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A Longitudinal Study of Preschoolers' Language-Based Bedtime Routines, Sleep Duration, and Wellbeing

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Abstract

Objective—To investigate the associations of caregiver-reported use of language-based bedtime routines among preschoolers at age 3 with children's nighttime sleep duration, and cognitive, behavioral and health outcomes at age 5. Further, to identify if parental or household characteristics help explain these associations.

Patients and Methods—We use data on 4,274 children from birth to age 5, drawn from the Fragile Families and Child Wellbeing Study (FFCW), a longitudinal birth cohort study of at-risk children born between 1998 and 2000 in 20 US cities. We use ordinary least squares (for continuous outcomes) and logistic regressions (for dichotomous outcomes) to estimate associations of language-based bedtime routines at age 3 with sleep duration, and cognitive, behavioral and health outcomes at age 5, net of a host of child and family background characteristics.

Results—After adjustment for child and family characteristics, we observed a positive association between language-based bedtime routines and both nighttime sleep duration and verbal test scores. Language-based bedtime routines were also inversely associated with behavior problems (anxious, withdrawn, and aggressive behaviors) and positively associated with better general health, yet adjustment for family background characteristics attenuated these associations. No associations were found between language-based bedtime routines and obesity. Results were confirmed using propensity score matching.

Conclusions—This research suggests regular use of language-based bedtime routines including singing, reading, and/or story-telling at bedtime may have a lasting positive benefit for children's sleep duration and cognitive development; we find little evidence of such a benefit for child behavior or health.

Keywords

Bedtime Routines; Preschoolers; Cognitive Development; Behavioral Outcomes; Health Outcomes

Introduction

Previous research indicates that psychosocial, cognitive, and health outcomes among children and adolescents are associated with inadequate and/or poorly timed sleep (Bates, Viken, Alexander, Beyers, & Stockton, 2002; Carskadon, Acebo, & Jenni, 2004; Lavigne, Arend, Rosenbaum, Smith, Weissbluth, Binns, & Christoffel, 1999; Sadeh, Gruber, & Raviv, 2003; Stein, Mendelsohn, Obermeyer, Amromin, & Benca, 2001). For example, behavioral problems are more common among preschool-aged children who have later bedtimes and less regular sleep schedules (Yokomaku, et al., 2008). There is also evidence that differences in nighttime sleep phase (midpoint of nighttime sleep) by race contribute to racial disparities in school readiness (Crosby, et al., 2006). Furthermore, preschool and school-age children (ages 3-12 years) who go to bed later have a larger increase in body mass index (BMI) over a 5-year period than children with earlier bedtimes (Snell, Adam, & Duncan, 2007). This finding is supported by a recent systematic review and meta-analysis of 17 studies, which found a clear association between nighttime sleep duration and weight, independent of other risk factors of obesity (Chen, Beydoun, & Wang, 2008). An established literature indicates sleep is influenced by bidirectional interactions between intrinsic child factors (e.g., sleep and circadian physiology, health and developmental status, individual difference characteristics) (Jenni & LeBourgeois, 2006; Lavigne et al., 1999; Ward et al., 2008; Malow et al., 2006); and environmental demands and opportunities (e.g., daycare/preschool schedules, family routines) (Jenni et al., 2005; Fukada et al., 2002). However, most of the literature on sleep and child outcomes focuses on bedtimes or sleep duration rather than on specific types of routines that occur at bedtime. This article extends current knowledge by assessing the extent to which parent-reported use of language-based bedtime routines (e.g., reading, singing, praying, story-telling, talking, or playing a game) with their children are associated with sleep duration and behavioral, cognitive, and health outcomes among a population sample of primarily disadvantaged young children in the US.

Language-Based Bedtime Routines

Language-based bedtime routines, such as reading a book or singing a song with a parent, are staples of numerous households. They are regularly recommended to parents as consistent bedtime activities to perform with their children (Mindell, Meltzer, Carskadon, & Chervin, 2009a; Mindell, Telofski, Wiegand, & Kurtz, 2009b; Moore, Meltzer, & Mindell, 2008). Despite this widespread recommendation, few studies focus on the presence of language-based bedtime routines or their associations with both sleep-related and other developmental outcomes. Research in this area is particularly rare with regard to low-income families.

We hypothesize that regular use of language-based bedtime routines with preschoolers will promote longer sleep duration. Furthermore, through this extended sleep duration, we expect to observe beneficial associations between language-based bedtime routines and children's behavioral, cognitive, and health outcomes. We view the regular use of language-based bedtime routines as an indication of commitment on the part of the caregiver to sharing time with the child at night and promoting positive verbal bedtime experiences. We expect that this regular closeness increases the opportunity for parents to be emotionally available (Teti, Kim, Mayer, & Countermine, 2010) and strengthens the relationship between parent and child, thereby allowing the child to feel safer, fall asleep faster, and sleep more soundly at night. As argued elsewhere, feeling safe at night is an essential part of a child's ability to fall asleep (Dahl & El-Sheikh, 2007). In addition, the regular use of a bedtime routine that engages the child with a parent teaches children that parents value bedtime and sleep as an important part of their daily routines. Finally, the regular use of nightly language-based bedtime routines, such as reading or telling the child stories, may stimulate cognitive development (verbal skills) and foster an interest in reading.

Research on Improving Sleep among Low-Income Children is Limited

While prior research has shown that the introduction of a bedtime routine is associated with reduced sleep problems (Adams & Rickert, 1989) and increased nighttime sleep hours for young children (Mindell, et al. 2009a), most existing studies focus on children from advantaged households. For example, a recent study of the influence of establishing a bedtime routine on sleep problems among infants and toddlers was based on a sample of households in which over 95% of parents were married, the majority of parents had at least some college education, and household incomes exceeded $50,000 (Mindell, et al., 2009b). We are aware of only a few studies that look at differences in preschooler bedtime routines using samples including significant numbers of minority and lower socioeconomic status households. Two studies use the Fragile Families and Child Wellbeing Study data, the same dataset that we use in the present analysis (Hale, Berger, LeBourgeois, & Brooks-Gunn, 2009; Milan, Snow, & Belay, 2007). One study found that black and Hispanic parents were 47% and 33%, respectively, less likely to report regular use bedtime routines (at least 4 out of the last 5 weeknights) compared to white parents; further, SES was positively associated with use of parent-child interactive and hygiene-related bedtime routines (Hale, et al., 2009). Another looked specifically at the type of bedtime routines and found that compared to whites, blacks and Hispanics, respectively, have a 36% and 29% reduced odds of parents reporting the routine of reading or telling a story at night (Milan et al, 2007). In a separate study, High and colleagues (High, Hopmann, LaGasse, & Linn, 1998) found that a clinic-based program was able to promote book sharing at bedtime but did not significantly reduce bedtime struggles among low-income urban families.

Shared book reading may be a particularly important bedtime routine through which to encourage healthy cognitive development as it facilitates children's vocabulary development, language and reading skills, and positive attitudes toward literacy (Bus, van Ijzendoorn, & Pelligrini, 1995; Debaryshe, 1993; Raikes, Pan, Luze, Tamis-LeMonda, Brooks-Gunn, Constantine, Tarullo, Raikes, & Rodriguez, 2006). Studies of low-income families consistently find that access to literacy activities and mother-child book-reading are positively associated with cognitive outcomes (Raikes, et al., 2006; Rodriguez, Tamis-Lemonda, Spellmann, Pan, Raikes, Lugo-Gil, & Luze, 2009). Yet prior research has produced no direct evidence of whether reading before bed may be associated with improved sleep. Understanding the implications of regular language-based bedtime routines in at-risk children is a necessary step in guiding recommendations regarding sleep and child development.

Participants and Methods

Participants

We used data on children followed from birth to age 5 in the Fragile Families and Child Wellbeing Study (FFCW). The FFCW is a longitudinal birth cohort study of children born between 1998 and 2000 in 20 US cities with populations of over 200,000. Due to an oversampling of unmarried births, sample children are more likely to live in low-income families, to have nonresident fathers, to be Black or Hispanic, and to have parents with lower levels of education than children in a nationally-representative sample. Within marital status categories, however, the demographic characteristics are similar to those reported by the National Center for Health Statistics (NCHS). A complete description of the sample and study design is available elsewhere (Reichman, Teitler, Garfinkel, & McLanahan, 2001).

Mothers included in the study were screened for eligibility shortly after the birth of a child. Study eligibility required that mothers intended on keeping their baby, spoke English or Spanish well enough to comprehend and answer interview questions, and were healthy

enough to complete the interview. Fewer than 5% of screened mothers were ineligible. Mothers younger than 18 years old were excluded in about half of the hospitals due to legal restrictions. However, since births to mothers less than 18 years old accounted for only 4% of all births in 1999 (NCHS, 1999), this exclusion should have little effect on our results. Mothers had a high baseline response rate: 82% among married mothers and 87% among unmarried mothers (where the denominator was eligible births). The baseline study sample consisted of 4,898 births.

FFCW researchers interviewed all mothers and all fathers (who agreed to be interviewed) shortly after the focal child was born, generally in person at the hospital, and conducted follow-up interviews by telephone when the child was approximately 12-, 36-, and 60-months of age. During each interview, respondents provided extensive information about family/household resources, structure, and functioning; program participation; physical and mental health; and parenting behaviors. Subsequent to the 36- and 60-month telephone interviews, parents were asked to participate in an in-home module designed to assess multiple domains of parenting, the home environment, mother-child interactions, and child cognitive and emotional/behavioral development through both a questionnaire and a set of interviewer observed items. Mothers who were unavailable for an in-home visit were asked to complete the questionnaire portion of the in-home module by telephone. The bedtime-related items that are the focus of this study were included in the questionnaire portion of the 36-month in-home module. The outcome measures were primarily collected via the 60-month in-home module (with the exception of the overall health measure which was drawn from the mother's 60-month core telephone interview). On average, sample children were just under 39 months of age at the time of the 36-month in-home interview and 64 months of age at the time of the 60-month interview. These findings pertain to children who were born in urban settings between 1998 and 2000, and who lived with their biological mother at ages 3 and 5.

We used multiple imputation techniques to impute values for all variables with missing data for the full FFCW sample of 4,898. Specifically, we used Stata's ICE program to impute 10 complete datasets. After conducting the imputations, we dropped the 624 observations that initially had missing data on all 9 outcomes from each dataset, resulting in a potential analysis sample of 4,274. Finally, following the strategy presented elsewhere (Von Hippel, 2007), we estimated our regression models using only those observations that initially had non-missing data on the particular outcome of focus. As shown in Table 1, the number of observations with non-missing outcomes varies from a low of 2,174 for overweight and obese to a high of 4,048 for poor health. Our regression models include imputed values for one or more covariates for 18 to 24 percent of observations, depending on the outcome of interest.

Measures

Language-Based Bedtime Routines—Our primary focal variable is a dichotomous measure of whether the parent reported that the family regularly engages in any language-based routine with the child at bedtime. First, we asked the parent (Yes/No response), “Some families have a routine of things they do when it is time to put their child to sleep, do you have a regular routine of thing you do when (CHILD) is put to sleep?” Parents responding “No” were not further questioned, and coded as “0” for language-based bedtime routines. Parents responding “Yes” were then asked in an open-ended format, “What kinds of things are part of (CHILD)'s regular bedtime routine” and prompted, “Anything else?” Responses including reading a story, telling a story, praying, talking, singing, and/or playing a game were coded as “1” for language-based routines. Such bedtime routine dimensions are consistent with those assessed in the Bedtime Routines Questionnaire (Henderson & Jordan,

2010), a parent-report measure with adequate reliability and validity for research instruments. The verbal-based bedtime routines variable was measured via the 36-month in-home module.

Outcomes

Nighttime Sleep Duration: Nighttime sleep duration is assessed by maternal report via the 60-month in-home questionnaire with the following question: "How many hours of sleep a night does (CHILD) usually get?" Longitudinal studies show that most preschool children sleep 10-11 hours regardless of napping status, and that children obtaining fewer hours are at risk for poor behavioral and cognitive functioning (Iglowstein, Jenni, Molinari, & Largo, 2003; Lavigne, et al., 1999; Touchette, Petit, Seguin, Boivin, Tremblay, & Montplaisir 2007; Touchette, Petit, Tremblay, & Montplaisir, 2009). Evidence suggests that parental reports of children's nocturnal sleep duration demonstrate adequate validity and test-retest reliability (Sadeh, 2004). In addition, LeBourgeois (LeBourgeois, 2003), using a racially diverse community sample in southern Mississippi, found maternal reports of child sleep duration corresponded well with actigraphic (r=.81) and sleep diary (r=.71) data.

Cognitive Skills: We use the Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1986; Dunn, Dunn, Robertson, & Eisenberg, 1981) to measure children's cognitive skills. The PPVT-R measures language ability and receptive vocabulary and has been widely used to study children's cognitive development. The PPVT-R was administered in-person in both the 36- and 60-month in-home FFCW modules. We use the 60-month administration as our outcome measure. Children's 60-month scores in FFCW range from 40 to 139.

Behavior Problems: Behavior problems are assessed by the anxious/depressed (14 items; possible range of 0-28 points; $\alpha = .68$), withdrawn (9 items; possible range of 0-18 points; $\alpha = .60$), and aggressive behavior (20 items; possible range of 0-40 points; $\alpha = .84$) subscales of the Child Behavior Checklist (CBCL) (Achenbach, 1992). The CBCL is one of the few quality measures of problem behavior among young children. These three subscales were chosen because they tap into major age-appropriate behavioral constructs for 3- to 5-year olds. In addition, these anxiety/depression, withdrawn behavior, and aggressive behavior have all been associated with sleep problems in young children (Touchette et al., 2007; Gregory et al., 2009). The CBCL is completed by the child's primary caregiver (generally the mother in FFCW) who is asked to report the extent to which a series of behaviors are characteristic of the child. For each item, children are assigned a score of 0 if the mother responded that a statement was "not true," 1 if she responded that the statement was "sometimes or somewhat true," or 2 if she responded that the statement was "very true or often true" of the focal child. For example, the types of statements included in the aggressive behavior scale are "he/she is defiant," "he/she gets in many fights" and "he/she has angry moods." Scores on each item were then summed to create a total score for each subscale and treated as continuous measures. The CBCL was administered either in person or by telephone as part of both the 36- and 60-month in-home FFCW module. We use the 60-month administration as our outcome measure.

Health: We utilize 2 health outcomes. First, we include a global measure of overall child health in which the mother was asked: "In general would you say (CHILD)'s health is Excellent, Very Good, Good, Fair, or Poor?" This measure is commonly dichotomized to reflect whether a child is reported to be in good, fair, or poor health (coded 1 in our study) versus excellent or very good health (coded 0), and we follow this approach. Given prior research on the links between sleep and BMI, we also utilize measures of whether the child is obese. As is standard in the children's health literature, we define obesity as having a BMI-for-age at the 95^{th} percentile or higher, where both child's height and weight are

measured objectively during the in-home interview (Centers for Disease Control and Prevention, 2000).

Covariates and Mediators—Our models adjust for three groups of covariates: (1) child characteristics; (2) demographic characteristics of the caregiver and household; and (3) child's sleep duration (if not the outcome variable). Child characteristics include the age of child in months at the 36-month in-home interview, an indicator for whether the child is female, and an indicator for whether the child was low birth weight. In the PPVT-R models, we also include an indicator for whether the child took the Spanish version of the PPVT-R (TVIP). Demographic characteristics of the caregiver and household include: the age of mother (in years) at the birth of the focal child, the ethnicity of mother (White, Hispanic, Black, Other), whether the mother was US born, the mother's educational attainment (less than high school, high school, more than high school), mother's PPVT-R score, the mother's depressive symptoms, family structure (single-mother family, mother and social father family, or mother and biological father family), number of adults in the household, number of children in the household, number of bedrooms in the household, and a measure of the family's mean income to poverty status. Maternal depressive symptoms are measured by the Composite International Diagnostic Interview – Short Form (Nelson, Kessler, & Mroczek, 1998) on a scale of 0 to 8. Poverty status is calculated as the mean annual income to poverty status from the focal child's birth through the age-3 interview. It is then divided into three categories: at or below the poverty threshold for their family size, 1-2 times the poverty threshold, or greater than 2 times the poverty threshold. In addition, in models for obese, we adjust for the mother's BMI and for whether the child was put to bed with a bottle at the time of the 36-month in-home assessment. Sleep duration is coded continuously as described above.

Data Analysis

First we examine whether language-based bedtime routines are associated with longer sleep duration. To do so, we begin by estimating two nested logistic regression models. Model 1 uses whether the parents report engaging language-based bedtime routines with their children as the only predictor variable. Model 2 includes the variables in Model 1 plus all of the other covariates and mediators described above.

To further ensure the robustness of our results, we estimated all of our models using the full analysis sample as well as a sample generated by using propensity score matching methods to construct treatment (language-based bedtime routines) and comparison (no language-based bedtime routines) that were statistically equivalent with regard to all observed background characteristics. This strategy increases our confidence that our analyses are based on comparable groups and restricts inference to treatment and comparison samples with adequate overlap in the covariate distributions, thereby avoiding unwarranted model extrapolation. Specifically, we used Stata's PSMATCH2 program to construct matched groups of families that did and did not utilize language-based bedtime routines but did not differ on any other observed characteristics. We used a one-to-one matching with replacement strategy to assign each family that utilized language-based bedtime routines a family that did not, but had the most similar conditional probability (propensity score) for doing so based on the full set of covariates. The matched analysis sample was limited to families for whom there was sufficient overlap in propensity scores (common support) and unmatched families were discarded from the sample, as were the 10 percent of families who used language-based bedtime routines but for whom the propensity score density of families who did not was the lowest. Matching was conducted separately in each of the 10 imputed datasets. After matching was complete, we confirmed in each dataset that there were no

significant differences between groups on any of the covariates. We then re-estimated our regression models using the matched sample.

The second step in our analysis is to investigate associations of language-based bedtime routines with the cognitive, behavioral, and health outcomes. Here, we estimate a series of nested logistic regression (for dichotomous outcomes: poor health and obese status) and ordinary least squares (OLS) regressions (for continuous outcomes: PPVT-R, anxious/depressed, withdrawn, and aggressive behavior) models. As in the sleep duration models, Model 1 includes only whether the child participates in a language-based bedtime routine, whereas Model 2 includes the bedtime routines and all of the covariates including the continuous measure sleep duration. To ease the interpretation of our results, for the regression models, we standardized the PPVT-R scores and CBCL subscales to have a mean of 0 and standard deviation of 1. As with the sleep duration models, we also estimate these models using the matched sample generated by the propensity score matching method described above.

Results

Table 1 presents descriptive statistics for our full analytic sample and also by whether or not families used language-based bedtime routines. The top panel shows that mothers reported that children slept an average of 9.5 hours per night at approximately age 5, and that children whose families utilized language-based bedtime routines slept slightly, but statistically significantly, longer than those whose families did not (9.6 vs. 9.4 hours). The raw data reveal that children whose families utilize language-based bedtime routines fare significantly better on all of the outcome measures except for obesity.

Turning to the other sample characteristics we find that 21% of the mothers in the sample are white, 27% are Hispanic and 49% are black; the remainder is of another ethnicity. Over half of the children have their biological father present (53%), 38% live with a single mother, and 9% have a social father (i.e., stepfather or unrelated cohabiting partner of their mother) present. We grouped cohabiting and married families together with regard to both biological and social (non-biological) father presence. Just over one-third of the mothers in the sample (34%) did not graduate from high school and about 38% had mean incomes that were at or below poverty during the first three years of the child's life. There are statistically significant differences between which families who regularly engage in language-based routines and those who do not for many of these characteristics. Specifically, black, less-educated, single-mother, and low-income families have significantly lower reported use of language-based bedtime routines than their counterparts.

Table 2 provides the results of models estimating associations of parent-child language-based bedtime routines with sleep duration. As shown in Model 1, Language-based bedtime routines are associated with increased sleep duration by approximately 0.3 hours ($p<.001$), however after adjustment for child, mother, and household, this increased association drops to about 0.2 hours ($p<.01$). The propensity score analyses, with and without adjustment, show a similar 0.2 hour ($p<.05$) increased association in reported sleep duration for the children who engaged in language-based bedtime routines, even after adjustment for confounding variables.

Table 3 presents results for the cognitive, behavioral, and health outcomes. Model 1 reveals significant advantageous associations between language-based routines at bedtime and the majority of our outcomes. Specifically, language-based routines are associated with higher PPVT-R scores (B=.35, 95% CI=.26-.44, $p<.001$), and fewer anxious behaviors (B=-.12, 95% CI=-.20- -05, $p<.01$), withdrawn behaviors (B=-.14, 95% CI=-.21- -.06, $p<.01$),

aggressive behaviors (B=-.13, 95%CI=-.22- -.05, p<.01), as well as a 28% lower odds of a parent reporting their child in good, poor, or very poor health, as opposed to very good or excellent health (OR=.72 95% CI=.57-.89, p<.01). We find no statistically significant association between regular use of language-based bedtime routines and whether a child is obese. In addition, we conducted supplemental analyses (results not shown) which used overweight status (85th percentile for BMI-for-age) as the outcome and also found no significant association.

The association between language-based bedtime routines and PPVT-R scores is attenuated by almost two-thirds with the addition of child, caregiver, and household characteristic (from a B of .35 in Model 1 to a B of .14 in Model 2), but remains statistically significant at the p<.01 level, suggesting that language-based bedtime routines are associated with a .14 standard deviation higher PPVT-R score. Full covariate results of Models 1-4 are shown in Table 4. Additionally, though the association is further attenuated with the introduction of children's lagged (36-month) PPVT-R scores to the model, it retains marginal statistical significance (p<.10) and continues to show an association of .08 standard deviations (results not shown). Furthermore, though slightly smaller in magnitude, these results are robust in the matched sample suggesting that they are not fully explained by other differences between families that do and do not regularly engage in language-based bedtime routines. Finally, the association between the number of hours the child sleeps (at 60-months) and PPVT-R is not significant at the p<.05 level in all models.

All of the statistically significant associations between language-based bedtime routines and the behavioral and health outcomes found in Model 1 are reduced to non-significance with the introduction of child, caregiver, and household characteristics to the model (Model 2). Likewise, although there are a few marginally significant associations in the unadjusted matched models, these are reduced to non-significance in the adjusted models. We do see, however, that sleep duration is associated with reductions in anxious/depressed behavior, withdrawn behavior, and aggressive behavior, above and beyond adjustment for the other child, maternal and family characteristics in Model 2 of the standard OLS models, as well as in the propensity score analyses.

Discussion

The results from this study provide support for the use of language-based bedtime routines as a sleep-promoting activity for disadvantaged preschoolers. The association between such routines and child sleep hours is robust, even after adjusting for a range of child, parent, and household characteristics.

One possible explanation for this finding may be found in recent research on infants and sleep, which indicates that maternal bedtime routines may not be as important for infant sleep quality as the maternal emotional availability that accompanies such routines (Teti, et al., 2010). Maternal emotional availability is thought to allow children to feel safe in an environment that is “reasonably predictable, controllable, and free of potential threats” (Teti, et al., 2010), and thereby promote sleep. While we are unable to adjust directly for maternal emotional availability in our study, we recognize that the parents who engage in language-based bedtime routines may either be more emotionally available to begin with, or may be interpreted by young children as being more emotionally available due to their regular use of such routines.

Another hypothesis is that the regular use of language-based bedtime routines, which tend to be time and attention intensive, are proxies for the quality of the overall home environment, such that more chaotic and less supportive home environments have lower rates of using

language-based bedtime routines. To gain insight into this possibility, we tested whether there were mean differences in several home characteristics by whether a family used language-based bedtime routines. We found (results not shown) that families who used such routines were also more likely to put the focal child to bed at a regular time and were less punitive, more emotionally responsive, exhibited better verbal and social skills, and provided a greater level of language stimulation in the home. This suggests that language-based bedtime routines are likely to be used in concert with other family behaviors that are also associated with improved child sleep (and stimulate child development).

Turning to the developmental outcomes, we find a positive association between engaging in a language-based bedtime routine and better cognitive skills (PPVT-R) for preschoolers which, though attenuated with the addition of child, caregiver, and family characteristics, remains statistically significant even when such characteristics are included in our regression models. The magnitude of this association represents a 0.14 standard deviation difference in PPVT scores (about 2.2 points) at age 5 between children who did and did not experience language-based bedtime routines at age 3. To put the magnitude of this effect in context, the Head Start Impact Study (U.S. Department of Health and Human Services, 2010) reports the intent-to-treat effect of one year of Head Start for randomly assigned 3 and 4 year olds, respectively, to be an increase of 0.18 and .09 standard deviations with regard to PPVT scores, relative to a control children. Thus, the effect size found in this study is slightly smaller than the average intent-to-treat effect of a randomly assigned year of Head Start for a 3 year old and about 50 percent larger than the average effect of a randomly assigned year of Head Start for a 4 year old.

This higher PPVT score among children engaging in regular language-based bedtime routines likely reflects the cognitive stimulation that occurs through the process of nightly engagement with a child through reading, storytelling, talking, singing, praying, and/or playing games. Our results also reveal that sleep duration does not fully mediate the association between language-based bedtime routine and higher PPVT-R scores. This suggests that improved sleep duration is probably not the sole mechanism explaining the higher scores, but rather that such activities directly stimulate literacy. Indeed, there is ample evidence that access and exposure to book sharing promotes positive cognitive development (Raikes, et al., 2006; Rodriguez, et al., 2009). Furthermore, as noted above, however, it is important to keep in mind that language-based bedtime routines are likely to co-occur with other language-stimulating behaviors.

Our findings with regard to behavior problems and general health indicate that associations between language-based bedtime routines and each of these outcomes are nonsignificant after adjusting for a range of confounding variables (e.g., child, caregiver, and household characteristics). That is, other characteristics that are likely associated with both bedtime routines and child development appear to be driving the associations we observe in our simplest unmatched models (Model 1). Whereas language-based bedtime routines may not be directly associated with child behavior, our findings show (Table 3), that there are statistically significant associations between sleep duration and reductions in anxious/depressed behavior, withdrawn behavior, and aggressive behavior. Even after adjusting for the other confounding variables (e.g., poverty and low levels of maternal education), longer sleep duration is associated with better behavioral outcomes in this population. Thus, given the strong association that we found between language-based bedtime routines and sleep duration, coupled with a growing literature on the association between short sleep duration and children being overweight and obese (Chen, et al., 2008; Marshall, Glozier, & Grunstein, 2008; Patel & Hu, 2008), we were surprised to find no association between language-based bedtime routines and obesity. It is possible that a longer time frame than 2 years may be necessary to observe higher levels of overweight and obesity in the children.

For example, Snell et al. (2007) and others (Touchette, et al., 2009) found associations between short sleep duration and child weight gains over a 5-year period.

Our analyses are limited by potential reporting or measurement error with regard to our measures of sleep duration and bedtime routines. However, prior work suggests reports of both by parents are relatively in line with observations of family behaviors. For example, a similar, parental reported measure of children's bedtime routines, the Bedtime Routines Questionnaire, has exhibited strong internal consistency (α=.88) and moderate correspondence with other measures of sleep quality, sleep hygiene, and routines (*r*=.36 to *r*=.51) (Henderson & Jordan, 2010). A more general assessment of children's daily routines, the Child Routine Inventory, has also shown strong internal validity (α=.90) and test-retest reliability (r=.86) (Sytsma, Kelley, & Wymer, 2001). Furthermore, previous research suggests parental-reports of sleep patterns in young children have adequate reliability and validity (LeBourgeois, 2003; Sadeh, et al., 2003). Other limitations include lack of information on daytime napping behaviors and other sleep behaviors, as well as more details about the characteristics of the language-based bedtime routine (e.g., length of activity, regularity, timing, and who carried out the activity). In addition, we had smaller sample sizes for the outcome measures that required in-person measurement (i.e., PPVT and obesity) compared to those that could be collected by phone (i.e., behavior and health status) Finally, while bi-directional associations may exist between verbal-related routines, sleep duration, and health/developmental outcomes, our longitudinal design provides robust temporal assessments suggesting bedtime activities of a verbal nature at an early age best predict later language outcomes. Nonetheless, it is important to consider that bedtime routines are likely to be serially associated. Indeed, although FFCW did not collect data on specific types of routines at the age-5 assessment, families were asked whether they engaged in any bedtime routines; 81 percent of those families who engaged in one or more bedtime routines at age 3 also engaged in bedtime routines at age 5.

Overall, our results indicate that language-based bedtime routines are associated with both increased sleep hours and improved cognitive skills. As is the case with all observational studies, our estimates do not reflect causal relations, despite that these findings withstand substantial adjustment for potentially confounding variables. Future research should seek to further investigate these findings, perhaps in the context of a language-based bedtime-routine related intervention study. In addition, future research should seek to understand the role of maternal emotional availability in moderating or mediating positive associations of language-based bedtime routines with preschoolers' sleep and cognitive outcomes. Finally, given evidence of similar socioeconomic risk factors with regard to both sleep-related problems and poor developmental outcomes for children, educational campaigns around sleep and sleep-related behaviors—particularly those that encourage language-based bedtime routines—may want to target low socioeconomic households.

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Table 1
Descriptive Statistics of the Analytic Sample

	Full Sample	Language-Based Bedtime Routines	No Language-Based Bedtime Routines	
	Mean (Std. Dev.)	**Mean (Std. Dev.)**	**Mean (Std. Dev.)**	**p-value**
Language-based Bedtime Routines (%)	0.56			
Sleep Duration at 60 months (hours)	9.48	9.56	9.37	***
Developmental Outcomes at 60 months	(1.23)	(1.22)	1.24)	
PPVT-R (N = 2,346)	92.88 (15.65)	95.41 (15.48)	89.75 (16.24)	**
Anxious/Depressed Behaviors (N = 3,001)	3.41 (3.10)	3.25 (3.02)	3.62 (3.19)	**
Withdrawn Behaviors (N = 3,001)	2.10 (2.06)	1.99 (2.01)	2.26 (2.11)	**
Aggressive Behaviors (N = 3,001)	11.85 (5.99)	11.52 (5.78)	12.27 (6.24)	**
Poor Health (%; N = 4,048)	0.12	0.10	0.14	**
Obese (%; N = 2,174)	0.14	0.14	0.13	
Child Characteristics				
Age (months at 36-month in-home assessment)	38.49 (3.21)	38.46 (3.24)	38.52 (3.17)	
Female (%)	0.47	.48	.47	
Low Birth Weight (%)	0.10	.09	.10	
Age of Mother (years at focal child's birth)	25.19 (6.05)	25.74 (6.31)	24.47 (5.61)	***
Mother is White (%)	0.21	.26	.15	+
Mother is Black (%)	0.49	.45	.54	***
Mother is Hispanic (%)	0.27	.26	.28	
Mother is Another Ethnicity (%)	0.04	.04	.03	
Mother US Born (%)	0.85	.84	.85	
Mother has Less than High School Education (%)	0.34	.29	.40	***
Mother has High School Education (%)	0.31	.28	.34	**
Mother has More than High School Education (%)	0.36	.43	.26	***
Mother's PPVT-R Score	90.11 (12.91)	91.65 (13.30)	88.12 (12.11)	***
Mother's Depressive Symptoms	1.19 (2.40)	1.17 (2.39)	1.21 (2.41)	
Mother and Biological Father in Household (%)	0.53	.56	.49	***
Single-Mother Household (%)	0.38	.35	.41	**
Mother and Social Father in Household (%)	0.09	.09	.10	
Number of Adults in Household	2.05 (0.90)	2.03 (0.85)	2.07 (.0.97)	
Number of Children in Household	2.31 (1.33)	2.20 (1.27)	2.47 (1.38)	**
Number of Bedrooms in Household	2.74 (0.92)	2.78 (0.93)	2.69 (0.90)	**

	Full Sample	Language-Based Bedtime Routines	No Language-Based Bedtime Routines	
	Mean (Std. Dev.)	**Mean (Std. Dev.)**	**Mean (Std. Dev.)**	**p-value**
Mean Income Birth-36-Months: <Poverty	0.38	.32	.47	***
Mean Income Birth-36-Months: 1-2x Poverty	0.29	.29	.30	
Mean Income Birth-36-Months: 2x^{+} Poverty	0.32	.39	.23	***
Additional covariates				
PPVT-R in Spanish	0.08	.08	.08	
Mother's BMI (36-months)	29.82 (7.19)	29.72 (7.33)	29.9 (7.0)	
Put to Bed with Bottle (36-months) (%)	0.08	.08	.07	

Note: Observations for each of the developmental outcomes are shown in parenthesis in the stub column. All estimates for the bedtime routines, child characteristics, and demographic characteristics of the caregiver and household are based on multiply imputed data for 4,274 observations with at least one non-missing outcome. Means and standard deviations or percentages (as indicated in the stub column) presented

$^{+}$p<.10;

*p<.05;

**p<.01;

***p<.00

Table 2

Results of Nested OLS Regression Models indicating Associations Between Language-Based Bedtime Routine at age 3 and Sleep Duration (hours) at Age 5

	Unmatched Results		Propensity Score Results	
	Model 1 (Unadjusted B)	**Model 2 (Adjusted B)**	**Model 1 (Unadjusted B)**	**Model 2 (Adjusted B)**
Language-based Bedtime Routine	0.26***	0.16**	0.19***	0.16*
	[0.16, 0.36]	[0.06, 0.26]	[0.05, 0.34]	[0.02, 0.29]
Observations	2,997	2,997	2,210	2,210

*** p<.001

** p<.01

* p<.05

+ p<.10

Note: Beta coefficients and confidence intervals are presented. Model 1 presents the unadjusted bivariate results. Model 2 includes controls for other bedtime routines, and all of the child characteristics and demographic characteristics of the caregiver and household (listed in Table 1)

Table 3

Results of Nested OLS Regression and Logistic Regressions Models indicating Associations Between Language-Based Bedtime Routine at age 3 and Cognitive, Behavioral, and Health Outcomes at Age 5

	PPVT-R	Anxious/Depressed	Withdrawn	Aggressive	Poor Health	Obese
	OLS	OLS	OLS	OLS	Logit	Logit
Model 1: Full sample, unadjusted						
Language-Based	0.35***	-0.12**	-0.14**	-0.13**	0.72**	1.06
Bedtime Routine (vs. No Language Based Routine)	[0.26, 0.44]	[-0.20, -0.05]	[-0.21, -0.06]	[-0.22, -0.05]	[0.57, 0.89]	[0.81, 1.38]
Model 2: Full sample, adjusted						
Language-Based	0.14**	-0.06	-0.02	-0.05	0.83	1.04
Bedtime Routine (vs. No Language Based Routine)	[0.05, 0.22]	[-0.14, 0.02]	[-0.10, 0.06]	[-0.14, 0.03]	[0.67,1.05]	[0.78, 1.39]
Sleep Duration (hours)	-0.01 [-0.04, 0.02]	-0.03* [-0.06, -0.00]	-0.04** [-0.07, -0.01]	-0.06*** [-0.09, -0.03]	0.99 [0.91, 1.08]	0.90+ [0.82, 1.00]
Observations	2,346	3,001	3,001	3,001	4,048	2,174
Model 3: Matched sample, unadjusted						
Language-Based	0.21**	-0.11+	-0.07	-0.11+	0.77	1.05
Bedtime Routine (vs. No Language Based Routine)	[0.08, 0.34]	[-0.21, 0.00]	[-0.18, 0.04]	[-0.24, 0.01]	[0.55, 1.06]	[0.72, 1.52]
Model 4: Matched sample, adjusted						
Language-Based	0.12*	-0.07	-0.01	-0.06	0.82	1.03
Bedtime Routine (vs. No Language Based Routine)	[0.01, 0.23]	[-0.18, 0.03]	[-0.11, 0.10]	[-0.18, 0.06]	[0.60,1.13]	[0.69, 1.53]
Sleep Duration (hours)	-0.01 [-0.05, 0.03]	-0.03+ [-0.06, 0.01]	-0.04+ [-0.07, -0.00]	-0.06** [-0.10, 0.03]	0.97 [0.86, 1.10]	0.92 [0.81, 1.04]
Observations	1,725	2,212	2,212	2,212	2,976	1,596

*** p<.001

** p<.01

* p<.05

+ p<.10

Note: Beta Coefficients (for OLS regressions) or odds ratios (for Logits) and confidence intervals presented. Model 1 controls only for the presence of language-based bedtime routines. Model 2 also controls for all of the child characteristics and demographic characteristics of the caregiver and household (listed in Table 1). Models for PPVT-R also control for whether the child took the test in Spanish. Models for obese also control for mother's BMI and whether the child is put to bed with a bottle

Table 4
Full Covariate Results for PPVT Outcomes, Models 1-4

	Full sample, unadjusted	Full sample, adjusted	Matched sample, unadjusted	Matched sample, adjusted
	Model 1	**Model 2**	**Model 3**	**Model 4**
Language-Based Bedtime Routine	0.35***	0.14**	0.21**	0.12*
Sleep Duration (hours)		-0.01		-0.01
Child Characteristics				
Age		-0.01*		-0.02*
Female		0.17***		0.17***
Low Birth Weight		-0.09		-0.06
Demographic Characteristics of Caregiver and Household				
Age of Mother (years at focal child's birth)		0.01		0.01
Mother is White		--		--
Mother is Black		-0.39***		-0.36***
Mother is Hispanic		-0.44***		-0.41***
Mother is Another Ethnicity		-0.05		-0.02
Mother US Born		0.24**		-.20+
Mother has < HS Education		-0.20***		-0.22**
Mother has HS Education		-0.19***		-0.19**
Mother has > HS Education		--		--
Mother's PPVT-R Score		0.18***		0.20***
Mother's Depressive Symptoms		0.01		0.01
Mother and Biological Father in Household		--		--
Single-Mother Household		-0.02		-0.03
Mother and Social Father in Household		-0.06		-0.07
Number of Adults in Household		0.00		-0.01
Number of Children in Household		-0.05**		-0.05*
Number of Bedrooms in Household		0.038		0.03
Mean Income Birth-36-Months: <Poverty		-0.37***		-0.35***
Mean Income Birth-36-Months: 1-2x Poverty		-0.13*		-0.12*
Mean Income Birth-36-Months: 2x+ Poverty		--		--
Observations	2,346	2,346	1,725	1,725

*** p<.001

** p<.01

*p<.05

+p<.10

Note: Beta Coefficients (for OLS regressions). Model 1 controls only for the presence of language-based bedtime routines. Model 2 also controls for all of the child characteristics and demographic characteristics of the caregiver and household (listed in Table 1). Models also control for whether the child took the test in Spanish