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Social Determinants of Health and ADHD Symptoms in Preschool-Age Children

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Abstract

Objective: Attention-Deficit/Hyperactivity Disorder (ADHD) disproportionately affects socioeconomically disadvantaged children, but for unclear reasons. We examined the association between social determinants of health (SDH) and ADHD symptoms in a national sample of preschool-age children. Methods: We conducted exploratory factor analysis (EFA) and exploratory structural equation modeling (ESEM) with a sample of 7,565 preschool-age children from the 2016 National Survey of Children's Health, to examine the association between ADHD symptoms and SDH. Results: EFA indicated a one-factor structure for ADHD symptoms, and three factors for SDH (socioeconomic status, access to basic needs, and caregiver well-being). Independently, all three SDH were significantly associated with higher ADHD symptoms. However, in the ESEM model, only worse caregiver well-being ($\beta = .39$, $p < .01$) was significantly associated with ADHD symptoms, and fully mediated the relationship between SDH and ADHD symptoms. Conclusion: Addressing caregiver well-being in preschoolers with ADHD symptoms could be an early intervention strategy.

Keywords

ADHD, preschoolers, family, parental functioning, SES

Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most common pediatric disorders, with a prevalence of 5% to 10% (Danielson et al., 2018), and disproportionately affects socioeconomically disadvantaged children (Brown et al., 2017; Melchior et al., 2012; Russell et al., 2015, 2016; Sagiv et al., 2013). Multiple adverse social determinants of health (SDH) including low income, low parental education level, short housing tenure, food insecurity, single parenthood, prenatal smoking, and familial mental illness are associated with ADHD diagnosis, symptom severity, inferior treatment response, and worse outcomes (Biederman et al., 1995; Brown et al., 2017; Ghuman et al., 2007; Melchior et al., 2012; Pulcini et al., 2017; Roy et al., 2017; Russell et al., 2015, 2016; Sagiv et al., 2013).

Existing data suggest that early adverse SDH increase the risk that a child will develop future ADHD, rather than the other way around. For example, Melchior et al. (2012) found that food insecurity in preschoolers predicted hyper-activity and inattention (OR 3.0) in grade school. Russell et al. (2015) demonstrated that ADHD was associated with multiple markers of socioeconomic disadvantage in a longitudinal birth cohort, but having a child with ADHD did not lead to future decreases in family income. Despite this evidence, it remains unclear why socioeconomic disadvantage increases the likelihood of developing ADHD. Existing literature has not elucidated which SDH are the strongest drivers of increased risk for ADHD, nor whether certain SDH could be realistic targets for early intervention in young children.

Therefore, we sought to model the associations between SDH—including modifiable environmental and family risk factors—and emerging ADHD symptoms in pre-schoolage children. ADHD symptoms typically begin in the preschool years, during which early interventions could plausibly target environmental influences of disorder progression. We examined the association between SDH and symptoms of ADHD—as opposed to diagnosis—in a national sample of children age 3 to 5 years old using structural equation modeling (SEM), a technique that combines factor analysis with multiple regression in one model. Because SEM allows examination of multiple measured variables and underlying constructs represented by those variables simultaneously, we could build this model based on individual ADHD symptoms in preschoolers as opposed to parent-reported diagnosis, and individual SDH as opposed to a composite measure of socioeconomic disadvantage. We also used this model to examine potential mediators of the association between SDH and ADHD symptoms.

Methods

Data Source

We used data from the 2016 National Survey of Children's Health (NSCH), a population-based survey of one primary caregiver for each child designed to produce nationally-representative data on the physical and emotional health of American children 0 to 17 years old. One child is selected at random from all children in each household to be the subject of the survey, with oversampling of children age 0 to 5 and Children with Special Health Care Needs. The survey is run by the United States Census Bureau on behalf of the United States Department of Health and Human Services, Health Resources and Services Administration's Maternal and Child Health Bureau (MCHB). More information about survey administration, the dataset, and questionnaires are publicly available on the MCHB website (Maternal and Child Health Bureau, n.d.; U.S. Census Bureau, 2016).

Candidate Independent Variables (SDH)

Specific SDH were measured by questions in the NSCH questionnaire. The SDH variables tested in the model were: percentage of federal poverty level; primary caregivers' education level; number of parents living at home (biological or adoptive); primary caregivers' employment status; physical health of primary caregivers; mental health of primary caregivers; difficulty accessing basic needs; difficulty affording food; difficulty accessing needed healthcare; housing instability; problems with child care; lack of access to preschool. We included adverse childhood experiences (ACEs) as a cumulative risk index (Brown et al., 2017; Felitti et al., 1998) (range 0–8), with some hesitation since these do not represent—but are likely to covary with—socioeconomic disadvantage (Chen et al., 2019).

Candidate Outcome Variables ADHD Symptoms

We chose to include symptoms instead of ADHD diagnosis because preschoolers with inattention and hyperactivity symptoms are often not yet diagnosed with ADHD (Applegate et al., 1997; Wilens et al., 2002). We used four items that assessed for inattention and hyperactivity from the 22-item "Healthy and Ready to Learn" survey content, new in the 2016 survey, which was designed to measure school readiness in 3 to 5 year-olds (Ghandour et al., 2019). The four items were: (1) Difficulty working until finished ("How often does this child keep working at something until he or she is finished?"); (2) Difficulty sitting still ("Compared to other children his or her age, how often is this child able to sit still?"); (3) Difficulty following instructions ("When he or she is paying attention, how often can this child follow instructions to complete a simple task?"); and (4) Easily Distracted ("How often is this child easily distracted?").

Primary caregivers answered all of these questions on a 4-point Likert scale, indicating the extent to which each item was true for their child: (1) All of the time; (2) Most of the time; (3) Some of the time; or (4) None of the time. For the analysis, item 4 (easily distracted) was reverse-coded so that for all items, higher scores represented more difficulty. We dichotomized all items such that an answer of 1 or 2 (All or Most of the time) was counted as presence of a symptom, while an answer of 3 or 4 (Some or None of the time) was considered as absence of a symptom, consistent with DSM-5 ADHD criteria and the scoring structure of standardized ADHD diagnostic rating scales (American Psychiatric Association, 2013; Bard et al., 2013; Wolraich et al., 2013).

Sociodemographic Covariates

Consistent with other studies, we adjusted for age and gender in our model in order to control for possible confounding (Schmiedeier et al., 2014). We controlled for age because attention and hyperactivity typically decline with age (Spencer et al., 2007) and developmental expectations for a child's attention change throughout this age range. We controlled for gender because ADHD symptoms are more common in boys than girls (Willcutt, 2012).

Data Analysis

Data analysis was conducted in MPlus 8 (Muthén & Muthén, 1998-2017), which utilizes full information maximum likelihood (FIML) estimation to handle missing data. Sample weights were used to adjust for probability of selection and non-response as well as the demographic distribution of non-institutionalized U.S. children. Variables were coded such that higher numbers represented worse situations (e.g. higher levels of poverty, increased ADHD symptoms). The total sample (N = 7,565 children) was divided into two random groups ($N1$ = 2522, $N2$ = 5043). The first third of the sample ($N1$ = 2522) was used to conduct an exploratory factor analysis (EFA) to determine the factor structure of each construct and make preliminary choices regarding inclusion of items. The remaining two-thirds of the sample ($N2$ = 5043) was used to test an exploratory structural equation model (ESEM) predicting emerging ADHD symptoms as a function of SDH. The size of the former sample was considered adequate for

EFA, while the larger sample was devoted to ESEM to provide more accurate parameter estimates.

Like other forms of structural equation modeling, ESEM: (a) allows for a priori tests of latent factor models; (b) includes multiple regression to simultaneously test relationships among multiple factors, and (c) includes indices of overall model fit to observed data. Unlike standard structural equation models, ESEM relaxes overly restrictive assumptions regarding factor loadings that are common to confirmatory factor models, thus resulting in better model fit (Asparouhov & Muthén, 2009; Marsh et al., 2014). Weighted least squares means and variance adjusted (WLSMV) estimation was used for all analyses to account for the categorical nature of the independent and dependent indicators. Standard fit indices were used to assess model fit (non-significant Chi Square; Root Mean Square Error of Approximation [RMSEA] $< .10$; Comparative Fit Index [CFI] and Tucker-Lewis Index [TLI] $> .90$; Kline, 2016). To minimize the possibility of false positive findings we pre-specified the significance level, α, to 0.001.

Results

Descriptive Statistics

Primary caregivers of 7,565 children age 3 to 5 years old completed the 2016 NSCH. Descriptive statistics of the sample, including sociodemographics and frequencies for both independent and outcome variables included in the final model, are shown in Table 1. The weighted sample was 50.9% male, 58.9% white, and 23.3% of Hispanic/Latino ethnicity.

EFA #1: Factor Structure of SDH

Several variables were excluded based on evaluation of construct validity as determined by an interdisciplinary team including researchers in psychiatry, pediatrics, psychology, and epidemiology, as well as fit to observed data. Excluded variables at this stage included problems with child care, access to preschool, and housing instability, which yielded models with inadequate fit to the observed data. Cumulative ACEs (rank 0–8) was also excluded for inadequate fit to the observed data (RMSEA > .05, CFI < .90, TLI < .90). EFA with the remaining variables indicated a three-factor solution for SDH using the criterion of Eigenvalues greater than 1 (see Figure 1) (Henry F. Kaiser, 1960). Although the $\chi 2$ test of model fit was significant, this was expected given the large sample size, and all other fit indices were consistent with good model fit: $\chi 2(12) = 22.39$, $p < .05$, RMSEA = .019, CFI = .992, TLI = .975. Three items loaded best onto Factor 1 ("socioeconomic status"), with factor loadings ranging from .60 to .76. Three items loaded best onto Factor 2 ("access to basic needs") with factor loadings ranging from .59 to .77. Two items loaded best onto Factor 3 ("caregiver well-being"), with factor loadings ranging from .69 to .84. Results for "employment of primary caregivers" were equivocal, as the indicator demonstrated low but significant loadings on both the socioeconomic status (.32) and the caregiver well-being factor (.35).

EFA #2: Factor Structure of ADHD Symptoms

EFA indicated a one-factor solution for ADHD symptoms using the criterion of Eigenvalues greater than 1 (see Figure 2). Fit indices were consistent with good model fit: $\chi 2(2) = .27$, $p = .88$, RMSEA = .00, CFI = 1.00, TLI = 1.01. Standardized factor loadings were all significant and above .40 (range = .72– .86). To assess the validity of this 4-item construct as a marker of children at high risk for ADHD, we conducted an independent samples t-test to determine whether children with a reported ADHD diagnosis (3.0% of weighted sample) had a higher number of symptoms. Children with an ADHD diagnosis had significantly more ADHD symptoms ($M = 3.24$, $SD = 1.05$) than children without an ADHD diagnosis ($M = 0.76$, $SD = 1.03$), $t(292{,}470.82) = 1{,}235.20$, $p < 0.001$.

Predicting ADHD Symptoms as a Function of SDH

We used Exploratory Structural Equation Modeling (ESEM) to examine whether each of the three factors from the SDH model predicted ADHD symptoms, controlling for age and gender. We first examined models using only one SDH factor at a time to predict ADHD symptoms. All three of these models were consistent with good model fit. Lower Socioeconomic Status ($\beta = .49$, $p < .001$), less Access to Basic Needs ($\beta = .49$, $p < .001$), and decreased Caregiver Well-being ($\beta = .75$, $p < .001$) were each significantly associated with ADHD symptoms. A second model included all three latent factors from the SDH model and allowed them to covary. In addition, the "employment of primary caregivers" indicator was allowed to crossload on both the Socioeconomic Status and Caregiver Well-being latent factors. Results are summarized in Figure 3. The overall model displayed good model fit ($\chi2[82] = 172.43$, $p < .05$, RMSEA = .02, CFI = .97, TLI = .96). Only decreased Caregiver Well-being ($\beta = .39$, $p < .01$) was significantly associated with ADHD symptoms in the final model. Socioeconomic Status ($\beta = .12$, $p = .14$) and Access to Basic Needs ($\beta = .08$, $p = .32$) were not significantly associated with ADHD symptoms. Parents of children who were female ($\beta = -.22$, $p < .001$) and older ($\beta = -.09$, $p < .05$) reported significantly fewer ADHD symptoms.

Caregiver Well-Being as a Mediator of the Relationship between SDH and ADHD Symptoms

A final model included all three latent factors from the SDH model, specifying caregiver well-being as a mediator in the relationship between SDH and ADHD symptoms. This model was consistent with good fit ($\chi2[82] = 172.43$, $p < .05$, RMSEA = .02, CFI = .97, TLI = .96). All factor loadings and direct effects remained the same as in the previous model. Direct effects between Socioeconomic Status, Access to Basic Needs, Caregiver Well-being, and ADHD symptoms are shown in Figure 4. Caregiver well-being fully mediated the relationship between socioeconomic status and ADHD symptoms (total effects = .22, $p < .001$; indirect effects = .11, $p < .05$) and the relationship between access to basic needs and ADHD symptoms (total effects = .25, $p < .001$; indirect effects = .17, $p < .01$).

Discussion

Using a nationally representative dataset, we found that the well-being of primary caregivers (including physical health, mental health, and employment status) mediated the association between SDH and ADHD symptoms in preschool-age children. Worse caregiver well-being was associated with higher levels of ADHD symptoms in preschoolers. Socioeconomic status (including income, education level, and number of parents living at home) and access to basic needs (including access to food, basic needs, and healthcare) were no longer significantly associated with ADHD symptoms in the model including all three factors. While multiple previous studies have shown links between various SDH and ADHD, to our knowledge this is the first study demonstrating that this association is fully mediated by worse caregiver well-being, rather than poverty itself.

There are a few possible explanations for our finding. One possibility is that poor caregiver health may decrease the quality time spent by a caregiver with their child, thus leading to or exacerbating ADHD symptoms in young children. In support of parenting involvement as a contributor, Russell et al. (2015) found that parenting involvement at age 6 partially mediated the association between ADHD diagnosis and several markers of socioeconomic disadvantage (financial difficulty, living in public housing, younger or single mothers) in a large, representative longitudinal UK birth cohort. In another longitudinal study, early home learning environment mediated the association between SES and ADHD symptoms in a community sample of school-age children in Germany (Schmiedeier et al., 2014).

Another possibility is that ADHD symptoms in young children worsen caregiver health and reduce likelihood of employment. Previous literature has documented high stress and depression in parents of children with ADHD (Theule et al., 2013). In the National Longitudinal Survey of Children and Youth, caregiver depressive and general health symptoms worsened with increasing complexity of child health problems (Brehaut et al., 2011), suggesting that childhood illness affects caregiver health. Other data suggests that having a child with ADHD may lead to a change of job or employment status (Flood et al., 2016).

One contributor to this finding could be a common genotype in both the caregiver and child. ADHD has high heritability (0.6–0.8) (Biederman & Faraone, 2005; Spencer et al., 2007), and thus both caregiver and child may have had a genetic predisposition to ADHD. This would explain both ADHD symptoms in the preschoolers and lower mental and physical health of their parents. The NSCH did not measure ADHD symptoms in caregivers, but ADHD is a chronic condition that is associated with lifelong morbidity, including higher prevalence of other psychiatric disorders, medical disorders including asthma and obesity, and decreased occupational success (Biederman et al., 2012; Uchida et al., 2015). Furthermore, parenting with ADHD may be related to low parental involvement or lack of parental consistency that may worsen ADHD symptoms in children, as well as parenting-induced stress that may further worsen mental health of parents (Johnston et al., 2012). Limited research has also suggested that parental ADHD can worsen treatment engagement and limit improvement with parent training interventions (Sonuga-Barke et al., 2002). This may explain some of the relationship between socioeconomic disadvantage and treatment resistance (Rieppi et al., 2002).

However, heritability is not likely to be the sole explanation for our findings. Environmental factors do explain some of the variance in ADHD etiology, and life stressors may have important epigenetic effects contributing to ADHD psychopathology (Hamza et al., 2019). Rather than simply confirming heritability of ADHD, our findings extend the current understanding of how nature and nurture interact to influence the development of ADHD symptoms in young children.

Our findings suggest that interventions focused on the well-being of caregivers with young children might have promise for mitigating the development of ADHD or reducing its severity in young, socioeconomically disadvantaged children with emerging ADHD symptoms. ADHD in preschoolers is typically chronic and impairing even with existing evidence-based treatments (Riddle et al., 2013), and socioeconomic disadvantage further worsens outcomes (Ghuman et al., 2007). Most evidence supports behavioral interventions (Mulqueen et al., 2015) as well as medication management (Riddle et al., 2013) for preschoolers with ADHD, but intervening specifically on caregiver well-being has not been as well-tested. There is emerging evidence that interventions focused on improving the relationship between parent and child such as Parent-Child Interaction Therapy (PCIT) may lead to modest improvements in ADHD symptoms as well as reduction in parent stress (van der Veen-Mulders et al., 2018). Further testing of these interventions and their impact on caregiver health is needed. For other child mental health problems, there is emerging evidence that treating parental depression can improve youth psychiatric outcomes. Swartz et al. (2016) reported that improvement of maternal depression led to improvement in adolescent depressive symptoms in a randomized trial of treatment for maternal depression in high-risk families. For young children with ADHD, assessment and treatment of parental mental and physical health conditions could also be an important early intervention strategy, and warrants further investigation.

Our study has a few limitations. Because this is cross-sectional data, we are unable to determine the directionality of our association. We were also limited by the variables collected. It is possible that our findings are confounded by other variables not measured in the survey or not included in our analysis. More parent variables, including parent ADHD diagnosis and symptoms, would have been particularly helpful but were not specifically measured in the NSCH. Some of the SDH we would have liked to include in the final model (e.g., unmet need for childcare) were not adequately measured by existing variables for our purpose, or did not fit our model and so were not used. The ADHD symptom variables were not specifically designed as a measure of ADHD risk, although they were adapted from existing, validated questionnaires on child behavior and development and in discussion with experts in the field (Ghandour et al., 2018, 2019). Finally, because these were parent-report symptoms, it is possible that caregivers with worse health over-report ADHD symptoms in young children.

Conclusion

This is the first study to demonstrate that the association between adverse SDH and ADHD symptoms in preschoolers is fully mediated by caregiver well-being. Our analysis of a large, nationally representative sample was unique in that we used parent report of ADHD symptoms, instead of diagnosis, in order to not miss affected children pre-diagnosis. Results suggest that caregiver well-being is a possible early intervention target for young children with emerging ADHD symptoms.

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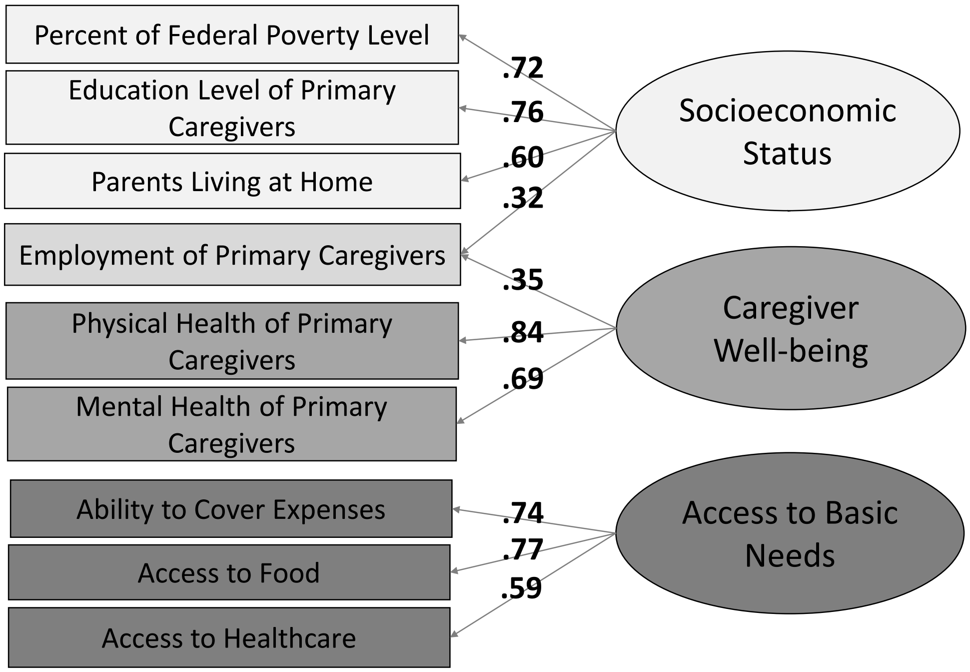
Table 1. Sociodemographic Characteristics and Variable Frequencies (SDH and ADHD Symptoms) among Preschool-Age Children
From the 2016 National Survey of Children's Health.

	N (unweighted)	% (Weighted)
Sex		
Male	3,968	50.9
Female	3,597	49.1
Age		
Three	2,530	33.2
Four	2,537	34
Five	2,498	32.8
Race		
White	5,773	58.9
Black	472	12.2
Asian	445	5.1
Other/multi-racial	875	6.9
Hispanic/latino ethnicity	834	23.3
ADHD symptoms (all or most of the time)		
Difficulty working until finished	1,123	29.5
Difficulty sitting still	2,126	26.2
Difficulty following instructions	623	10
Easily distracted	1,807	16.2
Ability to cover expenses (difficulty covering basic expenses)		
Never	3,631	42.9
Rarely	2,396	31.6
Somewhat often	1,054	19.1
Very often	356	6.3
Access to food		
Always afford to eat good nutritious meals	5,613	69.6
Always afford enough to eat but not always kind of food we should	1,502	24.7
Sometimes we could not afford enough to eat	256	5
Often we could not afford enough to eat	40	0.6
Access to healthcare (difficulty accessing needed healthcare)		
No	7,403	97.1
Yes	132	2.9
Employment of primary caregivers		
At least one primary caregiver employed	6,573	94.2
No primary caregivers employed	263	5.8
Education level of primary caregivers (highest degree completed by at least one caregiver)		
College degree	4,916	53.5
Some college/technical degree	1,784	22.5
High school/GED	554	16

Less than high school	153	8
Mental health of primary caregivers		
Primary caregivers have good, very good, or excellent mental health	6,396	92.6
At least one primary caregiver with fair/poor mental health	425	7.4
Physical health of primary caregivers		
Primary caregivers have good, very good, or excellent physical health	6,343	89.7
At least one primary caregiver with fair or poor physical health	470	10.3
Parents living at home (number of biological or adoptive parents living in the home)		
Two	6,266	77.9
One	895	15.3
Zero	290	6.9
Percent of federal poverty level		
400% or greater	3,088	29.9
200–399%	2,486	29.2
100–199%	1,235	20.6
0–99%	756	20.2

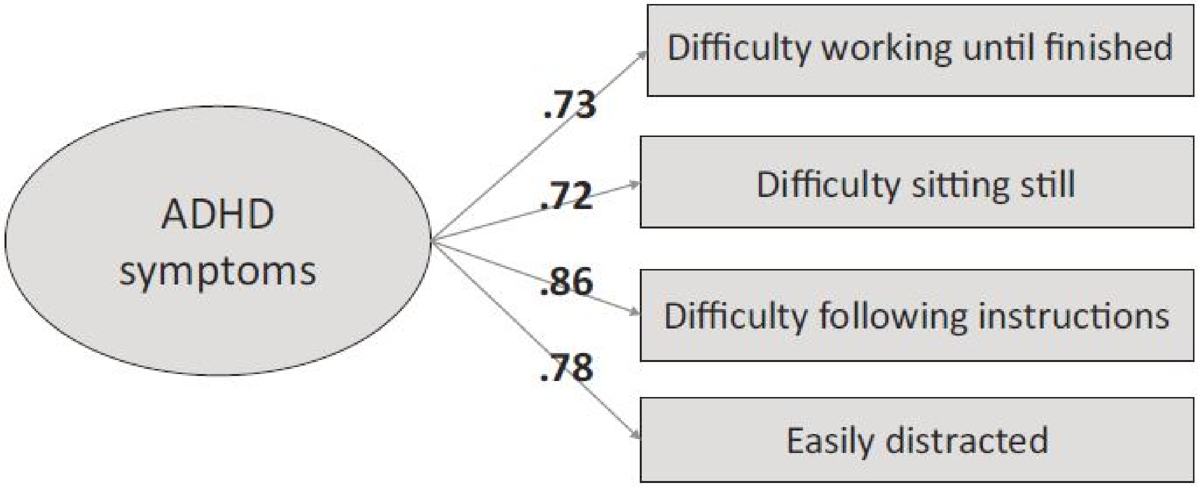
Note. ADHD = attention-deficit/hyperactivity disorder; SDH = social determinants of health; GED = general education diploma.

Figure 1. Exploratory Factor Analysis with SDH Variables from the 2016 National Survey of Children's Health results in a 3-factor solution.



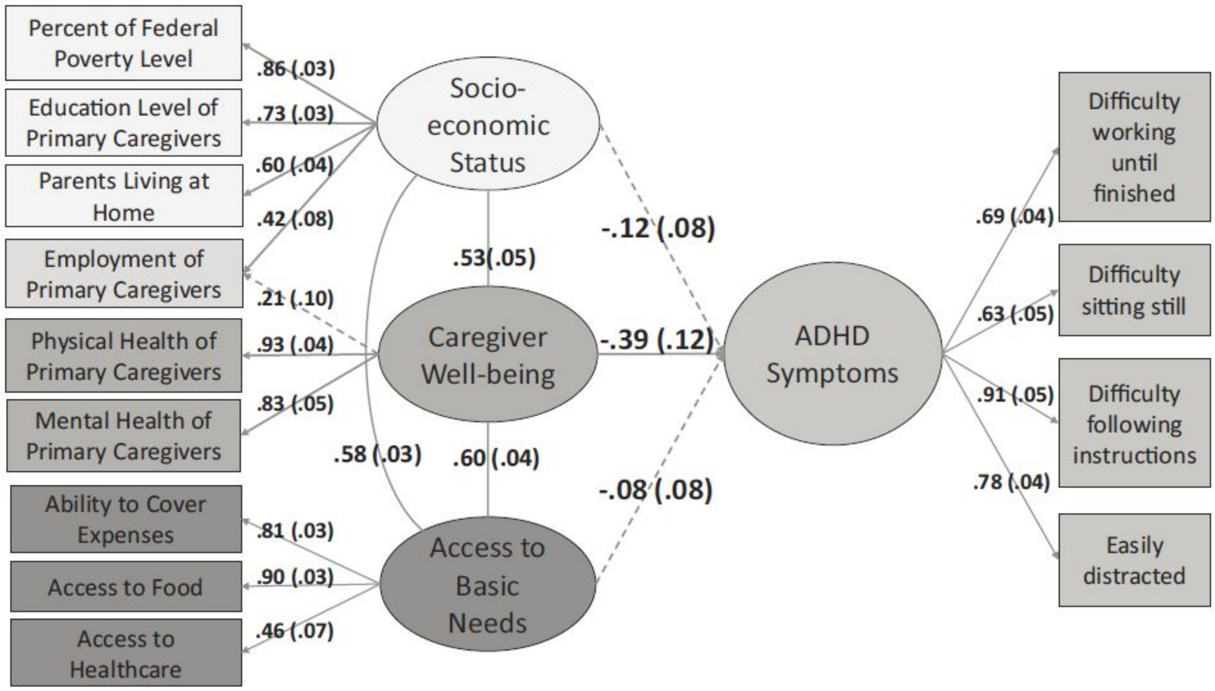
SDH=Social Determinants of Health

Figure 2. Exploratory factor analysis with ADHD symptoms from the National Survey of Children's Health yields a one factor solution.



Note. ADHD = attention-deficit/hyperactivity disorder.

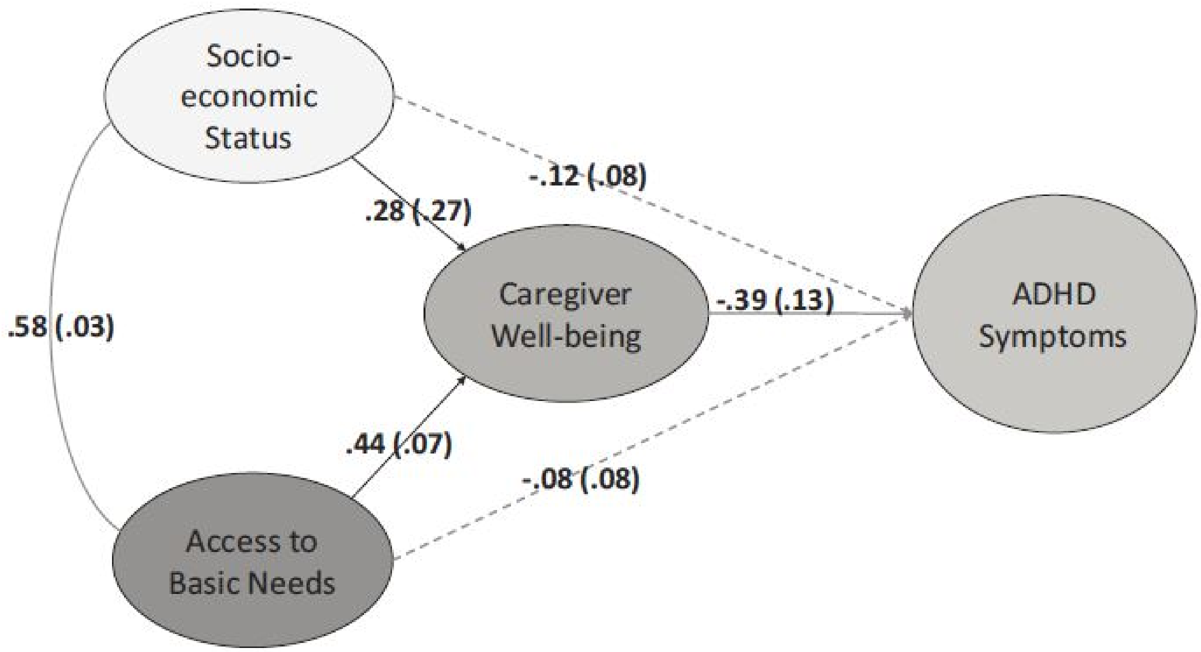
Figure 3. Exploratory structural equation model predicting ADHD symptoms in preschoolers as a function of SDH factors, controlling for age and sex.*



Note. ADHD = attention-deficit/hyperactivity disorder; SDH = social determinants of health.

*Solid lines represent statistically significant relationships. Dotted lines represent non-statistically significant relationships in the final model.

Figure 4. Mediation model testing caregiver well-being as a mediator between other SDH factors and ADHD symptoms.*



Note. Model is controlled for age and sex. ADHD = attention-deficit/hyperactivity disorder; SDH = social determinants of health.
*Solid lines represent statistically significant relationships. Dotted lines represent non-statistically significant relationships.