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Journal of Psychological Research
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REVIEW

Current Evidence and Diverse Perspectives on Attention-Deficit/Hyperactivity Disorder: A Systematic Review

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Abstract: Introduction: ADHD is one of the most common neurodevelopmental disorders in childhood and adolescence. Although the disorder starts to manifest early in childhood, a significant proportion of cases often persists into adulthood. ADHD negatively and significantly impacts social and occupational functioning and academic performance. A number of extant theories and scientific evidence provide insight into the genesis and manifestations of ADHD and the attendant challenges of significant dysfunction that individuals may encounter at home, school, and the workplace. **Method:** This systematic review was conducted through a literature search for published peer-reviewed articles using standard PRISMA guidelines. The goal of the study was to explore current theories, models, concepts, and risk factors about ADHD published in peer-reviewed literature. We made use of use several online databases—including PsycINFO, PubMed, Web of Science, ScienceDirect, and Medline in the process of searching for relevant studies. Relevant peer-reviewed publications since the 1980s when the term Attention-Deficit/Hyperactivity Disorder (ADHD) was introduced in DSM-III-R were included. Non-peer-reviewed publications, including dissertations, editorials, commentaries, and materials published in languages other than English were excluded. **Results and Discussion:** The results of the review indicated that ADHD is characterized by a behavioral reaction that interferes with personal and social functioning. The factors associated with ADHD fall into several major thematic areas, including genetic and hereditary factors; dietary and nutritional factors; parenting and behavioral factors; adverse early life events, and high-risk environmental factors, crystallized by a number of developmental and behavioral theories. The review also identified a number of extant models and theories that attempt to explain the diverse perspectives associated with ADHD. **Conclusions:** This study has attempted to identify the major risk factors and diverse models and theories associated with ADHD. The thematic risk factors include genetic and hereditary factors; dietary and nutritional factors; parenting and behavioral factors; adverse early life events, and high-risk environmental factors. The most prominent models identified include the biomedical model and the bio-psycho-social models, the latter being a more holistic approach which aims to treat both the patient and the disease. This review would provide an additional evidence base to individuals, families, and educators to make informed choices and decisions in the best interest of the affected children, including their personal growth, healthcare, and medical needs, academic performance, and social skills development.

Keywords: ADHD; Developmental disorders; Mental health; Behavioral disorders

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Received: 15 January 2022; **Revised:** 16 March 2022; **Accepted:** 25 March 2022; **Published Online:** 12 April 2022

Citation: Asrat Genet Amnie. Current Evidence and Diverse Perspectives on Attention-Deficit/Hyperactivity Disorder: A Systematic Review. *Journal of Psychological Research*, 2022, 4(2), 4384. https://doi.org/10.30564/jpr.v4i2.4384

DOI: https://doi.org/10.30564/jpr.v4i2.4384

1. Introduction

The condition called ADHD is one of the most common neuro-developmental disorders in childhood and adolescence. ADHD was first described in 1902 as a hyperkinetic syndrome. With further understanding and recognition of the condition, the disorder was termed Hyperkinetic Reaction of Childhood when it was included in DSM II in 1968 [1].

ADHD is persistent across the life span with varying degrees of manifestation, multimorbidity, co-morbidity, and significant levels of personal and social impairment. The major manifestations that characterize the disorder include inattention and impulsivity. The DSM- V ADHD diagnostic criteria require symptoms and/or behaviors that have persisted ≥ 6 months in ≥ 2 settings (e.g., school, home, church). Symptoms have negatively impacted academic, social, and/or occupational functioning. For patients aged < 17 years, ≥ 6 symptoms are necessary; in those aged ≥ 17 years, ≥ 5 symptoms are necessary. The most notable modifications in DSM-V diagnostic criteria pertains to the age of onset, which was changed from *onset of symptoms and impairments* before age 7 to *onset of symptoms* before age 12 [2].

The number of children affected by the disorder is estimated to be more than 6.4 million [3]. The prevalence of ADHD in the USA (4% to 10%) is comparable to its worldwide prevalence (3% to 9.5%) [4]. ADHD predominantly affects children although millions of adults also suffer from ADHD and associated social and occupational dysfunction, including high work impairment and loss of household income [5-7].

ADHD poses a significant challenge to affected children in their personal development and academic performance. Persons with ADHD often have problems with maintaining attention, cognitive function, and memory processing [8]. An established body of research indicates that children with ADHD had experienced much higher rates of adversity than those without ADHD [3]. Adverse life events like family dysfunction, suboptimal parenting, diminished economic opportunities, high level of family disruption, poor family functioning, parental substance abuse or criminality, socially disorganized neighborhoods often characterize children with ADHD [9]. The significance of eliciting the relevant family history including any possible exposure to physical injury or psychological trauma in affected children and its importance in subsequent therapeutic interventions cannot be overemphasized [3].

The usual age range for peak diagnosis of ADHD is 3-6 years with global prevalence rates estimated at 9.5% for children and adolescents and 3% in adults [10,11]. Three major subtypes of ADHD are identified: predominantly inattentive, predominantly hyperactive-impulsive, and combined [12]. The most significant risk factors for ADHD include genetics and hereditability accounting for 60-80% and epigenetic factors in the rest of instances [13].

A recent study posited that a tendency to impulsive and risky decision making, including trying drugs, driving under the influence, high-risk sexual behavior, and delinquency already present in adolescents is exacerbated by ADHD [14]. On the other hand, ADHD has also been found to be a risk factor for COVID-19 infection, as affected individuals appear to have difficulty in complying with available public health measures [15]. Individuals with manifest ADHD appear to have much lower levels of adherence to preventive measures and adaptation to the COVID-19 outbreak and exhibit higher levels of stress [16].

To dismiss ADHD as a non-disease entity, a social construct, or normal variation in development amounts to denying affected individuals the effective interventions, including existing pharmacologic and cognitive behavioral therapies for ADHD and the potential to restore individuals' academic performance and social functioning [17].

It is helpful to keep the lifespan perspective on ADHD. In the pre-teen years, ADHD is associated with low self-esteem, disruptive behavior, and poor social and academic performance. During the years of adolescence and beyond, ADHD is often associated with conduct disorder, substance abuse, and school exclusion, among other things [18]. An important consideration with regard to ADHD is the remarkable level of stigma associated with it. Stigma continues to be a significant risk factor affecting the mental wellbeing of persons with ADHD and the quality of their lives [19,20].

The successful management of ADHD requires an interdisciplinary and integrated approach, involving medical providers, counselors, teachers, parents, and other family members. Assistive technology coupled with personalized support could help individuals achieve success at home, school, and/or work.

ADHD being a complex disorder with multifactorial etiology calls for the personalization of its treatment, including both pharmacologic and non-pharmacologic treatment approaches. Some of the medications found to be effective to varying degrees in the treatment of ADHD include methylphenidate and atomoxetine. Non-pharmacologic therapies include behavioral parental training, cognitive behavioral therapy, attention training techniques, neurofeedback, and other non-pharmacologic approaches [12].

Over the years, a number of extant models and theories

have been proposed to understand ADHD, among which are the biomedical model [21-23] and the biopsychosocial model [24,25]. According to the biomedical model, ADHD is a disease, a disorder, or a disability [26,27]. It is neither a sociocultural construct nor a hoax invented by pharmaceutical companies for the purpose of selling drugs. The bio-psycho-social model is a more holistic approach which aims to treat both the patient and the disease.

Advanced by some proponents of the biopsychosocial model, the social construct theory, mostly critical of having ADHD included in the DSM III, posits that ADHD should be identified as neurodiversity and not inherently a neurological pathology [28-30]. According to this theory, other examples of neuro-divergent individuals include persons with Autism Spectrum Disorder, Dyslexia, Tourette Syndrome, and individuals with learning disabilities.

This review will focus on unpacking the prevailing current evidence and diverse perspectives on ADHD, including causes and the origins of ADHD and different models and theories developed to understand ADHD [31].

The stress associated with the care of children with ADHD, including emotional effects, social effects, and the impact of the educational challenges make it all the more difficult for parents to cope with [32].

The rationale for this study is founded in our collective responsibility to promote evidence-based practice. We live at time where research evidence may be eclipsed by uninformed consensus, science by suspicion; information by misinformation, and health literacy by hesitancy. A dearth of information or exposure to disinformation may lead to adverse health outcomes in children and adults by negatively impacting health-seeking behavior.

Objectives of the Review

The objectives of this review include, (1) critically examining the current evidence-based literature on the causes and risk factors of ADHD, (2) critically examining psychosocial models, theories and perspectives on ADHD, (3) summarizing significant findings in the existing literature, underscoring the importance of making informed choices for children, adolescents, and adults living with ADHD.

2. Method

This review was conducted through a literature search for published peer-reviewed articles using standard PRISMA guidelines. The goal of the study was to explore current theories, models, concepts and perspectives related to ADHD published in peer-reviewed literature. We made use of several online data bases— including PsycINFO, PubMed, Web of Science, ScienceDirect, and Medline in the process of searching for relevant studies. The terms used to search articles include ADHD causes and perceptions; nutrition and diet; heredity, and genetics; adversity, and environment. Searches were also conducted using ADHD-related theories, models, and perspectives designed to better understand the disorder.

Relevant peer-reviewed publications since 1980s, when the term Attention-Deficit/ Hyperactivity Disorder was introduced in *DSM-III-R* were included. The selection of published articles for review was conducted in multiple stages. First, non-peer reviewed publications, including dissertations, editorials, commentaries, and factsheets were eliminated from those identified through database search. Second, duplicate publications were excluded. Third, abstract-only publications, case reports, and articles presumed to be non-peer reviewed were excluded. The reference period for the review spans the years 2019 through 2020.

Accordingly, a total of 560 publications addressing current diverse perspectives on Attention- Deficit/ Hyperactivity Disorder were selected. After 255 duplicate articles were excluded, an additional 91 of the 305 manuscripts were removed after abstract evaluation for relevance. Subsequently, 138 manuscripts were re-evaluated for eligibility and 67 publications were selected to be included in this study. The PRISMA flow chart is presented in Figure 1.

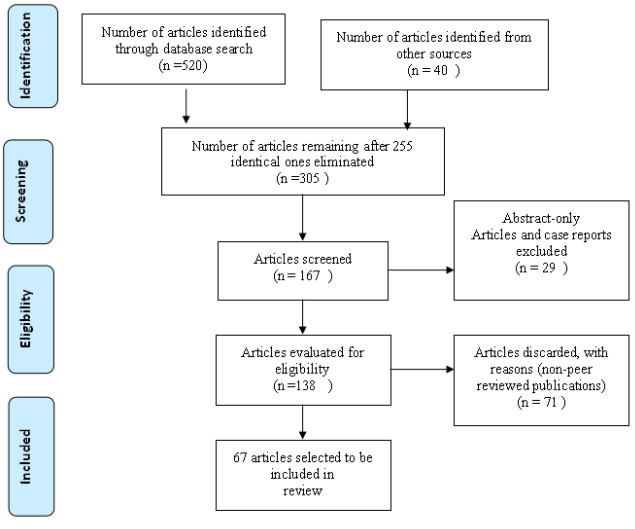

Figure 1. PRISMA* flow chart diagram of publications selection.

*PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analysis.

3. Results and Discussion

Emerging themes from the systematic analysis revealed

findings that relate mainly to the causes and risk factors of ADHD, including the models and theories that attempt to expand our understanding of ADHD. The review included thematic perspectives and risk factors as well as models and theories related to ADHD obtained from referenced publications.

(1) Genetic and hereditary factors

The development of ADHD is influenced by a number of factors, including genetic factors. A number of genetic studies on ADHD led to the discovery of several distinct chromosomal loci associated with ADHD. Paternal transmission of ADHD is significantly higher than maternal transmission, even more significantly higher to males than females [33]. Maternal substance abuse, including excessive alcohol consumption [34,35] and use of tobacco products increases the risk of ADHD [36-38]. A study on the developmental course of children with ADHD and identified multiple risk factors for ADHD posits that prenatal adversity and genetics significantly increase the risk for ADHD [39,40].

Evidence from twin studies demonstrates that genetic and hereditary factors accounted for as high as three-quarters of the population variance. There are three important factors that influence school-age and long term outcomes: severity of the manifestations, family-related factors, and co-morbid disorders [41-43]. Persons diagnosed to have ADHD and their parents, offspring, and siblings have a high risk of drug use disorders compared with controls [44]. The sharing of multiple genetic pathways is also a characteristic of ADHD and Autism Spectrum Disorders co-morbidity [45,46].

(2) Dietary and nutritional factors

Unlike genetic and hereditary factors, dietary and nutritional factors can be modified or strictly regulated. The therapeutic advantages of food restriction and exclusion of food additives in diets for children with ADHD are not significant. Research studies seem to support the assertion that food, if not the cause of ADHD, can certainly play a role in exacerbating ADHD manifestations; the major culprits considered being gluten, dairy, and artificial food dyes. On the other hand, certain nutrients such as vitamins and minerals appear to have substantial effects on ADHD manifestations. In some studies, excessive consumption of fat, refined sugars

Table 1. Selected Research Findings on the Influence of Genetic and Hereditary Factors and Dietary and Nutritional Factors on ADHD

Thematic Factors Associated with ADHD	Major Findings of Selected Studies	Authors, Year of Publication. Study Design
Genetic and Hereditary Factors	Parents, offspring, and siblings of persons with ADHD have an elevated risk of drug use disorders, resulting from genetic factors shared between the two disorders. Both genetic and epigenetic factors play a significant part in the complex etiology of ADHD [47].	47. Martin, J., Taylor, M. J., Rydell, M., Riglin, L., Eyre, O., Lu, Y., ... & Lichtenstein, P. (2018).Longitudinal Cohort Study [47].
	High levels of stress during pregnancy are associated with an elevated risk of ADHD among siblings, compared to unaffected siblings [48].	48. Grizenko, N., Fortier, M. E., Zadorozny, C., Thakur, G., Schmitz, N., Duval, R., & Joober, R. (2012). A Cross-sectional Study [48].
	Females who have anxiety and depression have a higher likelihood of being diagnosed with ADHD and the chances of misdiagnosing ADHD is higher in females [49].	49. Quinn, P. O., & Madhoo, M. (2014). A Review [49].
Dietary and Nutritional Factors	The intrauterine level of cholecalciferol (Vitamin D3) between ADHD-affected children and controls has no significant difference. Maternal age is linked to ADHD prevalence. Brain health largely benefits from Vitamin B6 and certain minerals which also affect ADHD manifestations [50,51].	Nigg, J. T., & Holton, K. (2014). A Review [50]. Gustafsson, P., Rylander, L., Lindh, C. H., Jönsson, B. A., Ode, A., Olofsson, P., ... & Källén, K. (2015) [51]. A Review
	The exclusion of food additives in the diets of children affected with ADHD does not have significant therapeutic benefits when used as a stand-alone treatment. Excessive consumption of dietary fat, refined sugar, and dietary salt result in elevated risk for the development of ADHD [52-54].	Greenblatt, J. M., & Delane, D. D. (2017). A Review [52]. Ly, V., Bottelier, M., Hoekstra, P. J., Arias Vasquez, A., Buitelaar, J. K., & Rommelse, N. N. (2017). A Review [53]. Brunault, P., Frammery, J., Montaudon, P., De Luca, A., Hankard, R., Ducluzeau, P. H., ... & Ballon, N. (2019). Cross-Sectional [54].

and salt as well as food addiction resulted in increase of an ADHD diagnosis [50-54]. Selected publications on the influence of dietary and nutritional factors on ADHD are displayed in Table 1.

(3) Adverse Early Life Events, Parenting, Behavioral, and Environmental Factors, Including Challenges in Families

A growing body of scientific evidence demonstrates that adverse childhood experiences that threaten child development at home and in the school environment can lead to long-term negative health outcomes in later life, significantly impacting behavioral and physical health outcomes [55-57]. Studies indicate that at-risk first-degree relatives of ADHD have significantly higher rates of post-traumatic stress disorder [58]. ADHD is more common in males than females but ADHD could be missed or miss understood or misdiagnosed in females as generalized anxiety disorder or depression [59].

Many of the developmental and intellectual disorders in children such as Autism Spectrum Disorder and ADHD have causal influences related to genetic, environmental, medical and, sociocultural factors during the prenatal, infancy, and childhood periods [60]. Moreover, clinical conditions such as significant maternal stress [61]; maternal anxiety [62]; and environmental risk factors such as family adversity [63] are significantly associated with developments of ADHD. On the other hand, ADHD imposes significant stress on parents and parenting [64]. ADHD persists into adolescence and even into adulthood in 50-80% of children with the disorder, co-occurring mood anxiety, substance use, and conduct disorders are common with ADHD. Adults who reported childhood abuse had significantly higher levels of ADHD [65-67].

On the other hand, concerns about a potential association between ADHD and immunizations/ vaccinations are unsupported by robustly designed research, including longitudinal studies [68]. Selected publications on prenatal, perinatal, adverse early life events, parenting, behavioral and environmental factors associated with ADHD are displayed in Table 2.

(4) Theories and Models with Diverse Perspectives Associated with ADHD.

This review has included three key models and four theories of dysfunction associated with ADHD: the

Table 2. Prenatal, perinatal, Adverse Early Life Events, Parenting, Behavioral and Environmental Factors Associated with ADHD

Thematic Factors Associated with ADHD	Major Findings of Selected Studies	Authors, Year of Publication, Study Design,
Adverse Early Life Events, Parenting, Behavioral, and Environmental Factors	The degree of severity of ADHD highly impacts parenting patterns, often leading to inappropriate practices that negatively influence a child's growth and development [69,70].	Deault, L. C. (2010). A systematic review [69]. Ellis, B., & Nigg, J. (2009). A Cross-Sectional study [70].
	Early childhood attachment issues have a significant correlation with ADHD; Appropriate parental training may prevents the development of insecure attachment [71].	Storebø, O. J., Rasmussen, P. D., & Simonsen, E. (2016). A Review [71].
	Elevated blood lead levels resulting from exposure to environment lead is significantly associated with ADHD outcomes [72,73].	Geier, D. A., Kern, J. K., & Geier, M. R. (2018). A cross-sectional study. [72.] Chronis-Tuscano, et al. (2011). Pre/Post-Intervention [73]. A Cross-sectional study
	Maternal and fetal exposure to certain environmental chemicals such as phthalates during pregnancy is significantly associated with the development of ADHD in childhood [74].	Barrett, J. R. (2019). A Case Control Study [74].
	Maternal obesity, gestational hypertension, and tobacco use during pregnancy are significantly associated with ADHD, independent of genetic and familial factors [75,76].	Mick, E., Biederman, J., Faraone, S. V., Sayer, J., & Kleinman, S. (2002). Case- control study [75]. Pohlabeln, H., Rach, S., De Henauw, S., Eiben, G., Gwozdz, W., Hadjigeorgiou, C., ... & Pigeot, I. (2017). A Cross Sectional Study [76].
	Statistically significant associations with unwanted/unplanned pregnancies, antenatal stress, mode of delivery, perinatal bonding, and quality of mother–child and father–child bonding [77].	Tole, F., Kopf, J., Schröter, K., Palladino, V. S., Jacob, C. P., Reif, A., & Kittel-Schneider, S. (2019). A Cross Sectional Study [77].

Biomedical, Biopsychosocial, and the State Regulation Model as well as The Executive Dysfunction Theory, The Delay Aversion Theory, The Dynamic Developmental Theory, and The Social Construct Theory, each of which has undergone varying levels of transformation over the years [78-83].

The Social Construct Theory is particularly interesting as its hypotheses do not conform to mainstream scientific thinking. The proponents contend that diverse neurological conditions, including ADHD are social constructs created by a culture that does not recognize neuro-divergent individuals as normal or variations of normal, and not real disorders [79,80]. Moreover, proponents of the social construct theory argue that impulsivity and hyperactivity are part of the normal process of growth and development in children. The social construct theory of ADHD contends that we live in a society where children are boxed into cultural expectations not commensurate with a child's growth and developmental milestones.

According to proponents of the social construct theory, ADHD is a sociocultural construct, and not a "mental disorder" at all [80,81]. Appropriate interventions can help affected individuals manage ADHD challenges at home, school, and work place and help lead a productive and constructive personal and social life. Parents, guardians, teachers, and students dealing or affected with ADHD directly or indirectly should have access to appropriate resources and be cognizant of current evidence to make informed choices and decisions regarding ADHD prevention and management education. The different models and theories related ADHD along with selected publications are displayed in Table 3.

Table 3. Selected Models and Theories of Attention-Deficit /Hyperactivity Disorder

Models and Theories Associated with ADHD	Major Descriptions of Models and Theories Related to ADHD	Authors, Year of Publication, Study Design
The Bio-Medical Model	Posits that the disability problem is contained in the individual and seeks to cure a person by medical professionals who can treat the effect of the disability with medications so that they can return to an able-bodied state [78].	Talbot, P., Astbury, G., & Mason, T. (Eds.). (2010). *Key concepts in learning disabilities*. Sage [78]. (A Book).
The Bio-Psycho-Social Model	Reflects the development of an illness through the complex interaction of biological, psychological, and social factors; for instance, a person's genetic predisposition to an illness may require cognitive and social factors to trigger the illness [79].	Wade, D. T., & Halligan, P. W. (2017). A Review [79].
The State Regulation Model	Posits that the efficiency with which a task is performed is considered to be a product of elementary cognitive stages such as stimulus encoding, memory search, binary decision and motor preparation, and their energy distribution. Children with ADHD have difficulty in keeping an optimal activation state [80].	Johnson, K. A., Wiersema, J. R., & Kuntsi, J. (2009). A Review [80].
The Executive Dysfunction Theory	Suggests that the symptoms of ADHD arise wholly as a result of a reduction in executive control, caused by abnormalities in the structure, function, and biochemical operation of the frontoparietal and frontostriatal neural networks [80].	Johnson, K. A., Wiersema, J. R., & Kuntsi, J. (2009). A Review [80].
The Delay Aversion Theory	Posits that children with ADHD are not impulsive in the sense of always opting for an immediate reward at the expense of overall rewards, but that they do so only in circumstances where this leads to a shorter overall delay [80].	Johnson, K. A., Wiersema, J. R., & Kuntsi, J. (2009). A Review [80].
The Dynamic Developmental Theory	Suggests that ADHD manifests because of altered reinforcement of novel behavior and deficient extinction of inadequate behavior. In ADHD socially desirable behavior is not reinforced in time as a result of a shorter window of opportunity than normal for the reinforcer to take effect [80].	Johnson, K. A., Wiersema, J. R., & Kuntsi, J. (2009). A Review [80].
The Social Construct Theory	Argues that attention deficit hyperactivity disorder is not necessarily an actual pathology, but that an ADHD diagnosis is a socially constructed explanation to describe behaviors that simply do not meet prescribed social norms [81,82].	Mather, B. A. (2012). A Review [81]. Timimi, S., & Taylor, E. (2004). A review [82].

4. Limitations of the Study

This systematic review has provided the current evidence on the diverse perspectives, risk factors, models, and theories about ADHD, one of the most common cognitive developmental disorders. However this study is not without limitations. The review consists of a number of both original research studies and systematic reviews but does not include a quality assessment and detailed characteristics of each of the articles included in the study. The evidence presented by the studies included in the review was not critically evaluated, thus treating the results of each study as equally relevant. Current evidence on the treatment of ADHD and/or assisted technology to help children or college students with ADHD challenges was not included in this study.

5. Conclusions

Millions of children and adults suffer from ADHD and associated social and occupational dysfunction and suboptimal academic performance. This study has attempted to identify the major risk factors and diverse models and theories associated with ADHD. The thematic risk factors include genetic and hereditary factors; dietary and nutritional factors; parenting and behavioral factors; adverse early life events, and high-risk environmental factors. The most prominent models include the biomedical model and the bio-psycho-social models, the latter being a more holistic approach which aims to treat both the patient and the disease. This review will provide additional evidence base to individuals, families, and educators to make informed choices and decisions in the best interests and diverse needs of the affected children and youth, including personal growth, healthcare and medical needs, academic performance, and social skills development.

Author Contributions

The corresponding author is the sole author of this systematic review.

Conflict of Interest

The author declares to have no conflict of interest.

Funding

This research received no external funding.

Acknowledgments

I would like to sincerely thank Yanna Almonte, Olakunbi Famuyiwa, and Yessica Liriano, for their immense contribution in the search for relevant peer-reviewed published articles for this study. Your individual and collective contribution is greatly appreciated.

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