Brandeis, D., Holtmann, M., Jans, T., Jenkner, C., Millenet, S., Renner, T., Romanos, M., & von Wirth, E. (2017). ESCAschool study: trial protocol of an adaptive treatment approach for school-age children with ADHD including two randomised trials. *BMC Psychiatry*, *17*(1), Article 269. https://doi.org/10.1186/s12888-017-1433-9

Dose, C., Hautmann, C., Bürger, M., Schürmann, S., & Döpfner, M. (2021). Negative parenting behaviour as a mediator of the effects of telephone-assisted self-help for parents of pharmacologically treated children with attention-deficit/hyperactivity disorder. *European Child & Adolescent Psychiatry*, *30*(6), 861-875. https://doi.org/10.1007/s00787-020-01565-w

Faraone, S. V., Asherson, P., Banaschewski, T., Biederman, J., Buitelaar, J. K., Ramos-Quiroga, J. A., Rohde, L. A., Sonuga-Barke, E. J. S., Tannock, R., & Franke, B. (2015). Attention-deficit/hyperactivity disorder. *Nature Reviews Disease Primers*, *1*(1), Article 15020. https://doi.org/10.1038/nrdp.2015.20

Faraone, S. V., Banaschewski, T., Coghill, D., Zheng, Y., Biederman, J., Bellgrove, M. A., Newcorn, J. H., Gignac, M., Al Saud, N. M., Manor, I., Rohde, L. A., Yang, L., Cortese, S., Almagor, D., Stein, M. A., Albatti, T. H., Aljoudi, H. F., Alqahtani, M. M. J., Asherson, P., . . . Wang, Y. (2021). The world federation of ADHD international consensus statement: 208 evidence-based conclusions about the disorder. *Neuroscience & Biobehavioral Reviews*, *128*, 789-818. https://doi.org/10.1016/j.neubiorev.2021.01.022

Faraone, S. V., Biederman, J., & Mick, E. (2006). The age-dependent decline of attention deficit hyperactivity disorder: a meta-analysis of follow-up studies. *Psychological Medicine*, *36*(2), 159-165. https://doi.org/10.1017/S003329170500471X

Faraone, S. V., & Larsson, H. (2019). Genetics of attention deficit hyperactivity disorder. *Molecular Psychiatry*, *24*(4), 562-575. https://doi.org/10.1038/s41380-018-0070-0

Ferguson, K. T., Cassells, R. C., MacAllister, J. W., & Evans, G. W. (2013). The physical environment and child development: An international review. *International Journal of Psychology*, *48*(4), 437-468. https://doi.org/10.1080/00207594.2013.804190

Fleming, M., Fitton, C. A., Steiner, M. F. C., McLay, J. S., Clark, D., King, A., Mackay, D. F., & Pell, J. P. (2017). Educational and Health Outcomes of Children Treated for Attention-Deficit/Hyperactivity Disorder. *JAMA Pediatrics*, *171*(7), Article e170691. https://doi.org/10.1001/jamapediatrics.2017.0691

Goodman, S. H., & Gotlib, I. H. (1999). Risk for psychopathology in the children of depressed mothers: a developmental model for understanding mechanisms of transmission. *Psychological Review*, *106*(3), 458-490. https://doi.org/10.1037/0033-295X.106.3.458

Granero, R., Louwaars, L., & Ezpeleta, L. (2015). Socioeconomic status and oppositional defiant disorder in preschoolers: parenting practices and executive functioning as mediating variables. *Frontiers in Psychology*, *6*, Article 1412. https://doi.org/10.3389/fpsyg.2015.01412

Grima, S., Grima, A., Thalassinos, E., Seychell, S., & Spiteri, J. V. (2017). Theoretical models for sport participation: literature review. *International Journal of Economics and Business Administration*, *5*(3), 94-116.

Grusec, J. E. (2011). Socialization processes in the family: Social and emotional development. *Annual Review of Psychology*, *62*, 243-269. https://doi.org/10.1146/annurev.psych.121208.131650

Hamshere, M. L., Langley, K., Martin, J., Agha, S. S., Stergiakouli, E., Anney, R. J., Buitelaar, J., Faraone, S. V., Lesch, K.-P., Neale, B. M., Franke, B., Sonuga-Barke, E., Asherson, P., Merwood, A., Kuntsi, J., Medland, S., Ripke, S., Steinhausen, H. C., Freitag, C., . . . Thapar, A. (2013). High loading of polygenic risk for ADHD in children with comorbid aggression. *American Journal of Psychiatry*, *170*(8), 909-916. https://doi.org/10.1176/appi.ajp.2013.12081129

Hanisch, C., Hautmann, C., Plück, J., Eichelberger, I., & Döpfner, M. (2014). The prevention program for externalizing problem behavior (PEP) improves child behavior by reducing negative parenting: Analysis of mediating processes in a randomized controlled trial. *Journal of Child Psychology and Psychiatry*, *55*(5), 473-484. https://doi.org/10.1111/jcpp.12177

Harter, S. (2008). The developing self. In W. Damon & R. M. Lerner (Eds.), *Child and adolescent development: An advanced course* (pp. 216-262). John Wiley & Sons, Inc.

Harvey, E. A., Metcalfe, L. A., Herbert, S. D., & Fanton, J. H. (2011). The role of family experiences and ADHD in the early development of oppositional defiant disorder. *Journal of Consulting and Clinical Psychology*, *79*(6), 784-795. https://doi.org/10.1037/a0025672

Hautmann, C., Döpfner, M., Katzmann, J., Schürmann, S., Wolff Metternich-Kaizman, T., Jaite, C., Kappel, V., Geissler, J., Warnke, A., Jacob, C., Hennighausen, K., Haack-Dees, B., Schneider-Momm, K., Philipsen, A., Matthies, S., Rösler, M., Retz, W., von Gontard, A., Sobanski, E., . . . Jans, T. (2018). Sequential treatment of ADHD in mother and child (AIMAC study): importance of the treatment phases for intervention success in a randomized trial. *BMC Psychiatry*, *18*(1), Article 388. https://doi.org/10.1186/s12888-018-1963-9

Heinrich, C. J. (2014). Parents' Employment and Children's Wellbeing. *The Future of Children*, *24*(1), 121-146. http://www.jstor.org/stable/23723386

Hinshaw, S. P., Arnold, L. E., & the MTA Cooperative Group (2015). Attention-deficit hyperactivity disorder, multimodal treatment, and longitudinal outcome: Evidence, paradox, and challenge. *Wiley Interdisciplinary Reviews: Cognitive Science*, *6*(1), 39-52. https://doi.org/10.1002/wcs.1324

Hinshaw, S. P., Nguyen, P. T., O'Grady, S. M., & Rosenthal, E. A. (2022). Annual Research Review: Attention-deficit/hyperactivity disorder in girls and women: underrepresentation, longitudinal processes, and key directions. *Journal of Child Psychology and Psychiatry*, *63*(4), 484-496. https://doi.org/10.1111/jcpp.13480

Jans, T., Jacob, C., Warnke, A., Zwanzger, U., Groß-Lesch, S., Matthies, S., Borel, P., Hennighausen, K., Haack-Dees, B., Rösler, M., Retz, W., von Gontard, A., Hänig, S., Sobanski, E., Alm, B., Poustka, L., Hohmann, S., Colla, M., Gentschow, L., . . . Philipsen, A. (2015). Does intensive multimodal treatment for maternal ADHD improve the efficacy of parent training for children with ADHD? A randomized controlled multicenter trial. *Journal of Child Psychology and Psychiatry*, *56*(12), 1298-1313. https://doi.org/10.1111/jcpp.12443

Javo, C., Rønning, J. A., Heyerdahl, S., & Rudmin, F. W. (2004). Parenting correlates of child behavior problems in a multiethnic community sample of preschool children in northern Norway. *European Child & Adolescent Psychiatry*, *13*(1), 8-18. https://doi.org/10.1007/s00787-004-0349-3

Jendreizik, L. T., Hautmann, C., von Wirth, E., Dose, C., Thöne, A.-K., Treier, A.-K., Banaschewski, T., Becker, K., Brandeis, D., Geissler, J., Hebebrand, J., Hohmann, S., Holtmann, M., Huss, M., Jans, T., Kaiser, A., Millenet, S., Poustka, L., Schneider, P., & Döpfner, M. (2022). The importance of familial risk factors in children with ADHD: direct and indirect effects of family adversity, parental psychopathology and parenting practices on externalizing symptoms. *Child and Adolescent Psychiatry and Mental Health*, *16*(1), Article 96. https://doi.org/10.1186/s13034-022-00529-z

Jendreizik, L. T., von Wirth, E., & Döpfner, M. (2022). Familial factors associated with symptom severity in children and adolescents with ADHD: a meta-analysis and supplemental review. *Journal of Attention Disorders*, *27*(2), 124-144. https://doi.org/10.1177/10870547221132793

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. https://doi.org/10.1016/j.jpsychires.2017.07.004

Kapellen, T. M., Reimann, R., Kiess, W., & Kostev, K. (2016). Prevalence of medically treated children with ADHD and type 1 diabetes in Germany–Analysis of two representative databases. *Journal of Pediatric Endocrinology and Metabolism*, *29*(11), 1293-1297. https://doi.org/10.1515/jpem-2016-0171

Kazdin, A. E. (2007). Mediators and mechanisms of change in psychotherapy research. *Annual Review of Clinical Psychology*, *3*, 1-27. https://doi.org/10.1146/annurev.clinpsy.3.022806.091432

Keilow, M., Wu, C., & Obel, C. (2020). Cumulative social disadvantage and risk of attention deficit hyperactivity disorder: Results from a nationwide cohort study. *SSM-Population Health*, *10*, Article 100548. https://doi.org/10.1016/j.ssmph.2020.100548

Kelly, M., & Coughlan, B. (2019). A theory of youth mental health recovery from a parental perspective. *Child and Adolescent Mental Health*, *24*(2), 161-169. https://doi.org/10.1111/camh.12300

Kennedy, M., Kreppner, J., Knights, N., Kumsta, R., Maughan, B., Golm, D., Rutter, M., Schlotz, W., & Sonuga-Barke, E. J. S. (2016). Early severe institutional deprivation is associated with a persistent variant of adult attention-deficit/hyperactivity disorder: clinical presentation, developmental continuities and life circumstances in the English and Romanian Adoptees study. *Journal of Child Psychology and Psychiatry*, *57*(10), 1113-1125. https://doi.org/https://doi.org/10.1111/jcpp.12576

Kian, N., Samieefar, N., & Rezaei, N. (2022). Prenatal risk factors and genetic causes of ADHD in children. *World Journal of Pediatrics*, *18*(5), 308-319. https://doi.org/10.1007/s12519-022-00524-6

Kim-Cohen, J., Caspi, A., Taylor, A., Williams, B., Newcombe, R., Craig, I. W., & Moffitt, T. E. (2006). MAOA, maltreatment, and gene-environment interaction predicting children's mental health: new evidence and a meta-analysis. *Molecular Psychiatry*, *11*(10), 903-913. https://doi.org/10.1038/sj.mp.4001851

Kline, R. B. (2015). *Principles and practice of structural equation modeling*. Guilford publications.

Lee, P. H., Anttila, V., Won, H., Feng, Y.-C. A., Rosenthal, J., Zhu, Z., Tucker-Drob, E. M., Nivard, M. G., Grotzinger, A. D., Posthuma, D., Wang, M. M. J., Yu, D., Stahl, E. A., Walters, R. K., Anney, R. J. L., Duncan, L. E., Ge, T., Adolfsson, R., Banaschewski, T., . . . Smoller, J. W. (2019). Genomic relationships, novel loci, and pleiotropic mechanisms across eight psychiatric disorders. *Cell*, *179*(7), 1469-1482. https://doi.org/10.1016/j.cell.2019.11.020

Lee, Y.-c., Yang, H.-J., Chen, V. C.-h., Lee, W.-T., Teng, M.-J., Lin, C.-H., & Gossop, M. (2016). Meta-analysis of quality of life in children and adolescents with ADHD: By both parent proxy-report and child self-report using PedsQL™. *Research in Developmental Disabilities*, *51*, 160-172. https://doi.org/10.1016/j.ridd.2015.11.009

Letourneau, N. L., Duffett-Leger, L., Levac, L., Watson, B., & Young-Morris, C. (2013). Socioeconomic status and child development: A meta-analysis. *Journal of Emotional and Behavioral Disorders*, *21*(3), 211-224. https://doi.org/10.1177/1063426611421007

Libutzki, B., Ludwig, S., May, M., Jacobsen, R. H., Reif, A., & Hartman, C. A. (2019). Direct medical costs of ADHD and its comorbid conditions on basis of a claims data analysis. *European Psychiatry*, *58*, 38-44. https://doi.org/10.1016/j.eurpsy.2019.01.019

Marmorstein, N., Iacono, W., & McGue, M. (2009). Alcohol and illicit drug dependence among parents: associations with offspring externalizing disorders. *Psychological Medicine*, *39*(1), 149-155. https://doi.org/10.1017/S0033291708003085

Min, X., Li, C., & Yan, Y. (2021). Parental Age and the Risk of ADHD in Offspring: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, *18*(9), Article 4939. https://doi.org/10.3390/ijerph18094939

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & the PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Medicine*, *6*(7), Article e1000097. https://doi.org/10.1371/journal.pmed.1000097

Mohr-Jensen, C., Bisgaard, C. M., Boldsen, S. K., & Steinhausen, H.-C. (2019). Attention-deficit/hyperactivity disorder in childhood and adolescence and the risk of crime in young adulthood in a Danish nationwide study. *Journal of the American Academy of Child & Adolescent Psychiatry*, *58*(4), 443-452. https://doi.org/10.1016/j.jaac.2018.11.016

Narad, M. E., Garner, A. A., Peugh, J. L., Tamm, L., Antonini, T. N., Kingery, K. M., Simon, J. O., & Epstein, J. N. (2015). Parent-teacher agreement on ADHD symptoms across development. *Psychological Assessment*, *27*(1), 239-248. https://doi.org/10.1037/a0037864

Nigg, J. T., Johnstone, J. M., Musser, E. D., Long, H. G., Willoughby, M. T., & Shannon, J. (2016). Attention-deficit/hyperactivity disorder (ADHD) and being overweight/obesity: New data and meta-analysis. *Clinical Psychology Review*, *43*, 67-79. https://doi.org/10.1016/j.cpr.2015.11.005

Norman, R. E., Byambaa, M., De, R., Butchart, A., Scott, J., & Vos, T. (2012). The long-term health consequences of child physical abuse, emotional abuse, and neglect: a systematic review and meta-analysis. *PLoS Medicine*, *9*(11), Article e1001349. https://doi.org/10.1371/journal.pmed.1001349

Obel, C., Zhu, J. L., Olsen, J., Breining, S., Li, J., Grønborg, T. K., Gissler, M., & Rutter, M. (2016). The risk of attention deficit hyperactivity disorder in children exposed to maternal smoking during pregnancy–a re-examination using a sibling design. *Journal of Child Psychology and Psychiatry*, *57*(4), 532-537. https://doi.org/10.1111/jcpp.12478

Østergaard, S. D., Larsen, J. T., Dalsgaard, S., Wilens, T. E., Mortensen, P. B., Agerbo, E., Mors, O., & Petersen, L. (2016). Predicting ADHD by assessment of Rutter's indicators of adversity in infancy. *PLoS One*, *11*(6), Article e0157352. https://doi.org/0.1371/journal.pone.0157352

Pachter, L. M., Auinger, P., Palmer, R., & Weitzman, M. (2006). Do parenting and the home environment, maternal depression, neighborhood, and chronic poverty affect child behavioral problems differently in different racial-ethnic groups? *Pediatrics*, *117*(4), 1329-1338. https://doi.org/10.1542/peds.2005-1784

Parent, J., Forehand, R., Pomerantz, H., Peisch, V., & Seehuus, M. (2017). Father participation in child psychopathology research. *Journal of Abnormal Child Psychology*, *45*(7), 1259-1270. https://doi.org/10.1007/s10802-016-0254-5

Patterson, G. R., DeGarmo, D., & Forgatch, M. S. (2004). Systematic changes in families following prevention trials. *Journal of Abnormal Child Psychology*, *32*(6), 621-633. https://doi.org/10.1023/B:JACP.0000047211.11826.54

Pinquart, M. (2017). Associations of parenting dimensions and styles with externalizing problems of children and adolescents: An updated meta-analysis. *Developmental Psychology*, *53*(5), 873-932. https://doi.org/10.1037/dev0000295

Piotrowska, P. J., Stride, C. B., Croft, S. E., & Rowe, R. (2015). Socioeconomic status and antisocial behaviour among children and adolescents: A systematic review and meta-analysis. *Clinical Psychology Review*, *35*, 47-55. https://doi.org/10.1016/j.cpr.2014.11.003

Polanczyk, G. V., Salum, G. A., Sugaya, L. S., Caye, A., & Rohde, L. A. (2015). Annual research review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. *Journal of Child Psychology and Psychiatry*, *56*(3), 345-365. https://doi.org/10.1111/jcpp.12381

Polanczyk, G. V., Willcutt, E. G., Salum, G. A., Kieling, C., & Rohde, L. A. (2014). ADHD prevalence estimates across three decades: an updated systematic review and meta-regression analysis. *International Journal of Epidemiology*, *43*(2), 434-442. https://doi.org/10.1093/ije/dyt261

Reale, L., Bartoli, B., Cartabia, M., Zanetti, M., Costantino, M. A., Canevini, M. P., Termine, C., & Bonati, M. (2017). Comorbidity prevalence and treatment outcome in children and adolescents with ADHD. *European Child & Adolescent Psychiatry*, *26*(12), 1443-1457. https://doi.org/10.1007/s00787-017-1005-z

Rijlaarsdam, J., Stevens, G. W., Van Der Ende, J., Hofman, A., Jaddoe, V. W., Mackenbach, J. P., Verhulst, F. C., & Tiemeier, H. (2013). Economic disadvantage and young children's emotional and behavioral problems: Mechanisms of risk. *Journal of Abnormal Child Psychology*, *41*(1), 125-137. https://doi.org/10.1007/s10802-012-9655-2

Romano, E., Babchishin, L., Marquis, R., & Fréchette, S. (2015). Childhood maltreatment and educational outcomes. *Trauma, Violence, & Abuse*, *16*(4), 418-437. https://doi.org/10.1177/1524838014537908

Ronald, A., de Bode, N., & Polderman, T. J. (2021). Systematic review: how the attention-deficit/hyperactivity disorder polygenic risk score adds to our understanding of ADHD and associated traits. *Journal of the American Academy of Child & Adolescent Psychiatry*, *60*(10), 1234-1277. https://doi.org/10.1016/j.jaac.2021.01.019

Russell, A. E., Ford, T., Williams, R., & Russell, G. (2016). The association between socioeconomic disadvantage and attention deficit/hyperactivity disorder (ADHD): a systematic review. *Child Psychiatry & Human Development*, *47*(3), 440-458. https://doi.org/10.1007/s10578-015-0578-3

Rutter, M., Cox, A., Tupling, C., Berger, M., & Yule, W. (1975). Attainment and adjustment in two geographical areas: I—the prevalence of psychiatric disorder. *The British Journal of Psychiatry*, *126*(6), 493-509. https://doi.org/10.1192/bjp.126.6.493

Sedky, K., Bennett, D. S., & Carvalho, K. S. (2014). Attention deficit hyperactivity disorder and sleep disordered breathing in pediatric populations: a meta-analysis. *Sleep Medicine Reviews*, *18*(4), 349-356. https://doi.org/10.1016/j.smrv.2013.12.003

Shaffer, A., Lindhiem, O., Kolko, D. J., & Trentacosta, C. J. (2013). Bidirectional relations between parenting practices and child externalizing behavior: A cross-lagged panel analysis in the context of a psychosocial treatment and 3-year follow-up. *Journal of Abnormal Child Psychology*, *41*(2), 199-210. https://doi.org/10.1007/s10802-012-9670-3

Silva, M., Loureiro, A., & Cardoso, G. (2016). Social determinants of mental health: a review of the evidence. *The European Journal of Psychiatry*, *30*(4), 259-292.

Skoglund, C., Chen, Q., D' Onofrio, B. M., Lichtenstein, P., & Larsson, H. (2014). Familial confounding of the association between maternal smoking during pregnancy and ADHD in offspring. *Journal of Child Psychology and Psychiatry*, *55*(1), 61-68. https://doi.org/10.1111/jcpp.12124

Solantaus, T., Leinonen, J., & Punamäki, R.-L. (2004). Children's mental health in times of economic recession: replication and extension of the family economic stress model in Finland. *Developmental Psychology*, *40*(3), 412-429. https://doi.org/10.1037/0012-1649.40.3.412

Sprich, S., Biederman, J., Crawford, M. H., Mundy, E., & Faraone, S. V. (2000). Adoptive and biological families of children and adolescents with ADHD. *Journal of the American Academy of Child & Adolescent Psychiatry*, *39*(11), 1432-1437. https://doi.org/10.1097/00004583-200011000-00018

Strine, T. W., Lesesne, C. A., Okoro, C. A., McGuire, L. C., Chapman, D. P., Balluz, L. S., & Mokdad, A. H. (2006). Emotional and behavioral difficulties and impairments in everyday functioning among children with a history of attention-deficit/hyperactivity disorder. *Preventing Chronic Disease*, *3*(2), Article A52.

Sun, W., Li, D., Zhang, W., Bao, Z., & Wang, Y. (2015). Family material hardship and Chinese adolescents' problem behaviors: A moderated mediation analysis. *PLoS One*, *10*(5), Article e0128024. https://doi.org/10.1371/journal.pone.0128024

Theule, J., Wiener, J., Tannock, R., & Jenkins, J. M. (2013). Parenting stress in families of children with ADHD: A meta-analysis. *Journal of Emotional and Behavioral Disorders*, *21*(1), 3-17. https://doi.org/10.1177/1063426610387433

Tung, I., Li, J. J., & Lee, S. S. (2012). Child sex moderates the association between negative parenting and childhood conduct problems. *Aggressive Behavior*, *38*(3), 239-251. https://doi.org/10.1002/ab.21423

Wakschlag, L. S., Gordon, R. A., Lahey, B. B., Loeber, R., Green, S. M., & Leventhal, B. L. (2000). Maternal age at first birth and boys' risk for conduct disorder. *Journal of Research on Adolescence*, *10*(4), 417-441.

Weyers, L., Zemp, M., & Alpers, G. W. (2019). Impaired interparental relationships in families of children with attention-deficit/hyperactivity disorder (ADHD). *Zeitschrift für Psychologie*, *227*(1), 31-41. https://doi.org/10.1027/2151-2604/a000354

Willcutt, E. G. (2012). The prevalence of DSM-IV attention-deficit/hyperactivity disorder: a meta-analytic review. *Neurotherapeutics*, *9*(3), 490-499. https://doi.org/10.1007/s13311-012-0135-8

World Health Organization. (2016). *International statistical classification of diseases and related health problems* (10th ed.). https://icd.who.int/browse10/2016/en

Yeh, J.-Y., Hou, T.-Y., Tseng, W.-T., Chen, V. C.-H., Yang, Y.-H., Kuo, T.-Y., Weng, J.-C., Lee, C. T.-C., Chen, Y.-L., & Lee, M.-J. (2020). Association between attention deficit hyperactivity disorder and risk of burn injury: a propensity-matched cohort study. *Neuropsychiatric Disease and Treatment*, *16*, 1249-1255. https://doi.org/10.2147/NDT.S242153

Zeanah, C. H., & Humphreys, K. L. (2018). Child abuse and neglect. *Journal of the American Academy of Child & Adolescent Psychiatry*, *57*(9), 637-644. https://doi.org/10.1016/j.jaac.2018.06.007

5 Appendix

Appendix 1: Supplemental material of the first scientific publication (Jendreizik, von Wirth, et al., 2022)

Appendix 2: Supplemental material of the second scientific publication (Jendreizik, Hautmann, et al., 2022)

Supplement I

Search Strategy

Operator	Search term	Type of term
	Attention deficit disorder with hyperactivity	MeSH / Subject term
AND	Severity	All fields
AND	Psychosocial or environment* or social or socio-economic or "SES" or home or housing or famil* or marital or parent* or mother or maternal or father or paternal or attachment or "life event" or violence or risk or mistreatment	All fields
AND	01.01.1988 - 16.07.2018	Date - Publication
AND	German or English	Language
AND	Journal	Publication Type

Supplement II

Assessment of Risk of Bias Within Studies - Criteria

	Criteria	Response format
ADHD diagnosis	Do the authors provide details on the procedure used to diagnose ADHD (reference to ICD or DSM, diagnostic instrument)?	(++, +, -)
Representativeness	Is the sample studied (sufficiently) representative of the group of children and adolescents affected by ADHD?	(+, -)
Sample size	Is the sample size of the (sub-)sample with ADHD sufficient?	(++, +, -)
Familial factor	Do the authors report information and if required psychometric details of the measurement of the familial factor they used?	(++, +, -)
Symptom severity	Do the authors report psychometric details of the measurement of ADHD symptom severity used? Is the measurement suitable?	(++, +, -)
Scale level	Is the analysis of the association of interest to the present work conducted at an appropriate scale level?	(++, +, -)
Missing values	Do the authors provide information about the extent of missing values and how to deal with them?	(+, -)
Transparency	Are the details on the statistical procedure and the results sufficient and transparent?	(++, +, -)

Supplement III

Summary of Study Characteristics

Studies were conducted in 17 countries on five continents (17 studies from North America, 11 studies from Asia, 11 studies from Europe, eight studies from Australia, and one study from Africa). Four studies were published before 2000, 19 studies between 2000 and 2009, and 25 studies between 2010 and 2018. Forty-three studies had a cross-sectional design and four studies had a longitudinal design, but only cross-sectional data were considered. Only one study had a longitudinal design and contributed longitudinal data to the present work. In 33 studies, recruitment was exclusively clinically based, in five studies recruitment was exclusively community-based, and ten studies used a combined recruitment strategy. Sample sizes of children and adolescents with ADHD studied varied between 24 and 4,290. Fifteen studies had a sample size below 100, 19 studies had a sample size between 100 and 200, and 14 studies had a sample size greater than 200. The patients studied had an average age between five and 13 years. The proportion of male patients ranged from 58 to 100 percent. In 40 of the 48 studies, the authors explicitly referred to the ICD or DSM criteria in making the ADHD diagnosis. In three studies, the clinical diagnosis was based on a clinical interview and in three other studies the diagnoses were requested from the parents. Two studies did not provide information on diagnosis. Thirty-one studies used a (mostly parent) rating scale, five studies used clinical interviews or diagnostic checklists, and two studies asked parents using one item to measure ADHD symptom severity. The findings of 10 studies were based on investigations of two or three subtypes of ADHD. Varying according to the familial factor, the respective familial factor was recorded using diagnostic checklists or clinical interviews, rating scales, behavioral observations, specially developed questionnaires, or simply asked about. Study results were reported using a correlation coefficient in 50% of cases, means in 25% of cases, event rates in 14% of cases, odds ratios in 10% of cases, Cohen's d in 2% of cases, and a regression coefficient in one study. In the meta-analysis, averaged means or event rates for the two ADHD subtypes predominantly inattentive and predominantly hyperactive-impulsive were obtained in eight cases, to be subsequently contrasted with the means or event rates of the combined ADHD subtype. In 20 cases, correlation coefficients or event rates were combined for the two ADHD subscales of inattentive and hyperactive-impulsive.

Supplement IV

Results of the Assessment of the Risk of Bias Within Studies

Familial factor	First author	Year	ADHD diagnosis	Represen-tativeness	Sample size	Familial factor	Symptom severity	Scale level	Missing values	Transparency
Socioeconomic status	Chronis	2007	++	+	+	++	++	++	+	+
	Counts	2006	++	+	+	++	++	+	+	++
	Faraone	2000	++	+	+	++	-	+	-	++
	Freitag	2012	++	+	++	++	+	++	+	++
	Graetz	2001	++	+	++	++	++	+	-	++
	Mulraney	2016	-	+	++	+	++	++	+	++
	Owens	2003	++	-	++	+	++	++	-	++
	Podolski	2001	++	-	-	++	++	+	+	++
	Razani	2015	-	+	++	-	++	+	+	++
	Schneider	2013	++	+	+	+	-	-	+	++
	Yang	2007	++	+	+	++	++	+	-	++
Ethnic group	Chronis	2007	++	+	+	++	++	++	+	+
	Podolski	2001	++	-	-	++	++	+	+	+
	Razani	2015	-	+	++	-	++	+	+	++
	Schneider	2013	++	+	+	+	++	++	+	++
	Tamayo	2008	++	+	++	+	++	++	+	++
Parental age	Baldwin	1995	++	-	-	+	++	++	-	++
	Park	2014	++	-	+	++	++	+	-	++
	Yang	2007	++	+	+	++	++	+	-	++
Single-parent family	Graetz	2001	++	+	++	++	++	+	-	++
	Razani	2015	-	+	++	-	++	+	+	++
	Schneider	2013	++	+	+	+	++	++	+	++
	Yang	2007	++	+	+	++	++	+	-	++
Stepfamily	Heckel	2013	++	+	+	+	++	++	-	++
	Razani	2015	-	+	++	-	++	+	+	++
Broken partnership	Counts	2006	++	+	+	++	++	+	+	++
	Heckel	2009	+	+	++	+	++	++	+	++

Familial factor	First author	Year	ADHD diagnosis	Represen-tativeness	Sample size	Familial factor	Symptom severity	Scale level	Missing values	Transparency
	Ramy	2018	++	+	+	+	++	+	+	++
	Tzang	2009	++	+	+	++	+	+	-	++
Number of children	Ghanizadeh	2015	++	+	++	+	++	++	-	++
	Graetz	2001	++	+	++	++	++	+	-	++
	Ramy	2018	++	+	+	+	++	+	+	++
Rank of birth	Ghanizadeh	2015	++	+	++	+	-	++	-	++
Playing environment & neighborhood	Razani	2015	-	+	++	-	-	+	+	++
	Taylor	2011	-	+	++	-	++	++	-	++
Critical life events	Counts	2006	++	+	+	++	++	+	+	++
	Daviss	2009	++	+	+	+	++	++	+	+
	Freitag	2012	++	+	++	++	++	++	+	++
	Gul [out]	2018	-	+	+	+	++	+	-	++
	Park	2014	++	-	+	++	++	+	-	++
	Park	2017	++	-	+	+	++	+	-	++
	Ramy	2018	++	+	+	+	++	+	+	++
	Schilpzand	2017	++	+	+	+	++	+	-	++
	Sugimoto	2015	-	-	-	-	-	++	-	++
	Tzang	2009	++	+	+	++	++	+	-	++
	Vitanza	1999	+	+	+	+	++	++	-	+
Parental ADHD	Agha	2013	++	+	++	++	++	+	-	++
	Counts	2006	++	+	+	++	++	+	+	++
	Freitag	2012	++	+	++	++	++	++	+	++
	López Seco	2015	++	+	+	+	++	++	-	++
	Macek	2012	+	-	-	+	++	++	-	++
	Ramy	2018	++	+	+	+	-	+	+	++
	Richards	2014	++	-	++	+	++	++	+	++
	Stadler	2006	+	+	+	+	++	++	-	++
	Takeda	2010	++	+	++	++	++	+	-	++
	Xia	2015	++	+	+	+	++	++	+	++
Familial ADHD	Faraone	2000	++	+	+	++	++	+	-	++

Familial factor	First author	Year	ADHD diagnosis	Represen-tativeness	Sample size	Familial factor	Symptom severity	Scale level	Missing values	Transparency
	Lee	2008	++	+	++	++	++	+	-	++
Parental affective psychopathology	Agha	2017	++	+	+	++	++	++	-	+
	Chronis	2007	++	+	+	++	++	+	+	+
	Harrison	2002	++	+	+	+	++	++	-	+
	Owens	2003	++	-	++	+	++	++	-	++
	Richards	2014	++	-	++	+	++	++	+	++
	van der Oord	2006	++	+	+	+	++	++	+	++
	West	1999	-	+	+	-	++	+	+	++
	Xia	2015	++	+	+	+	++	++	+	++
Parental antisocial personality	Chronis	2007	++	+	+	++	++	++	+	+
Parental mental health	Anastopoulos	1992	++	+	+	+	++	++	-	+
	Counts	2006	++	+	+	++	++	+	+	++
	López Seco	2015	++	+	+	+	++	-	-	++
	Ramy	2018	++	+	+	+	-	+	+	++
	Razani	2015	-	+	++	-	-	+	+	++
	Schneider	2013	++	+	+	+	++	++	+	++
	Tzang	2009	++	+	+	++	++	+	-	++
	Vitanza	1999	+	+	+	+	++	++	+	+
Familial and sibling mental health	Freitag	2012	++	+	++	++	++	++	+	++
	Schilling	2006	-	+	-	+	++	++	+	++
Parenting stress	Anastopoulos	1992	++	+	+	+	++	++	-	+
	Harrison	2002	++	+	+	+	++	++	-	+
	Li	2016	++	-	+	++	++	+	-	++
	Lin	2002	-	+	+	+	++	++	-	++
	McLaughlin	2006	+	+	+	+	++	++	+	+
	Podolski	2001	++	-	-	++	++	+	+	++
	Tzang	2009	++	+	+	++	++	+	-	++
	van der Oord	2006	++	+	+	+	++	++	+	++
	Yang	2007	++	+	+	++	++	+	-	++

Familial factor	First author	Year	ADHD diagnosis	Represen-tativeness	Sample size	Familial factor	Symptom severity	Scale level	Missing values	Transparency
Parental quality of life	Cappe	2017	++	+	+	+	++	++	-	++
	Schilling	2006	-	+	-	+	++	++	+	++
	Xiang	2009	-	-	+	+	++	++	-	+
Maternal social support and self-esteem	Muñoz-Silva	2017	+	+	+	+	++	++	+	+
	Vitanza	1999	+	+	+	+	++	++	+	+
Positive parenting practices	Chronis	2007	++	+	+	++	++	++	+	+
	Haack	2016	++	-	+	+	++	++	+	+
	Ramy	2018	++	+	+	+	-	+	+	++
	Richards	2014	++	-	++	+	++	++	+	++
Negative parenting practices	Chronis	2007	++	+	+	++	++	++	+	+
	Daviss	2009	++	+	+	+	++	++	+	+
	Haack	2016	++	-	+	+	++	++	+	+
	Mikami [out]	2015	++	-	+	+	++	++	+	+
	Podolski	2001	++	-	-	++	++	+	+	++
	Ramy	2018	++	+	+	+	-	+	+	++
	Richards	2014	++	-	++	+	++	++	+	++
Further parenting practices and parent-child relationship	Freitag	2012	++	+	++	++	++	++	+	++
	Heckel	2013	++	+	+	+	-	+	-	++
	McLaughlin	2006	+	+	+	+	++	++	+	+
Familial risk	Freitag	2012	++	+	++	++	++	++	+	++
	Lee	2008	++	+	++	++	++	+	-	++

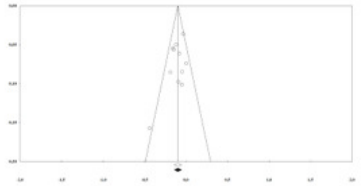
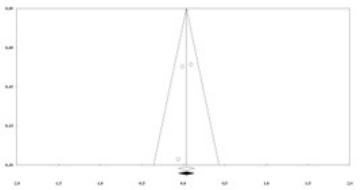
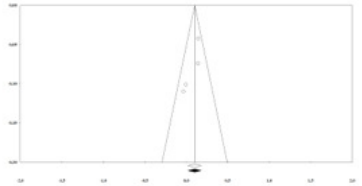
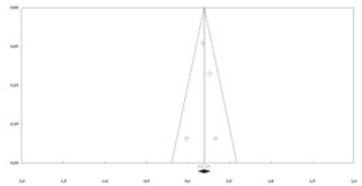
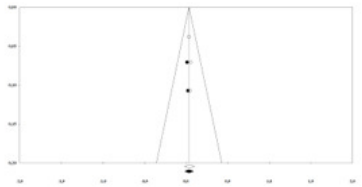
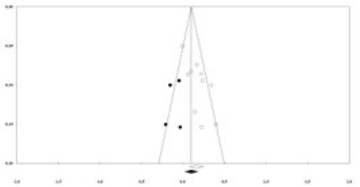
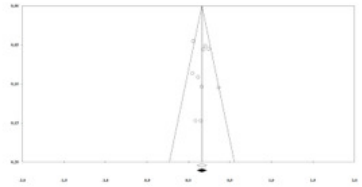
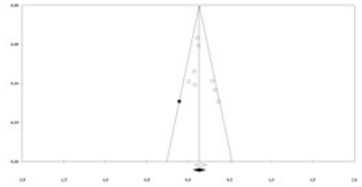
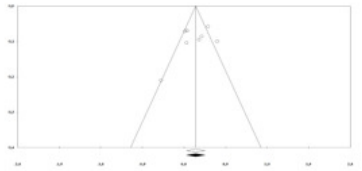
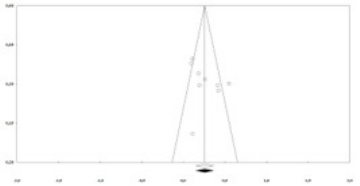
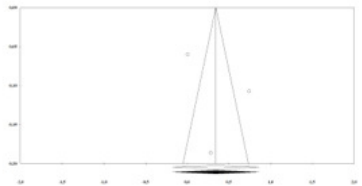
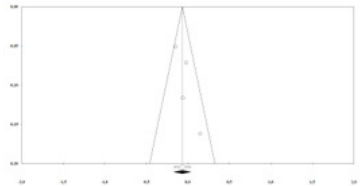
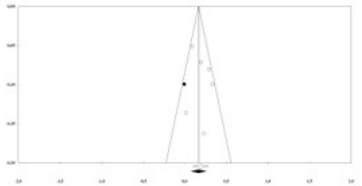
Note. [out] identified as an outlier; ++ good, + sufficient, - (potential) risk of bias.

Summary of the Assessment of the Risk of Bias Within Studies

As can be seen from the previous table, three aspects of study quality reached the best possible of three categories for over 75% of the included study findings: “ADHD diagnosis” (clinical diagnosis based on a recognized diagnostic system), “familial factor” (objectively measurable variable or use of a reliable and valid measurement instrument), and “transparency” (transparent reporting of the statistical procedure and the relevant results). While “transparency” was not rated as deficient (missing information or inconsistencies that made it impossible to take the results into account) for any of the study findings, “familial factor” was rated as deficient (use of a measurement instrument with insufficiently proven reliability and validity) for 10% of the study findings, and “ADHD diagnosis” was rated as deficient (no independent, clinical diagnosis in the study) for 14% of the study findings. Regarding the “scale level”, only 53% of the study findings reached the best possible of three categories (analysis of the association using the best possible scale levels). 45% of the study findings were accompanied by one subsequently dichotomized or categorized variable and 2% of the study findings were accompanied by two subsequently dichotomized or categorized variables. “Sample size” was rated in the best possible of three categories (N > 200) in 29% of study findings and in the worst possible category (N < 50) in 8% of study findings. The “ADHD symptom severity” was assessed in the best possible of three categories (clinical assessment based on a clinical interview) in 39% of the study findings and in the middle category (external or self-assessment based on a reliable and valid measurement instrument) in 52% of the study findings. Only 8% of the study findings used a method for measuring ADHD for which reliability and validity had not been adequately demonstrated. For the two two-step quality items, the best possible category was rated for 80% of the study findings (representativeness) and for 58% of the study findings (missing values), respectively. Accordingly, the representativeness of the investigated sample for the population of patients with ADHD in childhood and adolescence was rated as critical for 20% of the study findings. In addition, no (sufficient) information on missing values was available for 42% of the study findings.

Supplement V

Funnel Plots of Standard Error (y-axis) by Fisher's Z (x-axis) With Imputed Studies for Each of the 13 Familial Factors

Socioeconomic status	Parental age	Single-parent family	Broken partnership
			
Number of children	Critical life events	Parental ADHD	Parental affective psychopathology
			
Parental mental health	Parenting stress	Parental quality of life	Positive parenting
			
Negative parenting			
	*Note.* Observed studies are shown as open circles and the observed point estimate is shown as an open diamond. The imputed studies, as a result of the trim-and-fill procedure, are shown as filled circles and the imputed point estimate is shown as a filled diamond.		

Supplement VI

Results From Egger's Regression Test and the Trim-and-Fill Procedure Regarding the Assessment of Risk of Bias Between Studies

Familial factor				Egger's		Trim-and-fill	
	k	I^2	*r*	*t*	*p*	k^i	r^a
Socioeconomic status	11	26.33	-.10	1.43	.19	0	-.10
Parental age	3	0.00	.04	0.58	.67	0	.04
Single-parent family	4	23.22	.10	2.62	.12	0	.10
Broken partnership	4	0.00	.19	0.05	.97	0	.19
Number of children	3	0.00	.04	1.14	.46	2	.03
Critical life events	10	51.89	.16	3.25	.01	4	.10
Parental ADHD	10	36.69	.16	0.25	.81	0	.16
Parental affective psychopathology	8	42.22	.15	1.26	.26	1	.13
Parental mental health	8	71.42	.14	0.87	.42	0	.14
Parenting stress	9	67.02	.25	1.36	.22	0	.25
Parental QoL	3	94.46	.33	0.78	.58	0	.33
Positive parenting	4	35.60	-.07	2.19	.17	0	-.07
Negative parenting	6	43.77	.19	0.74	.50	1	.15

Note. *k* = number of included studies; k^i = number of imputed studies; *r* = effect estimates; r^a = effect estimates as a result of the imputation of studies according to the trim-and-fill procedure; *p* = two-tailed p-value.

Supplement VII

Results of Sensitivity Analyses

Familial factor	included studies	*k*	I^2	*r*	95% CI	*p*
Socioeconomic status	all	11	26.33	-.10	[-.14, -.05]	< .001
	dimensional ADHD	6	0.00	-.08	[-.13, -.04]	< .001
Parental age	all	3	0.00	.04	[-.06, .13]	.45
Single-parent family	all	4	23.22	.10	[.02, .18]	.02
Broken partnership	all	4	0.00	.19	[.12, .27]	< .001
Number of children	all	3	0.00	.04	[-.02, .10]	.22
Critical life events	all	11	66.41	.14	[.06, .22]	< .001
	without outlier	10	51.89	.16	[.08, .24]	< .001
	dimensional ADHD	8	58.32	.17	[.07, .27]	.001
	unbiased studies	9	48.22	.15	[.07, .22]	< .001
Parental ADHD	all	10	36.69	.16	[.10, .22]	< .001
	dimensional ADHD	9	35.94	.17	[.11, .23]	< .001
	unbiased studies	9	43.71	.16	[.10, .22]	< .001
Parental affective psychopathology	all	8	42.22	.15	[.08, .22]	< .001
	dimensional ADHD	7	28.57	.13	[.06, .19]	< .001
Parental mental health	all	8	71.42	.14	[.03, .25]	.02
	dimensional ADHD	6	74.35	.16	[.01, .29]	.03
	unbiased studies	7	65.55	.11	[-.00, .23]	.06
Parenting stress	all	9	67.02	.25	[.15, .35]	< .001
	dimensional ADHD	5	77.38	.32	[.16, .46]	< .001
Parental QoL	all	3	94.46	.33	[-.18, .70]	.20
Positive parenting	all	4	35.60	-.07	[-.17, .04]	.21
Negative parenting	all	7	81.97	.11	[-.04, .26]	.15
	without outlier	6	43.77	.19	[.10, .28]	< .001
	dimensional ADHD	5	54.38	.19	[.08, .29]	< .001

Note. k = number of included studies; *r* = effect estimates; 95% CI = Confidence Interval (95%).

Table A1

Direct, Indirect and Total Effects for the Extension of Model SEM 2

Effect	Path	*b* [95% CI]	*SE*	*ß*	*p*
Total	**Family adversity (FAI) → positive parenting (pPar)**	0.03 [-0.07, 0.11]	0.05	0.03	0.51
Direct	FAI → pPar	0.10 [-0.00, 0.18]	0.05	0.10	0.04
Indirect	FAI → parental psychopathology (pPSYC) → pPar	-0.07 [-0.11, -0.02]	0.02	-0.07	0.004
Total	**Family adversity (FAI) → negative parenting (nPar)**	0.11 [0.03, 0.20]	0.05	0.11	0.01
Direct	FAI → nPar	-0.05 [-0.14, 0.04]	0.05	-0.05	0.32
Indirect	FAI → parental psychopathology (pPSYC) → nPar	0.16 [0.101, 0.24]	0.04	0.16	< 0.001
Total	**Family adversity (FAI) → child ADHD (cADHD)**	0.07 [-0.01, 0.16]	0.04	0.09	0.08
Direct	FAI → cADHD	0.01 [-0.08, 0.10]	0.04	0.01	0.88
Indirect	FAI → parental psychopathology (pPSYC) → cADHD	0.05 [0.01, 0.10]	0.02	0.07	0.02
Indirect	FAI → positive parenting (pPAR) → cADHD	0.00 [-0.01, 0.01]	0.01	0.00	0.47
Indirect	FAI → negative parenting (nPAR) → cADHD	-0.00 [-0.02, 0.01]	0.01	-0.01	0.40
Serial indirect	FAI → pPSYC → pPAR → cADHD	-0.00 [-0.01, 0.00]	0.00	-0.00	0.48
Serial indirect	FAI → pPSYC → nPAR → cADHD	0.01 [-0.00, 0.03]	0.01	0.02	0.09
Total	**Parental psychopathology (pPSYC) → child ADHD (cADHD)**	0.31 [0.15, 0.47]	0.08	0.25	< 0.001
Direct	pPSYC → cADHD	0.25 [0.07, 0.43]	0.09	0.21	0.005
Indirect	pPSYC → positive parenting (pPAR) → cADHD	-0.01 [-0.04, 0.02]	0.02	-0.01	0.49
Indirect	pPSYC → negative parenting (nPAR) → cADHD	0.07 [-0.01, 0.15]	0.04	0.06	0.09
Direct	**Positive parenting (pPAR) → child ADHD (cADHD)**	0.04 [-0.06, 0.11]	0.05	0.04	0.44
Direct	**Negative parenting (nPAR) → child ADHD (cADHD)**	0.09 [-0.01, 0.18]	0.05	0.11	0.07
Total	**Family adversity (FAI) → child ODD (cODD)**	0.13 [0.05, 0.21]	0.04	0.17	0.002
Direct	FAI → cODD	0.08 [-0.00, 0.17]	0.04	0.10	0.08
Indirect	FAI → parental psychopathology (pPSYC) → cODD	0.04 [0.01, 0.08]	0.02	0.06	0.04
Indirect	FAI → positive parenting (pPAR) → cODD	-0.01 [-0.02, 0.00]	0.01	-0.01	0.23
Indirect	FAI → negative parenting (nPAR) → cODD	-0.01 [-0.02, 0.01]	0.01	-0.01	0.38
Serial indirect	FAI → pPSYC → pPAR → cODD	0.00 [0.00, 0.01]	0.00	0.01	0.17
Serial indirect	FAI → pPSYC → nPAR → cODD	0.02 [0.01, 0.04]	0.01	0.02	0.005
Total	**Parental psychopathology (pPSYC) → child ODD (cODD)**	0.30 [0.15, 0.45]	0.08	0.27	< 0.001
Direct	pPSYC → cODD	0.20 [0.04, 0.35]	0.08	0.17	0.02
Indirect	pPSYC → positive parenting (pPAR) → cODD	0.02 [0.00, 0.06]	0.02	0.02	0.17
Indirect	pPSYC → negative parenting (nPAR) → cODD	0.08 [0.02, 0.16]	0.04	0.08	0.02
Direct	**Positive parenting (pPAR) → child ODD (cODD)**	-0.07 [-0.16, 0.00]	0.04	-0.09	0.09
Direct	**Negative parenting (nPAR) → child ODD (cODD)**	0.11 [0.03, 0.20]	0.04	0.15	0.009

Table A2

Descriptive Statistics and Bivariate Correlations Separately for Younger and Older Children

	Younger children			Older children				Correlations									
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*1.*	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*	*9.*	*10.*
N Boys (%)	225 (80.6)			222 (80.4)													
1. FAI	277	0.78	0.86	272	0.75	0.84	0.36	1	0.20**	0.27**	0.16**	0.03	0.10	0.11	0.15*	0.17**	0.18**
2. pADHD	268	9.63	9.01	256	8.27	8.07	1.81	0.20**	1	0.50**	0.47**	-0.15*	0.21**	0.17**	0.23**	0.17**	0.17**
3. pDAS	265	11.28	8.86	253	10.53	7.97	1.01	0.29**	0.50**	1	0.59**	-0.15*	0.38**	0.22**	0.31**	0.26**	0.28**
4. pAGG	265	25.79	8.98	256	25.59	9.49	0.25	0.25**	0.49**	0.47**	1	-0.23**	0.45**	0.18**	0.16*	0.17**	0.15*
5. pPAR	268	1.92	0.39	249	1.82	0.37	2.96**	0.03	0.08	-0.11	-0.15*	1	-0.25**	-0.06	0.10	-0.12	-0.13
6. nPAR	258	1.98	0.38	251	2.02	0.41	-0.97	0.13*	0.26**	0.35**	0.35**	-0.19**	1	0.16**	0.21**	0.21**	0.25**
7. cADHD (C)	279	1.90	0.44	276	1.85	0.49	1.23	0.00	0.16**	0.09	0.06	-0.03	0.15*	1	0.65**	0.47**	0.43**
8. cADHD (P)	254	1.84	0.51	241	1.78	0.55	1.37	0.06	0.09	0.06	0.04	-0.05	0.17*	0.61**	1	0.28**	0.45**
9. cODD (C)	276	1.14	0.63	268	1.19	0.67	-0.78	0.14*	0.12	0.11	0.10	-0.12	0.19**	0.48**	0.39**	1	0.69**
10. cODD (P)	268	1.35	0.69	260	1.45	0.73	-1.71	0.17**	0.16*	0.17**	0.17**	-0.16*	0.25**	0.46**	0.63**	0.68**	1

Note. Correlations for younger children (≤ 8.8 years) are presented above the diagonal and correlations for older children (> 8.8 years) below the diagonal. Age categories (younger vs. older children) were formed using a median split.

cADHD (C) = clinician-rated child attention-deficit/hyperactivity disorder (DCL-ADHS), cADHD (P) = parent-rated child attention-deficit/hyperactivity disorder (FBB-ADHS), cODD (C) = clinician-rated child oppositional defiant disorder (DCL-SSV), cODD (P) = parent-rated child oppositional defiant disorder (FBB-SSV), FAI = Family Adversity Index, nPAR = negative parenting (FPNE), pADHD = parental attention-deficit/hyperactivity disorder (ADHS-SB), pDAS = parental depression, anxiety and stress (DASS21), pPAR = positive parenting (FZEV).

* $p < 0.05$, ** $p < 0.01$.

Table A3

Descriptive Statistics and Correlations Separately for Boys and Girls

	Boys			Girls				Correlations									
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*1.*	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*	*9.*	*10.*
Child age	447	8.95	1.49	108	8.89	1.35	0.38										
1. FAI	443	0.76	0.84	106	0.79	0.89	-0.39	1	0.25**	0.30**	0.26**	0.03	0.12*	0.06	0.12*	0.16**	0.20**
2. pADHD	424	9.01	8.91	100	8.78	7.09	0.24	-0.05	1	0.53**	0.50**	-0.03	0.21**	0.20**	0.17**	0.15**	0.17**
3. pDAS	416	11.06	8.61	102	10.35	7.71	0.75	0.20*	0.35**	1	0.56**	-0.15**	0.38**	0.16**	0.19**	0.19**	0.26**
4. pAGG	423	25.88	9.49	98	24.86	7.96	0.99	-0.03	0.33**	0.36**	1	-0.16**	0.40**	0.15**	0.12*	0.14**	0.21**
5. pPAR	418	1.86	0.38	99	1.94	0.37	-1.85	0.01	-0.09	0.02	-0.32**	1	-0.19**	-0.01	0.05	-0.12*	-0.15**
6. nPAR	412	2.00	0.39	97	1.98	0.43	0.66	0.10	0.30**	0.27**	0.38**	-0.38**	1	0.12*	0.19**	0.14**	0.22**
7. cADHD (C)	447	1.91	0.46	108	1.76	0.48	3.09**	0.07	0.02	0.12	-0.09	-0.12	0.27**	1	0.61**	0.45**	0.43**
8. cADHD (P)	404	1.83	0.53	91	1.74	0.52	1.49	0.07	0.14	0.18	-0.06	0.00	0.17	0.70**	1	0.32**	0.53**
9. cODD (C)	437	1.20	0.65	107	1.02	0.63	2.67**	0.15	0.09	0.18	0.05	-0.08	0.44**	0.53**	0.38**	1	0.68**
10. cODD (P)	427	1.44	0.70	101	1.23	0.71	2.73**	0.10	0.12	0.08	-0.10	-0.13	0.36**	0.44**	0.54**	0.69**	1

Note. Correlations for boys are presented above the diagonal and correlations for girls below the diagonal.
cADHD (C) = clinician-rated child attention-deficit/hyperactivity disorder (DCL-ADHS), cADHD (P) = parent-rated child attention-deficit/hyperactivity disorder (FBB-ADHS), cODD (C) = clinician-rated child oppositional defiant disorder (DCL-SSV), cODD (P) = parent-rated child oppositional defiant disorder (FBB-SSV), FAI = Family Adversity Index, nPAR = negative parenting (FPNE), pADHD = parental attention-deficit/hyperactivity disorder (ADHS-SB), pDAS = parental depression, anxiety and stress (DASS21), pPAR = positive parenting (FZEV).
* $p < 0.05$, ** $p < 0.01$.

Table A4

Model Fit Parameters of the Multi-Sample SEMs for Younger and Older Children and for Boys and Girls

Model	χ^2 (df)	*p*	CFI	SRMR	RMSEA	$\Delta\chi^2$ (df)	*p*
"Age"							
Configural invariance	73.11 (46)	.007	0.981	0.033	0.046		
Weak invariance	72.26 (50)	.021	0.984	0.034	0.041	1.24 (4)	0.87
Strong invariance	86.97 (56)	.005	0.978	0.040	0.046	14.96 (6)	0.02
"Gender" (C)							
Configural invariance	49.09 (24)	.002	0.967	0.033	0.060		
Weak invariance	46.98 (26)	.007	0.970	0.033	0.054	0.56 (2)	0.75
Strong invariance	63.85 (32)	.001	0.957	0.041	0.059	18.08 (6)	< 0.01
"Gender" (P)							
Configural invariance	48.95 (24)	.002	0.968	0.034	0.060		
Weak invariance	46.60 (26)	.008	0.972	0.034	0.055	0.64 (2)	0.72
Strong invariance	58.69 (32)	.003	0.964	0.039	0.055	12.27 (6)	0.06

Note. Configural and weak measurement invariance based on SEM 2 was confirmed for younger and older children, but estimation problems (i.e., negative variances) occurred for boys and girls. Consequently, SEM 2 was simplified, and instead of the two latent factors with two indicators, two separate SEMs with two manifest factors each were calculated. Specifically, one multi-sample SEM with clinician-rated child symptoms (DCL-ADHS, DCL-SSV) and one with parent-rated child symptoms (FBB-ADHS, FBB-SSV) were analyzed under the assumption of weak measurement invariance.
(C) = clinician-rated child symptoms, (P) = parent-rated child symptoms.
CFI = comparative fix index, RMSEA = root mean square error of approximation, SRMR = standardized root mean square residual.

Table A5

Direct, Indirect and Total Effects on Child ADHD and Child ODD Symptoms in the Multi-Sample SEM for Younger and Older Children

		Younger children (*n* = 279)				Older children (*n* = 276)			
Effect	Path	*b* [95% CI]	*SE*	*ß*	*p*	*b* [95% CI]	*SE*	*ß*	*p*
Total	FAI → cADHD	0.01 [-0.01, 0.22]	0.06	0.13	< 0.10	0.03 [-0.08, 0.13]	0.05	0.04	0.53
Total	pPSYC → cADHD	0.36 [0.16, 0.54]	0.10	0.35	< 0.001	0.13 [-0.11, 0.44]	0.14	0.11	0.33
Direct	pPar → cADHD	0.09 [-0.08, 0.19]	0.07	0.13	0.16	-0.02 [-0.12, 0.10]	0.06	-0.03	0.72
Direct	nPAR → cADHD	0.06 [-0.09, 0.17]	0.07	0.08	0.38	0.12 [-0.01, 0.25]	0.07	0.17	0.06
R^2 (cADHD)			14.9 %				3.6 %		
Total	FAI → cODD	0.13 [0.02, 0.25]	0.06	0.19	0.03	0.12 [0.02, 0.24]	0.05	0.17	0.02
Total	pPSYC → cODD	0.30 [0.08, 0.52]	0.11	0.30	0.006	0.25 [0.04, 0.51]	0.12	0.21	0.03
Direct	pPAR → cODD	-0.02 [-0.13, 0.06]	0.05	-0.03	0.69	-0.09 [-0.19, 0.01]	0.05	-0.12	0.11
Direct	nPAR → cODD	0.10 [-0.02, 0.21]	0.06	0.14	< 0.10	0.11 [0.00, 0.23]	0.06	0.16	0.07
R^2 (cODD)			13.7 %				10.7 %		

Note. Total and direct effects of familial factors on child symptoms for younger and older children were compared using χ^2 difference tests, and no effect differed significantly (all $p > 0.05$) for younger and older children.

cADHD = child attention-deficit/hyperactivity disorder, cODD = child oppositional defiant disorder, FAI = Family Adversity Index, nPar = negative parenting, pPAR = positive parenting, pPSYC = parental psychopathology.

Table A6

Direct, Indirect and Total Effects on Clinically Rated Child ADHD and Child ODD Symptoms in the Multi-Sample SEM for Boys and Girls

		Boys (*n* = 447)				Girls (*n*= 108)			
Effect	Path	*b* [95% CI]	*SE*	*ß*	*p*	*b* [95% CI]	*SE*	*ß*	*p*
Total	FAI → cADHD	0.05 [-0.04, 0.15]	0.05	0.05	0.25	0.06 [-0.13, 0.31]	0.11	0.06	0.59
Total	pPSYC → cADHD	0.33 [0.18, 0.50]	0.08	0.23	< 0.001	0.03 [-0.56, 0.76]	0.36	0.01	0.93
Direct	pPar → cADHD	0.03 [-0.07, 0.13]	0.05	0.03	0.54	-0.03 [-0.26, 0.12]	0.12	-0.03	0.79
Direct	nPAR → cADHD	0.02 [-0.11, 0.13]	0.06	0.02	0.77	0.33 [0.08, 0.65]	0.14	0.35	0.02
R^2 (cADHD)		5.0 %				9.7 %			
Total	FAI → cODD	0.16 [0.07, 0.26]	0.05	0.16	0.001	0.12 [-0.02, 0.32]	0.09	0.12	0.18
Total	pPSYC → cODD	0.27 [0.11, 0.43]	0.09	0.19	0.001	0.34 [-0.32, 1.07]	0.37	0.16	0.36
Direct	pPAR → cODD	-0.09 [-0.20, 0.01]	0.05	-0.09	0.07	0.08 [-0.12, 0.29]	0.10	0.08	0.77
Direct	nPAR → cODD	0.04 [-0.08, 0.16]	0.06	0.04	0.57	0.47 [0.23, 0.70]	0.12	0.52	< 0.001
R^2 (cODD)		6.6 %				22.2 %			

Note. Total and direct effects of familial factors on child symptoms for boys and girls were compared using χ^2 difference tests.

[a] Corresponding effects differed significantly based on χ^2 difference test for boys and girls (cADHD: χ^2_{diff} (1) = 5.032, p = 0.02; cODD: χ^2_{diff} (1) = 64.947, p < 0.001).

cADHD = child attention-deficit/hyperactivity disorder, cODD = child oppositional defiant disorder, FAI = Family Adversity Index, nPar = negative parenting, pPAR = positive parenting, pPSYC = parental psychopathology.

Table A7

Direct, Indirect and Total Effects on Parent-Rated Child ADHD and Child ODD Symptoms in the Multi-Sample SEM for Boys and Girls

		Boys (*n* = 447)				Girls (*n* = 107)			
Effect	Path	*b* [95% CI]	*SE*	*ß*	*p*	*b* [95% CI]	*SE*	*ß*	*p*
Total	FAI → cADHD	0.11 [0.00, 0.21]	0.05	0.11	0.04	0.08 [-0.09, 0.32]	0.10	0.09	0.41
Total	pPSYC → cADHD	0.32 [0.12, 0.51]	0.10	0.22	0.001	0.23 [-0.29, 1.02]	0.34	0.11	0.49
Direct	pPar → cADHD	0.07 [-0.04, 0.17]	0.05	0.07	0.21	0.04 [-0.20, 0.29]	0.12	0.04	0.72
Direct	nPAR → cADHD	0.10 [-0.02, 0.22]	0.06	0.10	0.09	0.14 [-0.12, 0.41]	0.15	0.15	0.36
R^2 (cADHD)			6.3 %				3.4 %		
Total	FAI → cODD	0.22 [0.13, 0.32]	0.05	0.21	< 0.001	0.07 [-0.11, 0.33]	0.13	0.08	0.56
Total	pPSYC → cODD	0.39 [0.20, 0.62]	0.10	0.27	< 0.001	0.09 [-0.57, 0.74]	0.33	0.04	0.78
Direct	pPAR → cODD	-0.09 [-0.18, 0.01]	0.05	-0.09	0.08	-0.01 [-0.22, 0.21]	0.11	-0.01	0.90
Direct	nPAR → cODD [a]	0.09 [-0.02, 0.22]	0.06	0.09	0.11	0.42 [0.00, 0.18]	0.14	0.45	0.02
R^2 (cODD)			12.4 %				15.7 %		

Note. Total and direct effects of familial factors on child symptoms for boys and girls were compared using χ^2 difference tests.

[a] Corresponding effect differed significantly based on χ^2 difference test for boys and girls (χ^2_{diff} (1) = 6.695, p = 0.01).

cADHD = child attention-deficit/hyperactivity disorder, cODD = child oppositional defiant disorder, FAI = Family Adversity Index, nPar = negative parenting, pPAR = positive parenting, pPSYC = parental psychopathology.

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7 Curriculum Vitae

AUSBILDUNG

09/16 – 08/23	**Medizinische Fakultät, Universität zu Köln** Interdisziplinärer Promotionsstudiengang Health Sciences (IPHS)
04/16 – 09/20	**AKiP – Ausbildungsinstitut für Kinder- und Jugendlichen Psychotherapie, Uniklinik Köln** Ausbildung als Kinder- und Jugendpsychotherapeutin mit abschließender Approbation (Schwerpunkt Verhaltenstherapie)
10/13 – 03/16	**Rheinische Friedrich-Wilhelms-Universität Bonn** Master of Science Psychologie (Notendurchschnitt: 1,1) Abschlussarbeit: „Gesteigerte kognitive Kontrolle durch verlangsamte Atmung? Eine Analyse des Atemzyklus, der Herzratenvariabilität und der EKP-Komponente N2.“
10/10 – 09/13	**Rheinische Friedrich-Wilhelms-Universität Bonn** Bachelor of Science Psychologie (Notendurchschnitt: 1,1) Abschlussarbeit: „Senkt die mentale Repräsentation einer Partnerschaft das Autonomiebedürfnis?“
06/10	**Humboldt-Gymnasium Köln** Allgemeine Hochschulreife (Notendurchschnitt: 1,2)

BERUFSERFAHRUNG

seit 02/22	**Kinder- und Jugendpsychiatrie, Uniklinik Köln** Wissenschaftliche Mitarbeiterin mit studienkoordinatorischen Aufgaben in einem Forschungsprojekt zur Überarbeitung der Klinischer Leitlinien zu Störungen des Sozialverhaltens. Projektleitung: Prof. Dr. Manfred Döpfner.
03/18 – 01/22	**Kinder- und Jugendpsychiatrie, Uniklinik Köln** Wissenschaftliche Mitarbeiterin mit studienkoordinatorischen Aufgaben in einem multizentrischen Projekt zur Optimierung der individualisierten Behandlungsstrategie für Patienten mit Aufmerksamkeitsdefizit-/Hyperaktivitätsstörung (ADHS). Projektleitung: Prof. Dr. Manfred Döpfner.
03/16 – 03/18	**Kinder- und Jugendpsychiatrie, Uniklinik Köln** Wissenschaftliche Hilfskraft in oben genanntem Projekt.

seit 10/17 **Perspektive Bildung e.V. / Internationale Friedensschule Köln**
Dozentin für Vorträge und Workshops zur pädagogischen Begleitung von Kindern und Jugendlichen mit ADHS und Autismus-Spektrum-Störung (ASS).

03/16 – 06/17 **Kinder- und Jugendpsychiatrie, Uniklinik Köln**
Praktische Tätigkeit in der ADHS-Schwerpunktambulanz mit dem Schwerpunkt Diagnostik und Behandlung von Schulkindern mit ADHS.

PUBLIKATIONEN –
ERSTAUTORENSCHAFTEN

Jendreizik, L. T., von Wirth, E., & Döpfner, M. (2022). Familial factors associated with symptom severity in children and adolescents with ADHD: a meta-analysis and supplemental review. *Journal of Attention Disorders*, *27*(2), 124-144. https://doi.org/10.1177/10870547221132793

Jendreizik, L. T., Hautmann, C., von Wirth, E., Dose, C., Thöne, A.-K., Treier, A.-K., Banaschewski, T., Becker, K., Brandeis, D., Geissler, J., Hebebrand, J., Hohmann, S., Holtmann, M., Huss, M., Jans, T., Kaiser, A., Millenet, S., Poustka, L., Schneider, P., & Döpfner, M. (2022). The importance of familial risk factors in children with ADHD: direct and indirect effects of family adversity, parental psychopathology and parenting practices on externalizing symptoms. *Child and Adolescent Psychiatry and Mental Health*, *16*(1), Article 96. https://doi.org/10.1186/s13034-022-00529-z

PUBLIKATIONEN –
MITAUTORENSCHAFTEN

Thöne, A.-K., Dose, C., Junghänel, M., Hautmann, C., Jendreizik, L. T., Treier, A.-K., Vetter, P., Von Wirth, E., Banaschewski, T., Becker, K., Brandeis, D., Dürrwächter, U., Geissler, J., Hebebrand, J., Hohmann, S., Holtmann, M., Huss, M., Jans, T., Kaiser, A., . . . Döpfner, M. (2023). Identifying Symptoms of ADHD and Disruptive Behavior Disorders Most Strongly Associated with Functional Impairment in Children: A Symptom-Level Approach. *Journal of Psychopathology and Behavioral Assessment*. https://doi.org/10.1007/s10862-023-10025-z

Klemp, M.-T., Dose, C., Hautmann, C., Jendreizik, L. T., Mühlenmeister, J., Plück, J., Wähnke, L., & Döpfner, M. (2022). Parenting Behaviors as Mediators of the Association Between Parental Internalizing Symptoms and Child Externalizing Symptoms. *Child Psychiatry & Human Development*. https://doi.org/10.1007/s10578-022-01462-0

Kaiser, A., Aggensteiner, P.-M., Holtmann, M., Fallgatter, A., Romanos, M., Abenova, K., Alm, B., Becker, K., Döpfner, M., Ethofer, T., Freitag, C. M., Geissler, J., Hebebrand, J., Huss, M., Jans, T., Jendreizik, L. T., Ketter, J., Legenbauer, T., Philipsen, A., . . . Brandeis, D. and on behalf of the ESCAlife-Consortium (2021). EEG Data Quality: Determinants and Impact in a Multicenter Study of Children, Adolescents, and Adults with Attention-Deficit/Hyperactivity Disorder (ADHD). *Brain Sciences*, *11*(2), Article 214. https://doi.org/10.3390/brainsci11020214

Thöne, A.-K., Junghänel, M., Görtz-Dorten, A., Dose, C., Hautmann, C., Jendreizik, L. T., Treier, A.-K., Vetter, P., Von Wirth, E., Banaschewski, T., Becker, K., Brandeis, D., Dürrwächter, U., Geissler, J., Hebebrand, J., Hohmann, S., Holtmann, M., Huss, M., Jans, T., . . . Döpfner, M. (2021). Disentangling symptoms of externalizing disorders in children using multiple measures and informants. *Psychological Assessment*, *33*(11), 1065-1079. https://doi.org/10.1037%2Fpas0001053

Becker, K., Banaschewski, T., Brandeis, D., Dose, C., Hautmann, C., Holtmann, M., Jans, T., Jendreizik, L., Jenkner, C., John, K., Ketter, J., Millenet, S., Pauli-Pott, U., Renner, T., Romanos, M., Treier, A.-K., von Wirth, E., Wermter, A.-K., & Döpfner, M. (2020). Individualised stepwise adaptive treatment for 3–6-year-old preschool children impaired by attention-deficit/hyperactivity disorder (ESCApreschool): study protocol of an adaptive intervention study including two randomised controlled trials within the consortium ESCAlife. *Trials*, *21*(1), Article 56. https://doi.org/10.1186/s13063-019-3872-8

Thöne, A.-K., Görtz-Dorten, A., Altenberger, P., Dose, C., Geldermann, N., Hautmann, C., Jendreizik, L. T., Treier, A.-K., von Wirth, E., Banaschewski, T., Brandeis, D., Millenet, S., Hohmann, S., Becker, K., Ketter, J., Hebebrand, J., Wenning, J., Holtmann, M., Legenbauer, T., . . . Döpfner, M. (2020). Toward a Dimensional Assessment of Externalizing Disorders in Children: Reliability and Validity of a Semi-Structured Parent Interview. *Frontiers in Psychology*, *11*, Article 1840. https://doi.org/10.3389/fpsyg.2020.01840

Hoffmann, S., Jendreizik, L. T., Ettinger, U., & Laborde, S. (2019). Keeping the pace: The effect of slow-paced breathing on error monitoring. *International Journal of Psychophysiology*, *146*, 217-224. https://doi.org/10.1016/j.ijpsycho.2019.10.001

8 Declaration

Hiermit versichere ich an Eides statt, dass ich die vorliegende Dissertationsschrift selbstständig und ohne die Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe. Alle Stellen − einschließlich Tabellen, Karten und Abbildungen −, die wörtlich oder sinngemäß aus veröffentlichten und nicht veröffentlichten anderen Werken im Wortlaut oder dem Sinn nach entnommen sind, sind in jedem Einzelfall als Entlehnung kenntlich gemacht. Ich versichere an Eides statt, dass diese Dissertationsschrift noch keiner anderen Fakultät oder Universität zur Prüfung vorgelegen hat; dass sie − abgesehen von unten angegebenen Teilpublikationen − noch nicht veröffentlicht worden ist sowie, dass ich eine solche Veröffentlichung vor Abschluss der Promotion nicht ohne Genehmigung der / des Vorsitzenden des IPHS-Promotionsausschusses vornehmen werde. Die Bestimmungen dieser Ordnung sind mir bekannt. Die von mir vorgelegte Dissertation ist von Univ.-Prof. a.D. Dr. Manfred Döpfner betreut worden.

Darüber hinaus erkläre ich hiermit, dass ich die Ordnung zur Sicherung guter wissenschaftlicher Praxis und zum Umgang mit wissenschaftlichem Fehlverhalten der Universität zu Köln gelesen und sie bei der Durchführung der Dissertation beachtet habe und verpflichte mich hiermit, die dort genannten Vorgaben bei allen wissenschaftlichen Tätigkeiten zu beachten und umzusetzen.

Übersicht der Publikationen:

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Jendreizik, L. T., Hautmann, C., von Wirth, E., Dose, C., Thöne, A.-K., Treier, A.-K., Banaschewski, T., Becker, K., Brandeis, D., Geissler, J., Hebebrand, J., Hohmann, S., Holtmann, M., Huss, M., Jans, T., Kaiser, A., Millenet, S., Poustka, L., Schneider, P., & Döpfner, M. (2022). The importance of familial risk factors in children with ADHD: direct and indirect effects of family adversity, parental psychopathology and parenting practices on externalizing symptoms. Child and Adolescent Psychiatry and Mental Health, 16(1), Article 96. https://doi.org/10.1186/s13034-022-00529-z

Ich versichere, dass ich alle Angaben wahrheitsgemäß nach bestem Wissen und Gewissen gemacht habe und verpflichte mich, jedmögliche, die obigen Angaben betreffenden Veränderungen, dem IPHS-Promotionsausschuss unverzüglich mitzuteilen.

Geleistete Beiträge erste Publikation:

PD Dr. Elena von Wirth und Prof. Dr. Manfred Döpfner haben den Prozess der Literatursuche und -auswertung und die Revision des Manuskripts unterstützt. PD Dr. Elena von Wirth fungierte zudem als Beurteilerin für die Qualitätsbeurteilung. Ich selbst habe das Review Protokoll maßgeblich ausgearbeitet, die systematische Suche durchgeführt, war die erste Beurteilerin für das Abstract-Screening, das Volltext-Screening und die Qualitätsbeurteilung, habe alle meta-analytischen Auswertungen vorgenommen und das Manuskript maßgeblich entwickelt. Unterstützt wurde ich von verschiedenen Hilfskräften bei der Studienauswahl und Datenextraktion.

Geleistete Beiträge zweite Publikation:

Die dieser Arbeit zugrundeliegenden Daten wurden im Rahmen eines von dem Bundesministerium für Bildung und Forschung (BMBF) geförderten Forschungsprojekts an der Klinik und Poliklinik für Psychiatrie, Psychosomatik und Psychotherapie des Kindes- und Jugendalters der Universität zu Köln erhoben (Förderkennzeichen 01EE1408B). Die Daten der multizentrischen, klinischen Studie zur evidenz-basierten, stufenweisen Versorgung von ADHS bei Schulkindern (ESCAschool) wurde an neun Studienstandorten erhoben. ESCAschool ist Teil des Forschungsverbunds ESCAlife.

Ein Großteil der Ko-Autoren der zweiten Publikation waren an der Konzeption der ESCAschool Studie (PD Dr. Christopher Hautmann, PD Dr. Elena von Wirth, Dr. Christina Dose, Prof. Dr. Tobias Banaschewski, Prof. Dr. Katja Becker, Prof. Dr. Daniel Brandeis, Prof. Dr. Johannes Hebebrand, Prof. Dr. Martin Holtmann, Prof. Dr. Michael Huss, PD Dr. Thomas Jans, Dr. Sabina Millenet, Prof. Dr. Manfred Döpfner) beteiligt, leiteten eines der teilnehmenden Studienzentren (Prof. Dr. Tobias Banaschewski, Prof. Dr. Katja Becker; Prof. Dr. Johannes Hebebrand; Prof. Dr. Martin Holtmann, Prof. Dr. Michael Huss, PD Dr. Thomas Jans, Dr. Sabina Millenet, Prof. Dr. Luise Poustka, Prof. Dr. Manfred Döpfner), koordinierten die ESCAschool Studie (PD Dr. Christopher Hautmann, PD Dr. Elena von Wirth, Dr. Christina Dose, Anne-Katrin Treier) oder wirkten maßgeblich bei der Patientenrekrutierung und dem Patientenmanagamenet mit (Ann-Kathrin Thöne, Anne-Katrin Treier, Dr. Julia Geissler, Dr. Anna Kaiser, Priska Schneider). Einige der Ko-Autoren übernahmen zentrale Aufgaben im ESCAlife Verbund (Prof. Dr. Tobias Banaschewski, Prof. Dr. Katja Becker, Prof. Dr. Daniel Brandeis, Prof. Dr. Sarah Hohmann, PD Dr. Thomas Jans, Prof. Dr. Manfred Döpfner). Das Datenmanagement wurde von Frau Dr. Carolin Jenkner (Studienzentrum Freiburg) durchgeführt.

Die Entwicklung des Konzepts der Studie wurde unterstützt von PD Dr. Christopher Hautmann und Prof. Dr. Manfred Döpfner und bei der Durchführung der Analysen unterstützte PD Dr. Christopher Hautmann. Im Besonderen PD Dr. Elena von Wirth, PD Dr. Christopher Hautmann und Prof. Dr. Manfred Döpfner, aber auch alle anderen Ko-Autoren, haben die Revision des Manuskripts unterstützt.

Ich selbst habe bei der Studiendurchführung von ESCAschool mitgewirkt, habe ESCAschool mehrere Jahre koordiniert, die Forschungsfragen der zweiten Studie dieser Thesis ausgearbeitet, die Analysen durchgeführt und das Manuskript maßgeblich verfasst.

Beide Publikationen wurden von Frau Sarah Mannion sprachlich überarbeitet.
Ergebnisse von (vorläufigen) Analysen der beiden Studien wurden in den Jahren 2019, 2021 und 2022 bei Kongressen und Tagungen verschiedener Fachverbände (Deutsche Gesellschaft für Kinder- und Jugendpsychiatrie, Psychosomatik und Psychotherapie; Fachgruppe Klinische Psychologie und Psychotherapie der Deutschen Gesellschaft für Psychologie; The European Network for Hyperkinetic Disorders) jeweils in Form eines Posters präsentiert.

08.08.2023 Lea Teresa Kohl (geb. Jendreizik)