# Racial/Ethnic Disparities in Attention Deficit/Hyperactivity Disorder Diagnosis at Kindergarten Entry: Evidence from a Nationally Representative Sample of U.S. Children

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**Abstract**

We analyzed data from a nationally representative, longitudinal sample of children (*N*=6,550) participating in the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B) to identify 24-month socio-demographic, gestational, birth, and additional child- and family-level characteristics predictive of a parent-reported attention-deficit/hyperactivity disorder (ADHD) diagnosis by 60 months of age. In particular, we investigated whether and to what extent racial/ethnic disparities in ADHD diagnosis were evident by kindergarten entry. Results indicated that Black children are 66% (1 - *OR* of .34) less likely to receive an ADHD diagnosis than Whites. This disparity was evident despite extensive statistical control for many confounds. Hispanic children initially appeared also to be under-diagnosed for ADHD. However, their disparity was explained by whether a language other than English was primarily spoken in the home. Follow up analyses of kindergarten teacher-reported classroom behavior indicated that neither Blacks nor those primarily speaking a language other than English in the home displayed less frequent ADHD-related symptomology than Whites. Other groups of children (e.g., children with very low birth weight, those whose mothers reported that they or their families had experienced mental illness) were at greater risk of an ADHD diagnosis, but these groups also displayed increased rates of ADHD-related symptomology. In contrast, children who are Blacks or primarily speaking non-English at home were less likely to be diagnosed with ADHD, but were not less likely to display ADHD symptomology.

# Racial/Ethnic Disparities in Attention Deficit/Hyperactivity Disorder Diagnosis at Kindergarten Entry: Evidence from a Nationally Representative Sample of U.S. Children

Between 2-8% of U.S. preschool and kindergarten children have attention-deficit/hyperactivity disorder (ADHD) (Egger & Angold, 2006; Egger, Kondo, & Angold, 2006). ADHD is the most common diagnosis for young children referred for mental health services (Gadow, Sprafkin, & Nolan, 2001; Keenan & Wakschlag, 2000; Willens, Biederman, & Spencer, 2002). Receipt of an ADHD diagnosis allows children entering kindergarten to receive specialized adapted educational services as well as behavioral therapy and prescription medication (Scheffler, et al., 2009). Receipt of these treatments can improve academic and behavioral functioning over time (American Academy of Pediatrics Subcommittee on Attention-Deficit/Hyperactivity Disorder and Steering Committee on Quality Improvement and Management, 2011; MTA Cooperative Group, 1999; Powers, Marks, Miller, Newcorn, & Halperin, 2008). Identifying risk factors for ADHD diagnosis, particularly as early as kindergarten, can inform screening, monitoring, and treatment delivery efforts by mental health professionals, pediatricians, and preschool- and school-based staff at an age when these efforts may be maximally effective.

## Limited Knowledge Base about Early Risk Factors for ADHD Diagnosis

Yet limited knowledge exists about factors associated with young children's risk of an ADHD diagnosis. Extant work has mostly analyzed clinic-referred samples (Barnow, Schuckit, Smith, & Freyberger, 2006; Biederman, Petty, Evans, Small, & Faraone, 2010; Doyle, Biederman, Seidman, Reske-Nielsen, & Faraone, 2005; Hervey-Jumper, Douyon, & Franco, 2006; Mick, 2002; Mick, Biederman, Faraone, Sayer, & Kleinman, 2002; Mick, Biederman, Prince, Fischer, & Faraone, 2002; Seidman, et al., 2005). Generalizability to the heterogeneous

population of U.S. children, particularly racial/ethnic minorities, is limited because clinic-referred samples typically consist mostly of White children and over-represent males and those with more severe symptoms (Brassett-Harknett & Butler, 2007). Comparatively few studies have analyzed population-based or nationally representative samples (Braun, Kahn, Froehlich, Auinger, & Lanphear, 2006; Froehlich, et al., 2007; Sauver, et al., 2004; Schneider & Eisenberg, 2006; Sciberras, Ukoumunne, & Efron, 2011). St. Sauver et al.'s (2004) analysis indicated that males and those with less-educated parents were more likely to be diagnosed with ADHD. Braun et al.'s (2006) analyses indicated that racial/ethnic minorities and females were under-diagnosed as ADHD. Scriberras et al.'s (2011) indicated that males, children raised by less-educated parents, and those whose mothers frequently smoked during pregnancy were more likely to be diagnosed as ADHD. Sagiv, Epstein, Bellinger, and Korrick's (in press) reported that low paternal education, smoking, drug use, maternal depression, and lower quality home environments were risk factors for ADHD diagnosis.

However, the existing studies using large-scale samples also have methodological and substantive limitations. Methodologically, extant studies have sometimes used cross-sectional designs (Braun, et al., 2006; Cuffe, Moore, & McKeown, 2005; Pastor & Reuben, 2005), analyzed later (e.g., diagnosis by 3rd grade) time periods (Schneider & Eisenberg, 2006), have not been designed to generalize to the heterogeneous U.S. population (Sagiv, et al., in press), or analyzed non-U.S. samples (Sciberras, et al., 2011). Potentially strong confounds have typically not been statistically controlled (e.g., lower SES, prior level of cognitive functioning, the quality of children's home environments). Prior work has also failed to control for the autoregressive effects of prior level of learning-related behavioral functioning (e.g., attention, task persistence). This limitation has likely resulted in less accurate estimates of the risk attributable to any

particular factor. Inclusion of autoregressive learning-related behavioral functioning would provide stronger evidence of the risk attributable to other types of factors that may themselves be causally related to the etiology of ADHD, particularly as it relates to children's early learning environments. Measuring multiple learning-related behaviors should also help identify the specific behavior(s) most predictive of ADHD diagnosis (e.g., attention vs. task persistence vs. frustration). For example, the ability to persist at cognitively or academically demanding tasks has been hypothesized to be especially relevant to ADHD (Hoza, Pelham, Waschbusch, Kipp, & Owens, 2001). Task persistence has been reported to better distinguish children with ADHD than frustration (Scime & Norvilitis, 2006) or limited attention span (Balint, Czobor, Komlosi, Meszaros, Simon, & Bitter, 2008).

An additional substantive limitation is incomplete knowledge about which socio-demographic, gestational, birth, family history, parenting, and other home characteristics occurring in children's early life most strongly predict the likelihood of ADHD diagnosis by kindergarten entry. Kindergarten entry is a particularly important time because children's academic and behavioral difficulties often persist across their early elementary years (Juel, 1988; Kieffer, 2008; Morgan, Farkas, & Qiong, 2009). ADHD symptomology quickly becomes developmentally persistent (Daley, Jones, Hutchings, & Thompson, 2009; Lahey, et al., 2004). The timing of onset of racial/ethnic disparities in ADHD diagnosis is largely unknown, as is whether and to what extent these disparities are mediated by socio-demographic, gestational, birth, parenting, home environment, or other child characteristics. Societal mechanisms that may be contributing to racial/ethnic disparities in ADHD in very young U.S. children have yet to be empirically investigated, particularly in a large-scale, longitudinal sample (Bailey, et al., 2010; Samuel, et al., 1998).

**Racial/Ethnic Disparities in ADHD Diagnosis**

Racial/ethnic minority children may be less likely to receive an ADHD diagnosis, and so have unmet treatment needs (Froehlich, et al., 2007; Mehta, Nagar, & Aparasu, 2003; Schneider & Eisenberg, 2006). A recent research synthesis reported that Black children are diagnosed with ADHD at two thirds the rate of white children, despite displaying much greater ADHD symptomatology (Miller, Nigg, & Miller, 2009). Hispanics and other racial/ethnic groups may also be less likely than otherwise identical whites to receive an ADHD diagnosis (Blumberg, Read, Avila, & Bethell, 2010; Froehlich, et al., 2007), although less is known about the experiences of these other groups (Guevara, et al., 2005). Racial/ethnic minority children may be less likely to be diagnosed with ADHD because their families have less access to health professionals (Coker, et al., 2009) and, when seen, receive fewer solicitations by professionals of developmental concerns (Guerrero, Rodriguez, & Flores, 2011). Additional hypothesized mechanisms include limited ability to pay for health care, non-English language use, and negative socio-cultural views towards disability and the resulting potential stigma (Hervey-Jumper, Douyon, Falcone, & Franco, 2008; Olaniyan, et al., 2007).

Investigating racial/ethnic minority disparities in a large-scale, nationally representative, and longitudinal sample of children from kindergarten entry would better establish whether disparities are occurring and the time period in which they begin. Extant work suggests that racial/ethnic disparities in ADHD diagnosis occur in older, school-aged populations (Miller et al., 2009; Pastor & Reuben, 2005), but whether and to what extent these disparities occur as early as kindergarten entry is unknown (Miller, et al.; Samuel, et al., 1997). Establishing that racial/ethnic disparities in ADHD diagnosis occur by kindergarten entry would suggest the need for culturally sensitive screening and monitoring efforts at early ages to ensure that racial/ethnic

minority children with ADHD are appropriately diagnosed and treated by school entry (Subcommittee on Attention-Deficit/Hyperactivity Disorder Steering Committee on Quality Improvement and Management, 2011). However, accurate estimation of racial/ethnic disparities in ADHD diagnosis requires statistical control of many factors that may function as confounds, including minority children's higher exposure to low birthweight, low maternal education, low household income, and single parent families, (Breslau & Chilcoat, 2000; Froehlich, et al., 2007). For example, control for SES is important because lower SES increases the risk of a disability referral generally (e.g., Delgado & Scott, 2006), and ADHD diagnosis specifically (Claycomb, Ryan, Miller, & Schnakenberg-Ott, 2004).

**Study's Purpose**

We sought to identify socio-demographic, gestational, birth, and additional child- and family-level characteristics associated with U.S. children's receipt of an ADHD diagnosis by kindergarten entry. We were particularly interested in whether and to what extent racial/ethnic minority diagnosis disparities were already occurring by kindergarten entry. We estimated racial/ethnic minority children's risk both prior to and after extensive statistical control for many individual characteristics that might themselves increase the risk for an ADHD diagnosis and so result in any observed disparities, as well as societal mechanisms that previously have been theorized to help explain racial/ethnic disparities in ADHD diagnosis (i.e., limited health care access, non-English language in the home). We also examined whether and to what extent those population subgroups at greater or less risk of receiving an ADHD diagnosis were, correspondingly, more or less likely to display ADHD symptomology. We designed the study to extend prior work by (a) analyzing a nationally representative, longitudinal dataset and (b) accounting for many potential confounds, thereby providing rigorously derived estimates for a

wide range of factors (measured by when children were 24 months old) that might predict these children's receipt of ADHD diagnosis as they entered kindergarten.

## Method

### Database and Analytical Sample

We analyzed data collected from children and their families participating in the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B), a dataset maintained by the National Center for Education Statistics (NCES). The ECLS-B is a longitudinal cohort study representative of the population of children born in the U.S. in 2001. NCES originally recruited 10,200[1] participants including those from diverse socioeconomic and racial/ethnic backgrounds, and oversampled Asian and Pacific Islanders, Native Americans and Alaska Natives, low (1,500 - 2,500 g) and very-low birthweight (less than 1,500 g) children, and multiple births. The ECLS-B measures the quality of early home, care, and educational experiences, and includes both direct and indirect assessments of children's cognitive, academic, behavioral, and physical functioning. Child assessments were directly administered by ECLS-B field staff. Home interviews were conducted with parents. Data were collected at approximately 9 months (in 2001-02), 24 months (in 2003-04), 48 months (in 2005-06), and 60 months (in the fall of 2006 or 2007) after birth. Additional information about the ECLS-B is available at http://nces.ed.gov/ECLS/birth. This study's analyses were based on birth certificate data as well as data collected directly from children and their parents at 24- and 60-months. Our analytical sub-sample of children ($N$ = 6,550) included those with and without an ADHD diagnosis at 60 months. Missing data on predictor variables were multiply imputed (using five datasets) with the IVEWARE software add-on to SAS (Raghunathan, Solenberger, & Van Hoewyk, 2002).

[1] All sample sizes reported for the ECLS-B data have been rounded to the nearest 50, as specified by ECLS-B data confidentiality requirements (please see http://nces.ed.gov/ecls/birthdatainformation.asp).

## Measures

**ADHD Diagnosis**. At 60 months, NCES field staff asked parents the following: "Since (child) turned 4 years old, has a doctor has ever told you that your child has the following condition? Does (he/she) have…?" The field staff then presented a list of conditions (e.g., a heart defect, diabetes, epilepsy or seizures, autism, mental retardation), with one response option being ADHD. About 150 children were identified by parents as having an ADHD diagnosis. Parents have repeatedly been found to be valid and reliable reporters on ADHD diagnosis, symptoms, and receipt of treatment (Biederman, Faraone, Milberger, & Doyle, 1993; Biederman, Faraone, Monuteaux, & Grossbard, 2004; Biederman, Gao, Rogers, & Spencer, 2006; Bussing, Mason, Leon, & Sinha, 2003; Faraone, Biederman, & Zimmerman, 2005). For example, Biederman et al.'s (1993) analyses indicated that a clinical diagnosis of ADHD based on parent report was likely to be corroborated by a teacher report, while Faraone et al.'s (1995) reported "both reliability and accuracy were excellent for ADHD" (p. 1001). To further validate whether parents in the ECLS-B sample were accurately reporting their child's ADHD diagnosis status, we examined to what extent children identified by their parents as diagnosed with ADHD by 60 months were also, independently, rated by their kindergarten classroom teachers as displaying learning-related behavior problems (operationalized as having a composite behavioral rating score in the bottom 22% of the score distribution). Of those children identified by their parents as having received an ADHD diagnosis, kindergarten teachers independently rated 71% (weighted) of the children as more frequently engaging in learning-related behavior problems (i.e., more frequently inattentive, less likely to work independently, less likely to finish classroom work, greater difficulty concentrating).

**Socio-demographic characteristics**. Socio-demographic data were also collected using parental report including children's race/ethnicity, age, gender, whether the child was a non-singleton, family SES, mother's age at child's birth, and parental marital status by the 24-month survey. For race/ethnicity, non-Hispanic White was coded as the reference group, and compared to non-Hispanic Black, Hispanic, and other races/ethnicities. We included children's age in months to account for variations in actual age at administration of the assessments. In coding gender, female was the reference category. We analyzed SES using a composite measure of five indicators including father's education, mother's education, father's occupation, mother's occupation, and household income. This allowed us to more fully model SES as a risk factor than in prior studies, which often relied on single (and so less precise) indicators of SES (e.g., eligibility for free and reduced lunch). We divided the SES distribution into quintiles, represented in regressions as a set of dummy variables, allowing us to evaluate whether SES was nonlinearly related to ADHD diagnosis. The first quintile represented the lowest and the fifth quintile represented the highest SES. In single parent families (about 16% of the full sample) SES is estimated using the available information. We also used an indicator of the mother's age at child's birth (35 years old or older vs. under 35 years old). For mother's marital status at the time of assessment, married mothers was the reference category.

**Gestational and birth characteristics**. Data on gestational and birth came from birth certificates. Birthweight was indicated by two dichotomous variables: very low birthweight (coded 1 for $\leq$1500 grams) and moderately low birthweight (coded 1 for 1,501-2,500 grams). We also included count variables for each of several sets of risk factors: obstetrical procedures (induction of labor, stimulation of labor, tocolysis, amniocentesis, and cesarean section); labor complications (abruptio placenta, anesthetic complications, dysfunctional labor,

breech/malpresentation, cephalopelvic disproportion, cord prolapsed, fetal distress, excessive bleeding, fever of > 100$^{o}$F, moderate/ heavy meconium, precipitous labor (< 3 h), prolonged labor (> 24 h), placental previa, or seizures during labor); medical risk factors during pregnancy (incompetent cervix, acute or chronic lung disease, chronic hypertension, pregnancy-induced hypertension, eclampsia, diabetes, hemoglobinopathy, cardiac disease, anemia, renal disease, genital herpes, oligohydramnios, uterine bleeding, Rh sensitization, previous birth weighing 4,000+g, or previous preterm birth); and behavioral risk factors during pregnancy (maternal alcohol and/or tobacco use).

**Vocabulary knowledge.** Lower vocabulary knowledge may increase the occurrence of atypical behavioral functioning (Qi & Kaiser, 2004), so we included vocabulary knowledge as a covariate in analyses. NCES field staff administered a modified version of the MacArthur Communication Development Inventory (M-CDI) (Fenson, et al., 1994) to evaluate children's vocabulary knowledge during the 24-month survey wave. The modified instrument surveyed 50 words typically known and said by children in the target age range. NCES field staff asked parents: "We want to know how children learn language. I'm going to read a list of words that children of different ages sometimes can say. For each word, please say 'yes' if (child) can say it, or 'no' if (he/she) can't say it yet. Can (child) say 'meow,' 'shoe,' 'mommy,'…?" Field staff continued asking whether the child could say additional words or phrases, including "fast," "chase," "us," "thank you," "juice," "all gone," and "them." We summed the number of words parents reported their children were able to say, then analyzed this total score as a continuous variable. The M-CDI vocabulary scales have high internal consistency ($\alpha$=.96) and ratings are highly correlated with scores on other standardized measures (Fenson, et al., 1993). Prior work substantiates the validity of using parent report as a measure of children's vocabulary. For

example, the modified M-CDI classifies children into language status groups with 97% accuracy (Skarakis-Doyle, Campbell, & Dempsey, 2009).

**Cognitive functioning.** Lower cognitive functioning may also elevate children's risk of atypical behavioral functioning generally (Brocki, Eninger, Thorell, & Bohlin, 2010; Willcutt, et al., 2010), as well as ADHD specifically (Willcutt, et al.). Children's cognitive functioning was evaluated using the Bayley Short Form-Research Edition (BSF-R), a modified version of the Bayley Scales of Infant Development, 2nd Edition (BSID-II; Bayley, 1993). The BSF-R includes both a mental and motor scale. The mental scale measures age-appropriate cognitive functioning as manifested in memory, habituation, preverbal communication, problem-solving and concept attainment. Examples of the mental scale items used in the 24-month wave include "imitates a two-word sentence," "builds tower of eight cubes," and "matches three colors." The Bayley's items "challenge young children cognitively and require focused attention, persistence, and cooperation with an examiner" (Raikes, Robinson, Bradley, Raikes, & Hyoub, 2007, p. 134). The IRT reliability coefficient of the BSF-R mental scale at 24 months was .88 (Andreassen, Fletcher, & Park, 2007). The BSF-R maintains the psychometric properties of the BSID-II and accurately measures children's performance over the entire ability distribution (Andreassen, et al.). The $R^2$ between BSF-R and BSID-II scores was 0.99.

**Learning-related behaviors.** ECLS-B field staff used the Behavior Rating Scale-Research Edition (BRS-R) to rate children's behavioral self-regulation at 24 months. The BRS-R was adapted from the Behavior Rating Scale (BRS) (Bayley, 1993) and included 11 interviewer-rated items from the full BRS at the 24 month assessment. These items measured developmentally appropriate behaviors for 24-month-olds (Nord, Edwards, Andreassen, Green, & Wallner-Allen, 2006) including attention to task, persistence, cooperation with an examiner,

and interest in the testing materials. Children's attention-related behaviors were observed and each rated on a 5-point scale (low=1; high=5) while they completed the BSF-R's cognitive and physical tasks. For example, examiners rated the child's attention to task behavior during administration of the Bayley task items from a 1 for "constantly off task, does not attend" to a 5 for "constantly attends." Raikes et al. (2007) report a Cronbach's alpha of 0.92 for the BRS's self-regulatory items. Scores on the BRS were also found to moderately-to-highly correlate with scores on other measures of young children's socio-emotional adjustment (Buck, 1997). We used four items from the BRS to assess children's learning-related behaviors: (a) pays attention to tasks, (b) is persistent in tasks, (c) is frustrated by the tasks, and (d) displays cooperation. We also summed these item scores to create a continuous scale score. The Cronbach's alpha for these items was 0.87.

**Home environment quality.** The quality of children's home environment may be a risk factor for ADHD diagnosis (Khamis, 2006; Sagiv, et al., in press). The quality of children's home environments was measured using a modified version of the Home Observation for Measurement of the Environment (HOME) (Caldwell & Bradley, 1984), a widely used measure of the quality of the child's home environment and parenting (NICHD Early Child Care Research Network, 2005). The ECLS-B modified the measure, retaining a subset of the original measure's 21 items. The HOME score is constructed as a count of items measuring (a) parental activities including reading to the child, telling stories, singing, and taking the child on errands or to public places; (b) having toys, records, books, and audiotapes available in the home; and (c) having a safe and supportive home environment. Some of the HOME score's items were observational, including "respondent responded verbally to the child" and "respondent spanked the child." The interviewer surveyed the parent on other items such as "How often do you tell the

child stories?" and "How many times do you spank your child?" Because the Cronbach alpha for the HOME score was fairly low at .46, NCES advises researchers to consider other alternatives rather than scaling the items. We therefore analyzed a summed score (please contact the study's first author for additional details) of the HOME items (i.e., peerand + pbooks + ptells + psoft + ppull + ptalk + pnospank + rspeak + rverb + rhug + rnospank + rinter + rtoys + rview + rsafe).

**Parenting quality.** Lower quality parenting may also increase children's risk of ADHD (Cussen, Sciberras, Ukoumunne, & Efron, 2012; Keown, 2012). The quality of a parent's interactive support of their child was measured based on videotaped interactions during the Two Bags Task. This is a simplified version of the Three Bags Task, which was used in the Early Head Start Research and Evaluation Project and the NICHD Study of Early Child Care (Nord, et al., 2006). Interviewers read a script to the child's parents, after which, over the next 10 minutes, parents were asked to play with their children. Parents were first asked to interact with their child over a children's picture book (i.e., *Goodnight Gorilla*), then interact with a set of toy dishes. Coding of the videotaped interactions was the same as that for the original Three Bags Task developed for the Early Head Start Research and Evaluation Project and obtained from the measure's developers (Bradley-Smith, O'Brien, Berlin, & Ware, 1999). Of the videotaped interactions, 99.2% consisted of mothers interacting with their children; the remainder involved fathers (0.4%), grandmothers (0.3%), or another relative (0.1%). A composite parent support variable was created for the ECLS-B representing the mean of three types of parent interactions, each scored on a 7 point scale from 1 = very low to 7 = very high. The first type was parental sensitivity. Parents rated as sensitive interacted in ways that were child-centered and focused on responding to the child's needs and capabilities. Parental stimulation of cognitive development was the second type of interaction. Parents rated as stimulating interacted in ways that advanced

the child's cognitive development, typically by using behaviors that were matched or slightly above the child's developmental level or interest. The third type was parental positive regard. Parents rated as displaying positive regard were observed to listen to the child, watch attentively, look into the child's face when talking to him or her, and to give praise. Mean inter-rater reliability for the parent rating scales was 97%, with mean reliabilities of 97%, 93%, and 94% for sensitivity, cognitive stimulation, and positive regard, respectively (Andreassen, et al., 2007).

**Mother's or her family's history of mental illness.** Impaired maternal mental health is a risk factor for childhood ADHD (Sagiv, et al., in press). To determine the family's history of mental illness, during the 24-month wave mothers were asked "Now thinking about your relatives, whether they live with you or not, have you or any of your blood relatives every had..." with the field staff reading from a list of conditions (e.g., "asthma," "allergies," "diabetes"), including "a serious mental illness, such as schizophrenia, a paranoid disorder, a bipolar disorder, or manic episodes?" If the child's mother answered "yes" to this specific question, a value of 1 was given to the dummy variable (i.e., variable "p2menill").

**Limited access to health insurance.** Limited access to health insurance may limit children's ADHD diagnosis and care (Rushton, Fant, & Clark, 2004). We coded as "1" those parents who reported that their child had no health insurance, had a gap in insurance coverage since the last interview, or had ever had a need for health care and could not obtain it.

**Non-English as primary language in the home.** Parental limited English-language proficiency may lessen children's likelihood of receiving a diagnosis and treatment for ADHD (Rothe, 2005). Parents reported during the 24-month home interview whether their child lived in a household where English was not the primary language spoken at in the home (coded as "1").

**ADHD Symptomology at 60 months.** Kindergarten teachers were surveyed on children's classroom behavior. We identified 4 behaviors that related to learning-related behaviors, and so ADHD symptomology. These were: (a) "child is eager to learn"; (b) "child pays attention well"; (c) "child works independently"; and (d) "child finishes tasks." Teachers used the following scale: (a) 1 = *never shows this type of behavior*; (b) 2 = *rarely shows this type of behavior*, (c) 3 = *sometime shows this type of behavior*; (d) 4 = *often shows this type of behavior*, and (e) 5 = *very often shows this type of behavior*. We summed the values for these variables, with higher values indicating better classroom behavior. The Cronbach alpha for the four behaviors was 0.89.

**Analytical Strategies**

We estimated six multiple logistic regression models to identify factors measured by 24-months-of-age that increased children's risk of being diagnosed with ADHD by 60-months-of-age. Model 1 estimated to what extent children's race/ethnicity predicted their ADHD diagnosis at 60 months. Model 2 then added children's or their family's socio-demographic characteristics to examine whether these variables partially or fully mediated the effects of children's race/ethnicity on the ADHD diagnosis. Model 3 estimated whether children's birth and gestational characteristics further mediated the risk attributable to children's race/ethnicity. Model 4 included children's prior levels of vocabulary knowledge and cognitive functioning. Model 5 included the prior history of learning-related behavioral functioning, as indicated by the composite scale score, as well as indicators of the quality of the child's home environment and parenting. Model 6 replaces the learning-related behaviors scale with the individual learning-related behavioral items. Doing so helped identify the specific learning-related behaviors that might increase children's risk of receiving an ADHD diagnosis. Also included in Model 6 was

whether the family had limited access to health insurance and whether the family spoke a language other than English in the home. Table 1 displays the sample's descriptive statistics; Table 2 displays the *OR* coefficients for logistic regression Models 1-6. Table 3 shows similar regressions but with the dependent variable being whether or not the child scored low on the 60-month composite measure of attentive behavior. This allowed us to examine whether the groups with unusually high or low ADHD diagnosis rates in Table 2 displayed unusually high or low ADHD symptomology. These regression analyses accounted for sampling weight and design effects to account for oversampling and the ECLS-B's stratified cluster design (i.e., WKICO and both Strata and PSU variables). We used SAS version 9.2 to conduct all analyses.

## Results

Table 1 displays the *M*s and (for the continuous variables) *SD*s of the analytical sample. Of this sample, 2.42% had received an ADHD diagnosis by 60 months of age. Table 2 reports logistic regressions predicting the odds of ADHD diagnosis. Model 1 shows the results when only race/ethnicity is used to predict ADHD diagnosis. Black and Hispanic children have odds that are well below those of Whites. However, they are not statistically significant. Model 2 adds child and family socio-demographic characteristics to the logistic regression equation. With these variables statistically controlled, children who are Black or Hispanic are found to have very low, statistically significant odds of ADHD diagnosis (*OR*s of .38 and .37, respectively) compared to children who are White. These initial *OR*s are fully 62% and 63% less than those for White children. This is a strong indication of racial/ethnic disparities in ADHD diagnosis by kindergarten entry.

Several of the socio-demographic variables are statistically significant and strong predictors of ADHD diagnosis. The odds of such a diagnosis for males (controlling for Model

2's other predictors) are 4.45 times larger than for females. Higher family SES reduces the odds of diagnosis considerably. Children in the highest and second highest SES quintiles have odds that are only .22 and .35 of those of children in the lowest SES quintile, respectively. Children in homes where the biological father is absent have odds of an ADHD diagnosis that are more than double those of children whose biological father is present in the household, increasing to 2.22.

Model 3 adds birth and gestational characteristics as predictors. Only one of these is statistically significant. Children with very low birthweight have odds of ADHD diagnosis that are 2.88 higher than those born at normal weight. Adding these gestational and birth controls to the logistic regression equation makes no appreciable difference to the racial/ethnic disparity estimates. Children who are Black or Hispanic continue to be less likely to receive an ADHD diagnosis by school entry than children who are White. Model 4 adds 24-months-old children's vocabulary knowledge and cognitive functioning as predictors. Higher levels of cognitive functioning significantly reduce these children's risk of later being diagnosed with ADHD at 60 months of age. Statistical control for Model 4's variables further reduces the odds of ADHD diagnosis for Blacks, Hispanics, and males. Model 5 adds 24-month-old children's learning-related behavioral functioning, quality of their home environments, and the quality of their parenting as predictors. Children's learning-related behavioral functioning is significantly related to the risk of ADHD diagnosis at 60 months of age. Specifically, a 1-unit increase in the frequency of the behaviors, as observed during the administration of the Bayley during the 24-month home interview, reduces the odds of ADHD diagnosis to .87 (i.e., a 13% reduction). Controlling these additional variables does not substantially mediate the *OR*s attributable to Model 4's predictors.

Model 6 differs from Model 5 in two ways. First, we replace the learning-related behavior's composite scale score of general behavioral functioning at 24 months with the scale's specific items (i.e., "attentive," "persistent," "not frustrated," and "cooperative"). Doing so allowed us to better identify specific learning-related behaviors, as rated during the administration of the Bayley during the 24-month home interviews, predictive of ADHD diagnosis at 60 months. Second, we added three additional variables to the logistic regression equation. There were whether the child's mother reported that she or her family had a history of mental illness by the 24-month survey wave, whether the family had limited health insurance at this time, and whether a language other than English was being spoken in child's home.

Model 6's results indicate that the statistically significant *OR* associated with 24-month learning-related behavioral functioning is attributable to one particular behavior—task persistence. Twenty-four-month-old children rated by NCES field staff as displaying more frequent task persistence when completing the Bayley's activities had odds of ADHD at 60 months that were reduced by 43% (1 - .57) compared to the odds of otherwise identical children (i.e., holding Model 6's other predictors constant) whose behavior was not considered to be as persistent. This suggests that ADHD symptomatology, at least as indexed by this specific behavior, persists across very early childhood. Children displaying greater task persistence as 24-month-olds are less likely to receive an ADHD diagnosis by 60 months of age than those displaying lower task persistence, even accounting for other types of ADHD-related symptomatology (e.g., inattentive, easily frustrated). The odds that children whose mothers or their families had a history of mental illness will be diagnosed with ADHD at 60 months of age are about three times higher than those for otherwise similar children whose mothers or their families did not have a history of mental illness. Model 6 also shows that, among otherwise

identical children, speaking a language other than English in the home significantly reduces the odds of an ADHD diagnosis. Furthermore, inclusion of this control fully mediates the *OR* associated with being Hispanic. Thus, Model 6's results indicate that non-English language use in the home may be the mechanism responsible for the disparities in ADHD diagnosis between children who are Hispanic and White. However, statistical control for Model 6's wide range of socio-demographic, gestational, birth, learner, and additional characteristics does not mediate the *OR* for children who are Black. Results from Model 6 indicate that, after controlling a large number of potential confounds, the odds that children who are Black will receive a diagnosis for ADHD by kindergarten entry are 66% lower than those for closely matched peers who are White.

In order to test whether the lower diagnosis rates of Black and Hispanic children might be attributable to their lower display of ADHD symptomatology, we estimated models similar to those in Table 2, but with the child's attention-related behaviors, as by their kindergarten teacher (when the child was approximately 60 months of age) as the dependent variable. These results are reported in Table 3. These are logistic regressions predicting the child's odds of being reported by their teacher as displaying behaviors signifying low attention, using Models 1-6 identical to those in Table 2, with an added Model 7 in which ADHD diagnosis is included as a predictor. We focus on the variables that were found, in Table 2, to be significantly related to ADHD diagnosis.

Model 1 indicates that even though Black and Hispanic students have lower ADHD diagnosis rates than Whites, their kindergarten teachers report them to have significantly *higher* rates of ADHD symptomology. After control variables are added in Models 2-7, these rates decline and lose statistical significance. Yet there is no evidence that children who are Black or Hispanic display lesser ADHD symptomatology than children who are White. Thus, the

significantly lower rates of ADHD diagnosis are not explained by a lower incidence of ADHD symptomology. This is also the case for students in families where English is not the primary language spoken in the home.

However, the same is not true for males, very low or high SES children, children without a biological father in the household, children with very low birth weight, or children whose mother had a family member with mental illness. Each of these groups, who experienced significantly differential ADHD diagnosis rates in Table 2, also show significantly differential ADHD symptomatology in Table 3. Thus, only Blacks, Hispanics, and children in households where English is not the primary language do not manifest behaviors that explain their differential rates of ADHD diagnosis. Finally, Model 7 adds ADHD diagnosis to the regression predicting a teacher report of low attention-related behaviors. The effect is statistically significant and very large. Children who have been diagnosed have odds of teacher reported symptomatology that are five times those of non-diagnosed children. This further supports the reliability of parent reports of ADHD diagnosis.

**Discussion**

We sought to identify socio-demographic, gestational, birth, and additional child- and family-level characteristics, measured at24-months-of-age, that predicted the receipt of an ADHD diagnosis at kindergarten entry. We were particularly interested in establishing whether and to what extent racial/ethnic minority disparities in ADHD diagnosis were evident by this early time period. We estimated these disparities both prior to and after extensive statistical control for many additional factors that themselves might be related to the risk for ADHD diagnosis and so function as confounds. We also estimated whether and to what extent societal mechanisms previously theorized to explain racial/ethnic disparities in ADHD diagnosis (i.e.,

limited health care access, non-English language in the home) might explain any observed disparities. Because of both the ECLS-B's large-scale and heterogeneous sample and its measurement of many child- and family-level characteristics, we were able to estimate the differential risk (whether higher or lower) associated with an unusually wide range of factors over and above those of race/ethnicity. These risk factor estimates might be used to better direct early screening, monitoring, and intervention efforts.

Our results indicated disparities in ADHD diagnosis at kindergarten entry between Black and White children. Moreover, this disparity in diagnosis was not attributable to any of the study's many other measured factors. In contrast, results from our study indicated that the diagnosis disparity between children who were Hispanic and White was largely accounted for by the use of non-English as the primary language in Hispanic children's households. Factors other than children's race/ethnicity that were predictive of a decreased likelihood of an ADHD diagnosis at school entry included being raised in a higher SES household, being more likely to engage in learning-related behaviors while presented with cognitively demanding tasks (and, in particular, remaining persistent), and being raised in a home where English was not the primary spoken language. Factors that increased children's likelihood of an ADHD diagnosis included being White, being male, being raised in a low SES household, being raised by a single mother, low birthweight, engaging in learning-related behaviors less frequently, being raised in a family with a history of mental illness, and being raised where English was the language primarily spoken in the home. Follow up analyses indicated that those groups of children experiencing differential rates of diagnosis also displayed correspondingly differential rates of ADHD symptomology in their kindergarten classrooms—except for children who are Black or being raised in homes where a language other than English is primarily spoken. These two groups of

children were less likely to receive an ADHD diagnosis, but not less likely to display ADHD symptomology.

**Limitations**

This study has several limitations. Our analyses rely on multi-item parent response to identify children as being diagnosed with ADHD. We were unable to independently verify whether and to what extent children identified by their parents met formal ADHD diagnosis criteria. However, prior work has repeatedly found that parents are valid and reliable reporters of their children's ADHD symptomology, diagnosis, and treatment response. Prior work has also identified risk factors for ADHD using the same type of parent survey items used in our study. Many of the risk factors for ADHD identified in our study (e.g., gender, SES, being raised by a single mother, being raised in a family with a history of mental illness) are consistent with prior research, and thus provide some additional indication that parents were fairly accurate reporters of their child's ADHD status. Our findings are also consistent with prior work on racial/ethnic disparities in older samples (see Miller et al., 2009). Our supplementary analyses (Model 7 of Table 3) indicated good agreement between parental report of an ADHD diagnosis and independent teacher ratings of children's learning-related behavior problems, as well as prior work using teacher report and examining disability identification more generally (Hibel, Farkas, & Morgan, 2010). The extensive statistical control used in our analyses greatly reduces the likelihood that the disparity in diagnosis we observe for Black or Hispanic children is attributable to confounding factors, including lower SES, being raised by an unmarried or single mother, being born with low birthweight, or the student's prior history of behavioral or cognitive functioning. However, it remains possible that unmeasured variables may help account for the lower odds of ADHD diagnosis attributed to race/ethnicity. Consistent with prior work (e.g.,

Miller et al., 2009), we interpret the directionality of the disparities as indicating under-diagnosis for children who are Black. However, we acknowledge that another interpretation is that children who are White are comparatively over-diagnosed. Our study examines factors predictive of an ADHD diagnosis at kindergarten, which constituted the final survey wave of the ECLS-B. The risk associated with the study's factors may have fluctuated if we had been able to analyze diagnosis rates as these same children continued through elementary school.

**Study's Contributions and Implications**

Our study contributes to the field's knowledge base in at least three important ways. First, our findings indicate that Black and Hispanic children are less likely to be diagnosed with ADHD than children who are White, these disparities are evident as early as kindergarten entry, and that they are not attributable to many potential confounds. Although Black children have been reported to be less likely to be diagnosed for ADHD when they are older, despite displaying greater ADHD symptomology, whether and to what extent these disparities are occurring as early as school entry has previously been unknown (Miller, et al., 2009). Establishing whether and to what extent this is occurring is important in part because increasing children's academic and behavioral functioning in kindergarten may help increase their academic and behavioral functioning throughout the rest of elementary school (Duncan, et al., 2007). Second, and despite calls for this research (e.g., Miller et al.), few studies have examined whether the diagnosis disparity observed for Black children also extends to Hispanics. We answer this in the affirmative – Hispanic children appear to have lower ADHD diagnosis rates than otherwise identical whites. However, the mechanism responsible for this disparity appears to be the use of a language other than English in these children's homes. Third, our study addresses a number of methodological and substantive limitations in the prior work, including the frequent reliance on

convenience samples that typically consist of white children displaying relatively severe ADHD symptomology. Our use of a large, longitudinal, nationally representative sample of 24- to 60-month old children, whose socio-demographic, gestational, birth, parenting, home, and additional child-level characteristics were extensively measured, should therefore have resulted in risk estimates for a range of factors that are more accurate than those previously available. This knowledge should inform efforts to identify young children who may at risk for ADHD, particularly at a young age when screening, monitoring, and intervention efforts are likely to be maximally effective.

Our analyses indicate that efforts to reduce racial/ethnic disparities in ADHD diagnosis should begin by kindergarten entry for children who are Black or may by speaking a language other than English in their homes. Our findings support efforts to increase solicitations by clinicians of concerns by minority parents for their children's learning and behavior, more frequently employ culturally sensitive screening methods that account for differing cultural values about disability, and to train minority parents to recognize potential ADHD symptoms in their children, as well as encouraging help-seeking behaviors by these parents, with these efforts delivered in the language best understood by minority parents (Hillemeier, Foster, Heinrichs, & Heier, 2007; Miller, et al., 2009).

Our results can also help direct efforts to ensure that all children in the U.S. receive equitable monitoring, diagnosis, and treatment for ADHD. However, our research also indicates that the mechanisms responsible for Black children's under-diagnosis have yet to be identified, at least in that these children's under-diagnosis is not attributable to the many confounds evaluated here. However, our study does suggest that using the native language of non-English-speaking parents during well child visits or other settings when professionals are soliciting developmental

concerns may be one way to reduce ADHD diagnosis disparities between kindergarten-aged children who are Hispanic and White.

Our study can also inform early screening, monitoring, and intervention efforts for young children at risk for ADHD. From the standpoint of screening by kindergarten entry, our results indicate that those kindergarten children most at risk for an ADHD diagnosis include those who are boys, those being raised in a very low SES household or by a single mother, those born with very low birth weight, and those raised in household where the mother or her family has a history of mental illness. Children who are Black and those speaking a language other than English in their homes are comparatively under-diagnosed for ADHD at kindergarten entry. Targeting these sub-populations for additional screening efforts may be necessary because these subpopulations appear to have unmet treatment needs.

From an intervention standpoint, our findings indicate that potentially malleable factors that might be targeted include helping to increase young children's learning-related behaviors, particularly the use of strategies that help children persist while attempting to complete cognitively challenging tasks, may help reduce the risk of an ADHD diagnosis. Our findings in this regard are consistent with several prior studies, which have also reported that relatively lower task persistence is an especially important behavioral characteristic of ADHD (Balint, et al., 2009; Hoza, Pelham, Waschbusch, Kipp, & Owens, 2001). Collectively, our results should help direct efforts to better screen, monitor, and prevent or remediate ADHD in young children, especially those who, because of their status as being Black, Hispanic, or raised in homes where English is not spoken, make them more likely to be under-diagnosed for the disorder as they are entering kindergarten classrooms in the U.S.

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Table 1. *Analytical Sample's Descriptive Statistics (N = 6,550)*

| | *M* (*SD*) |
|---|---|
| ADHD diagnosis at 60 months | 2.42% |
| Child is White | 53.7 % |
| Child is African American | 13.9 % |
| Child is Hispanic | 25.1 % |
| Child is Other Race | 7.2 % |
| Child age, 60 month assessment | 64.7 (3.8) |
| Child is male | 51.2 % |
| Lowest SES quintile, 24 month assessment | 19.9 % |
| Second lowest SES quintile, 24 month Assessment | 20.5 % |
| Middle SES quintile, 24 month assessment | 20.5 % |
| Second highest SES quintile, 24 month assessment | 19.8 % |
| Highest SES quintile, 24 month assessment | 19.3 % |
| Non-singleton | 3.2 % |
| Mother 35 years old or older at time of birth | 13.9 % |
| Mother not married, 24 month assessment | 32.4 % |
| Very low birth weight | 1.3 % |
| Moderately low birth weight | 6.2 % |
| Labor complications | 28.4 % |
| Obstetric procedures | 47.6 % |
| Medical risk factors | 15.2 % |
| Behavioral risk factors | 11.0 % |
| Number of words spoken, 24 months | 29.1 (12.0) |
| Bayley (cognitive) Score, 24 month assessment | 127.2 (10.8) |
| Attentive, 24 month assessment [a] | 3.5 (1.0) |
| Persistent, 24 month assessment [a] | 3.4 (1.1) |
| Degree of frustration, 24 month assessment [a] | 3.7 (1.0) |
| Cooperative, 24 month assessment [a] | 3.4 (1.1) |
| Learning-related behavioral functioning scale score (sum of 4 items above), 24 month assessment [a] | 14.5 (3.5) |
| HOME (home environment) score, 24 month assessment | 10.0 (1.9) |
| Two Bags (parenting) score, 24 month assessment | 4.4 (0.9) |
| Limited health insurance coverage, 24 month assessment | 10.22 % |

*Note:* [a] Higher score=more positive behavior.

Table 2. *Logistic Regression Models (Odds Ratios) of Predicting ADHD Diagnosis by 60 Month Assessment (N = 6,550).*

| | *Model 1* | *Model 2* | *Model 3* | *Model 4* | *Model 5* | *Model 6* |
|---|---|---|---|---|---|---|
| Child is African American | 0.72 | 0.38** | 0.38** | 0.34*** | 0.33*** | 0.34** |
| Child is Hispanic | 0.58 | 0.37* | 0.39* | 0.31* | 0.31* | 0.52 |
| Child is Other Race | 0.91 | 0.82 | 0.80 | 0.67 | 0.58 | 0.69 |
| Child age at 60 month Assessment | | 1.01 | 1.01 | 1.02 | 1.01 | 1.01 |
| Child is male | | 4.45*** | 4.48*** | 3.30*** | 3.16*** | 3.23*** |
| Second lowest SES quintile, 24 month assessment | | 1.38 | 1.36 | 1.35 | 1.27 | 1.34 |
| Middle SES quintile, 24 month assessment | | 0.55 | 0.56 | 0.59 | 0.54 | 0.52 |
| Second highest SES quintile, 24 month assessment | | 0.35* | 0.35* | 0.42 | 0.38* | 0.35* |
| Highest SES Quintile, 24 month assessment | | 0.22* | 0.23* | 0.31 | 0.26* | 0.26* |
| Non-singleton | | 0.95 | 0.69 | 0.56 | 0.55* | 0.55* |
| Mother 35 years old or older at time of birth | | 0.87 | 0.83 | 0.81 | 0.83 | 0.92 |
| Mother not married, 24 month assessment | | 0.71 | 0.71 | 0.74 | 0.68 | 0.64 |
| Biological father not living in household, 24 month assessment | | 2.22 * | 2.16* | 2.24* | 2.30* | 2.26* |
| Very low birth weight | | | 2.88*** | 1.65 | 1.74 | 1.75 |
| Moderately low birth weight | | | 1.35 | 1.15 | 1.16 | 1.24 |
| Labor complications | | | 1.25 | 1.28 | 1.24 | 1.24 |
| Obstetric procedures | | | 0.91 | 0.91 | 0.93 | 0.89 |
| Medical risk factors | | | 1.39 | 1.38 | 1.34 | 1.33 |
| Behavioral risk factors | | | 1.10 | 1.13 | 1.12 | 0.92 |
| Number of words spoken, 24 month assessment | | | | 0.97 | 0.98 | 0.98 |
| Bayley (cognitive) score, 24 month assessment | | | | 0.96* | 0.98 | 0.98 |
| Attentive, 24 month assessment [a] | | | | | | 0.97 |
| Persistent, 24 month assessment [a] | | | | | | 0.57** |
| Degree of frustration, 24 month assessment [a] | | | | | | 0.98 |
| Cooperative, 24 month assessment[a] | | | | | | 1.06 |
| Learning-related behaviors scale score [a,b] | | | | | 0.87*** | |
| Home (home environment) score, 24 month assessment | | | | | 0.94 | 0.91 |
| Two bags (parenting) score, 24 month assessment | | | | | 1.36 | 1.32 |
| Mother had family member with mental illness | | | | | | 2.57** |
| Limited health insurance coverage, 24 month assessment | | | | | | 1.83 |
| Non-English is primary language at home, 24 month assessment | | | | | | 0.31* |

*Note.* $n$ = 6,450. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$ [a] Higher score=more positive behavior; [b]Learning-related behavior scale score is the sum of scores on 4 items measuring the frequency that the child was attentive, persistent, degree of frustration, and cooperative during 24 month administration of the Bayley Short Form-Research Edition.

Table 3. *Odds Ratios of Logistic Regression models predicting Low Teacher Ratings of Child's Approaches to Learning Behaviors at 60-month assessment (N = 4,800).*

| | *Model 1* | *Model 2* | *Model 3* | *Model 4* | *Model 5* | *Model 6* | *Model 7* |
|---|---|---|---|---|---|---|---|
| Child is African American | 1.97*** | 1.16 | 1.22 | 1.15 | 1.06 | 1.04 | 1.14 |
| Child is Hispanic | 1.49** | 1.08 | 1.18 | 1.01 | 0.98 | 1.10 | 1.18 |
| Child is Other Race | 1.51** | 1.46 | 1.49* | 1.36 | 1.28 | 1.34 | 1.40 |
| Child is Male | | 2.26*** | 2.30*** | 1.91*** | 1.89*** | 1.88*** | 1.81*** |
| Second Lowest SES Quintile at 24 Month Assessment | | 1.02 | 1.04 | 1.07 | 1.09 | 1.06 | 1.04 |
| Middle SES Quintile at 24 Month Assessment | | 0.85 | 0.89 | 0.97 | 1.01 | 0.97 | 1.02 |
| Second Highest SES Quintile at 24 Month Assessment | | 0.65* | 0.70 | 0.80 | 0.84 | 0.79 | 0.85 |
| Highest SES Quintile at 24 Month Assessment | | 0.43*** | 0.49** | 0.62* | 0.65 | 0.62 | 0.67 |
| No Biological Dad in Household at 24 Month Assessment | | 1.58** | 1.55** | 1.51** | 1.53** | 1.52* | 1.46* |
| Very Low Birth Weight | | | 2.37*** | 1.62** | 1.62** | 1.60** | 1.58** |
| Mother had family member with mental illness | | | | | 1.41* | 1.38 | 1.39 |
| Non-English is Primary Language at Home at 24 Month Assessment | | | | | | 0.78 | 0.80 |
| ADHD at 60 Months | | | | | | | 5.03*** |

*Note.* $n$ = 4,800. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; Variables controlled in Model 2 are Child Age at 60 months, Non-Singleton Birth, Mother's Age and Marital Status, Region of U.S. and Urbancity; Variables controlled in Model 3 include variables listed in Model 2 and Moderately Low Birth Weight, Labor Complications, Obstetric Procedures, Medical and Behavioral Risk Factors; Variables controlled in Model 4 include variables listed in Model 3 and Number of Words Spoken and the Bayley Score; Variables controlled in Model 5 include variables listed in Model 4 and R-Scale, HOME and Two Bags Score; Variables controlled in Model 6 include variables listed in Model 5 and the Number of Well-Child Checkups.