Effects of the Home Environment on School-Aged Children’s Sleep

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Study Objective: Examine the relationship between the sleep behavior of elementary school-aged children and characteristics of the home environment.

Design: Cross-sectional analysis of children participating in a cohort study.

Setting: Cleveland Children’s Sleep and Health Study, an ethnically mixed, urban, community-based cohort.

Participants: Four hundred forty-nine children (50% girls, 46% African-American) aged 8 to 11 years.

Measurements and Results: Sleep and health data were obtained from a child-completed 7-day sleep journal and caregiver-completed health and sleep questionnaire. Home-environment predictors were Middle-Childhood Home Observation for Measurement of the Environment (MC-HOME) total score and Encouragement of Maturity and Physical Environment subscale scores. Sleep outcomes were mean nightly sleep duration, night-to-night variation in sleep duration, and bedtime of 11 PM or later. Adjusted analyses showed that higher Encouragement of Maturity subscale scores were associated with longer sleep duration ($P < .05$) and decreased odds of a bedtime of 11 PM or later (odds ratio = .74, 95% confidence interval, 58% - .95). In girls, higher Encouragement of Maturity scores were also associated with decreased nightly variation in mean sleep duration ($P < .001$). Increases in total MC-HOME score were associated with increased mean sleep duration among African-American children only ($P < .05$).

Conclusion: Collectively, results indicate that a parenting style encouraging social maturity in children is linked to healthier sleep patterns.

Keywords: Sleep, home environment, schoolchildren, parenting style

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INTRODUCTION

STUDIES INDICATE THAT SUBSTANTIAL NUMBERS OF ELEMENTARY-SCHOOL CHILDREN IN THE UNITED STATES ARE NOT GETTING ENOUGH SLEEP.1-2 Insufficient sleep may lead to significant daytime consequences: excessive daytime sleepiness,3,4 decreased cognitive functioning and poorer academic performance,5,6 increased behavioral problems and aggression,7,8 and accidents such as falls from playground equipment and bicycles.9

Multiple, interrelated biologic, social, and environmental factors may disrupt children’s sleep and, therefore, be responsible for insufficient sleep. Biologic factors may involve an underlying sleep disorder, such as sleep-disordered breathing,10,11 narcolepsy,12 or other medical, neurologic, or psychiatric conditions, such as obesity, asthma, depression, and epilepsy.3,13 Besides biologic factors, the effects of various social and environmental factors on sleep are well documented. For example, the schedule and demands of school, extracurricular activities, and work may lead to substantially decreased sleep and subsequent daytime sleepiness, particularly among adolescents.14-17

Disclosure Statement
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SLEEP, Vol. 28, No. 11, 2005

One poorly understood set of contributors to inadequate sleep includes exposures specific to the home environment. For example, excessive noise or light, uncomfortable sleeping surface, low bedroom temperatures, and limited space, may adversely affect sleep.18-21 Additional factors related to the home’s social environment may also play a role. For example, family stress22 and maternal stress or depression,23-25 as well as specific bedtime practices, such as sharing a bed26 or, in 1 study, having a private bedroom26 have been associated with sleep problems.

Among all these factors, the relationship between 1 important component of the home environment—parenting style—and children’s sleep behavior has not been well studied. Although cultural, sex, and social-class differences have been noted,27,28 evidence suggests that a parenting style that is supportive, is warm or responsive, and that provides a degree of supervision or control but is not coercive (especially with adolescents) generally promotes healthy behaviors in a wide range of health domains.29-32 Two studies that have investigated the relationship between parenting style and children’s sleep found that parenting styles consistent with increased bedtime “vigilance” (ie, checking the bedroom to ascertain whether children are in bed, turning the bedroom lights off on school nights) and not “lax” (permissive, inconsistency in disciplining style) were associated with healthier sleep outcomes in children.33-35 However, these 2 studies involved small, ethnically homogeneous samples and did not fully address potential home-environment influences on sleep.

Our study was designed to address these limitations by collecting standardized data concerning the home environments of a large, urban, ethnically and socioeconomically diverse sample of children. Moreover, compared with other studies of children’s sleep behavior that involved single measures of sleep outcomes (eg, caregiver’s report of the child’s “average” sleep duration or “usual” bedtime on week nights),34,36,37 this study (1) collected data on sleep parameters over multiple nights, which accounted for nightly variation in sleep and (2) used children’s report of sleep,
which may provide a more complete picture of children’s sleep behavior.\textsuperscript{3,38}

Based on the reported association between a permissive, lax parenting style and problematic sleep,\textsuperscript{35} we hypothesized that a parenting style that promotes children to act responsibly in terms of their daily routines would be associated with positive sleep outcomes, ie, greater mean sleep duration, less nightly variation, and an earlier bedtime. Moreover, given the suggested connections between noisy, crowded physical environments and sleep problems,\textsuperscript{18-21} we hypothesized that a home environment providing a nonnoisy, clean, adequately sized living space for children would be similarly associated with positive sleep outcomes.

**METHODS**

The current study is an analysis of cross-sectional data collected as part of the Cleveland Children’s Sleep and Health Study (CCSHS), an ongoing investigation of the epidemiology of sleep-disordered breathing and health in an urban, ethnically diverse, community-based cohort of school-aged children.\textsuperscript{13,39-41}

**Sample**

Methods for the CCSHS cohort assembly and recruitment have been previously reported.\textsuperscript{13,39-41} In brief, the CCSHS is a stratified, random sample of 907 full-term and preterm (< 37 weeks’ gestational age at birth) children born between 1988 and 1993 at 1 of 3 major hospitals in the greater Cleveland, Ohio, area and studied at 8 to 11 years of age. During the second year of data collection, an assessment of the home environment was included in the protocol (see below). This report focuses on the 666 children in whom measures of the home environment were obtained. The study was approved by the Institutional Review Boards of all participating institutions. Written informed consent was obtained from all guardians, and assent was obtained from all children.

**Measurements and Protocol**

As reported previously,\textsuperscript{13,39-41} the study protocol included home visits to participating families, which included in-home overnight cardiorespiratory studies and assessments of the child’s general health status, the family home environment, sleep patterns, and other behavioral/functional outcomes (the latter not reported here). In brief, data on sleep patterns and sleep duration were ascertained from a child-completed 7-day sleep journal. Using a structured form, each morning, children recorded information concerning specific features of the previous day, such as whether they attended school or were sick, the time they went to bed, the time they attempted to fall asleep, the number of times they woke up during the night, and the time they finally awoke. Children and their caregivers were instructed on the use of the journal, and parents were encouraged to assist as needed. Chronic health or behavioral conditions that impact sleep patterns were identified from data collected using the caregiver-completed Children’s Health Questionnaire-PF50\textsuperscript{42} and Children’s Sleep and Health Questionnaire,\textsuperscript{43} a pediatric modification of a validated questionnaire that assesses sleep symptoms and disorders. Beginning in the second year of the study, trained interviewers collected data on the family home environment using the Middle-Childhood (Elementary) Home Observation for Measurement of the Environment (MC-HOME).\textsuperscript{44} In 17\% of cases, interviews were administered in a research setting rather than the participant’s home, either because of the family’s preference or staff concerns related to accessing the home.

**Covariates**

Covariates were selected based on empirical research and theory concerning biologic and social factors that affect children’s sleep patterns.\textsuperscript{3,12,13,39} Covariates included child’s age, sex, and ethnicity (African-American vs White). Other covariates consisted of child health problems, a 3-level categorical variable: (1) no reported problems; (2) symptoms of an underlying sleep problem, such as excessive daytime sleepiness (eg, child “sometimes,” “frequently,” or “always” falling asleep at school, while eating, while playing, or while talking) or sleep-disordered breathing, which included either habitual snoring (snoring loudly at least 3 times per week) or sleep apnea (ie, apnea-hypopnea index ≥ 5 events per hour or obstructive apnea index ≥ 1 event per hour, assessed by overnight cardiorespiratory measurements); or (3) other health condition (eg, epilepsy, diabetes, cerebral palsy), congenital syndrome (eg, Turner syndrome), or behavioral problem (eg, attention-deficit/hyperactivity disorder, Tourette syndrome). Caregiver education was classified as less than high school versus high school diploma or more; education was assumed to be the latter for 7 individuals with missing education data. Median annual income in resident census tract was determined by matching the child’s current address to the corresponding 2000 United States Bureau of the Census tract. Children were categorized as on vacation if either their sleep journals were completed over the summer or winter break or if the child reported being out of school at least 4 of 5 weekdays and was not sick (eg, a nonholiday family vacation). The cohort was originally assembled to examine the effects of prematurity on a range of child health outcomes. Thus, by study design, approximately one half of the CCSHS cohort was born prematurely, defined as < 37 weeks gestational age; preterm status was therefore added as a covariate to control for a possible design effect. Collectively, the inclusion of these covariates in the analyses constitute a robust test of the potential contribution of the home environment to sleep outcomes, after accounting for the effects of several other biologic and social factors.

**Home Environment Predictors**

The MC-HOME was used to assess children’s home environments. The instrument was developed to assess the quality of the social, emotional, and physical dimensions of the home environment provided to school-aged children.\textsuperscript{52} The MC-HOME and versions for both younger (eg, Infant-Toddler HOME, Early Childhood HOME) and older children (Early Adolescence HOME) have been standardized and validated across diverse populations.\textsuperscript{44-49} Convergent validity is supported by correlations between HOME scores and demographic indexes, eg, parent’s education or occupation, and socioeconomic status as measured by the Hollingshead 4-factor Index of Social Position.\textsuperscript{44} Several studies in multiple settings have found correlations between HOME scores and various developmental outcomes, such as social competence, intelligence, and behavior problems, among others.\textsuperscript{45,48} Estimates of the HOME’s reliability (internal consistency) among diverse study samples have generally been at acceptable levels: α coefficients of at least .80 for the total scale, and from .30 to .80 for the subscales.\textsuperscript{35} The instrument also exhibits acceptable stability across both observers and time.\textsuperscript{45} Moreover,
factor analysis has shown substantial stability in the underlying factor structure of the HOME across versions.49

The instrument consists of 8 subscales, each of which measures a domain considered important to the healthy development of children: encouragement of maturity (degree to which the home environment fosters development of the child’s social maturity); the physical environment (whether home space is clean, adequately sized, not overly noisy, and safe); parental responsivity (level of family emotional and verbal response to the child); emotional climate (the degree to which the home’s emotional climate is supportive and accepting, not harsh or punitive); provision for active stimulation (e.g., hobbies, museums, sports or music lessons); learning materials (presence of learning materials fostering intellectual development such as books or reading/studying space); family companionship (family participation in developmentally stimulating experiences with child); and paternal involvement (father or father figure’s presence in family activities and routines). MC-HOME items are binary, scored 1 point for yes, 0 points for no. Subscale items are summed to produce a score for that domain. Moreover, the 8 subscales are summed to produce a global measure of the overall quality of the home’s social, emotional, and physical environment. Higher scores are indicative of more favorable home environments. In the current study, 3 MC-HOME measures were utilized to address study hypotheses:

**Encouragement of Maturity**

The 7-item Encouragement of Maturity Subscale measured the degree to which the home’s social environment encouraged development of the child’s social maturity via enactment of self-care routines and enforcement of family rules: e.g., whether the child is required to carry out various self-care routines such as making the bed, cleaning the room, picking up clothes; whether there are set, enforced times for homework, bed, play; whether family rules are applied consistently. Scores may range from a minimum of 0 to a maximum of 7.

**Quality of Home’s Physical Environment**

The 8-item Physical Environment Subscale assessed if the domicile’s physical environment was safe and livable. Items included whether the home is reasonably clean, has adequate living space, is not overly noisy, and contains no potentially dangerous structural or health defects. Scores may range from 0 to 8.

**MC-HOME Total Score**

The entire 59-item scale provided a measure of the quality of the home’s overall social, emotional, and physical environment. Scores may range from 0 to 59.

**Sleep Outcomes**

To assess the influence of the home environment on different aspects of sleep behavior, 3 different sleep outcomes relating to sleep duration, nightly variation in sleep duration, and bedtime were used. Sleep outcomes were calculated as the mean values over all available days of self-reported journal information (over a maximum recording period of 7 days and requiring at least 2 weekday nights and 1 weekend night). Other research has demonstrated agreement between self-report measures of sleep behavior and an objective measure among adolescents.50 The specific sleep outcomes included sleep duration, coefficient of variation, and bedtime of 11:00 PM or later.

**Sleep Duration**

The total hours slept was calculated as the difference between the average time the child awoke in the morning and the average time when the child attempted to fall asleep.

**Coefficient of Variation**

The coefficient of variation (CV) is a measure of the night-to-night variation in sleep duration. CV was selected as a study outcome because consistency in sleep patterns (ie, bedtime, wake time, hours slept) is considered important for healthy sleep.12 CV is calculated as the standard deviation of sleep duration divided by mean sleep duration, expressed as a percentage.

**Bedtime of 11:00 PM or Later**

The specific cut-off point in time of a mean bedtime of 11:00 PM or later was selected because children going to bed at or after 11:00 PM and waking up at the average reported wake time in the sample (7:45 AM) would not have obtained the recommended 9 to 10 hours of nightly sleep currently recommended by the National Sleep Foundation51 and the National Institutes of Health’s “Starsleeper” Campaign.52

The 3 outcome variables were modestly correlated with each other (Spearman r ranged in magnitude from .17 to .39, P < .01), thereby indicating that the outcomes, while interrelated, represented different aspects of sleep.

**Statistical Analysis**

Proportions and means were used to summarize sample characteristics for categorical and continuous data, respectively. T tests and analyses of variance were used to compare group differences for normally distributed data. The Mann-Whitney U and Kruskal-Wallis tests were used for nonnormally distributed data, and the Pearson χ2 test was used for categorical data. Because the distribution of the CV in the analytic sample was skewed, we transformed the variable by taking the natural logarithm of CV. Linear regression was used to assess the relationship between the HOME and mean sleep duration and logarithm of CV, controlling for covariates and potential confounders. The results of these models are summarized via slopes and their standard errors. Logistic regression was used to estimate the odds of going to bed at 11:00 PM or later. The results are expressed as odds ratios (OR) and corresponding 95% confidence intervals (95% CI). Because previous research has revealed differential effects of sex and ethnicity on sleep patterns, statistical interactions with MC-HOME predictors were also assessed using a backward elimination procedure. Interaction terms were retained only if they were statistically significant (P < .05). Analyses were conducted with SPSS version 12.0 (SPSS Inc., Chicago, IL) and SAS version 9.1 (SAS Institute, Inc., Cary, NC).

**RESULTS**

**Sample Characteristics**

Of the 666 children eligible for inclusion in this analysis, 581

*SLEEP, Vol. 28, No. 11, 2005*
children had complete MC-HOME data, and 542 children had sufficient sleep-journal data to calculate average bedtime and wake time. Among these children, 95% completed at least 6 days of the weeklong journal, and fewer than 1% of children had what we considered the minimum requirement of at least 2 weekday nights and at least 1 weekend night. Two children were excluded from the CV analysis because they reported the same bedtime and wake time for all 7 days, resulting in a CV of 0 (ie, no nightly variation in sleep duration). Most (96%) of the children were either White (n=241) or African-American (n=208), and 4% were of other ethnicities: multiracial/ethnic (n=10), Hispanic (n=4), Native American (n=2), and Asian American (n=2). Because the sample sizes of the non-White or non-African-American groups were small, they were excluded from analyses. The final analytic sample consisted of 449 African-American or White children with both MC-HOME and sleep-journal data.

Sample characteristics are described in Table 1. Participants had an average age of 9.5 years, with nearly equal proportions by sex and ethnicity. Consistent with the cohort design, nearly half of the children were of preterm birth. Most primary caregivers (93%) had completed high school. The average annual median income in the United States census tract of residence was $46,477. Mean nightly sleep duration for the sample was 9.6 hours, and the mean CV was 8.9%. Approximately 15% of the sample had an average bedtime of 11:00 PM or later.

Comparison of the analytic sample with the 217 eligible children who were excluded from the analytic sample because of missing data (ie, incomplete MC-HOME, sleep journal, or both), no reported CV, or non-White/African-American ethnicity showed that both groups were of similar age and had similar proportions by sex and preterm status. A higher proportion of excluded children had a caregiver who had completed high school (97.7%) compared with the analytic sample (93.1%) (P < .05). The distribution of MC-HOME scores differed across certain sample subgroups. First, homes of African-American children had lower scores than those of White children on 2 measures: median MC-HOME total score 47.0 (interquartile range = 42.5-51.0) versus 52.0 (49.0-54.0), Z = -9.982, P < .001. Similarly, children whose primary caregivers did not graduate from high school had significantly lower scores than did children whose primary caregivers had at least a high-school education on 2 measures: median MC-HOME total score 44.0 (42.0-47.0) versus 51.0 (46.0-53.0), Z = -5.024, P < .001 and median Physical Environment score 8.0 (7.0-8.0) versus 8.0 (8.0-8.0), Z = -8.894, P < .001. Similarly, children whose primary caregivers did not graduate from high school had significantly lower scores than did children whose primary caregivers had at least a high-school education on 2 measures: median MC-HOME total score 44.0 (42.0-47.0) versus 51.0 (46.0-53.0), Z = -5.024, P < .001 and median Physical Environment score 7.0 (5.5-8.0) versus 8.0 (7.0-8.0), Z = -4.628, P < .001. Finally, median Encouragement of Maturity subscale scores for children who were born prematurely were lower than those for children born at full term: 6.0 (5.0-6.0) versus 6.0 (5.0-7.0), Z = -3.116, P < .01.

Unadjusted Relationships of MC-HOME Predictors With Sleep Outcomes

Results of unadjusted and adjusted linear regression models are summarized in Table 2.

Encouragement of Maturity

Higher scores on the Encouragement of Maturity Subscale were significantly associated with longer mean sleep duration (β = .067, SE=0.030, P < .05). However, higher scores on the subscale were not significantly associated with lower average

SLEEP, Vol. 28, No. 11, 2005

Figure 1—Nightly Variation in Sleep Duration by Encouragement of Maturity Score. Dashed line for girls. Slope for logarithm of coefficient of variation (CV) = -.113, SE = 0.032, P = .0004. Solid line for boys. Slope for logarithm of CV = .059, SE = 0.032, P = .062

night-to-night variability in sleep duration as indicated by a lower CV, or with decreased odds of a bedtime at or after 11:00 PM.

Physical Environment

The physical environment subscale was not significantly related to any sleep outcome.

Total MC-HOME Score

The total MC-HOME score was a significant predictor of a decreased CV (β = -.012, SE=0.005, P < .05) and decreased odds of a later bedtime (OR = .95, 95% CI .91-.99).

Adjusted Results: Relationship of Encouragement of Maturity with Sleep Outcomes

Multiple linear regression of mean sleep duration revealed a small, statistically significant, main effect for Encouragement of Maturity (P < .05) after controlling for covariates and potential confounders (Table 2). Each 1-unit increase in the subscale score was predicted to be associated with an average increase in sleep duration of 0.063 hours (4 minutes). The change in Encouragement of Maturity from lowest to highest observed score corresponded to an increase of 26 minutes. Average night-to-night variability showed a significant interaction between the Encouragement of Maturity score and sex (P < .001). For girls, a 1-unit increase in the subscale score corresponded to a .113 decrease in the logarithm of CV, or a 10.6% decrease in mean CV (P < .001) (Figure 1). Encouragement of Maturity was not a significant predictor of CV in boys.

Results for a bedtime at or after 11:00 PM revealed a significant main effect for Encouragement of Maturity, in which a 1-point increase in the subscale score was associated with a significant decrease in the odds of a late bedtime (OR = .74, 95% CI .58-.95).

Adjusted Results: Relationship of Physical Environment to Sleep Outcomes

Similar to unadjusted analyses, adjusted results revealed that the Physical Environment subscale score was not a statistically significant predictor of any sleep outcome.
Adjusted Results: Relationship of MC-HOME Total Scale Scores to Sleep Outcomes

Adjusted results revealed a significant interaction between ethnicity and the total MC-HOME score (P < .05): each 5-point increase in the total score was associated with an average 5-minute increase in mean sleep duration for African-American children, corresponding to a 48-minute increase in mean sleep duration in the change from lowest to highest observed total scores (Figure 2). In contrast, the total MC-HOME score was not significantly associated with mean sleep duration among White children. Moreover, after controlling for covariates and confounders, the total MC-HOME score was not significantly associated with night-to-night variability in sleep duration or the odds of a bedtime of 11 PM or later.

Exploratory Analyses of Remaining MC-HOME Subscales

Because of their associations with other health outcomes, it seemed plausible that the constructs represented by the other subscales of the MC-HOME (eg, responsivity, emotional climate, learning materials, enrichment, family companionship, paternal involvement) might also be associated with our 3 sleep outcomes of interest. We therefore conducted secondary analyses of the relationship of the MC-HOME’s remaining 6 subscales with the 3 sleep outcomes. The analyses were exploratory and, therefore, limited to tests for main effects after adjusting for the effects of covariates. Results showed that Emotional Climate (the degree to which the home’s emotional climate is supportive and accepting) was associated with decreased odds of a bedtime at or after 11 PM (OR .69, 95% CI .52-.93). None of the subscales was related to sleep duration or night-to-night variability.

DISCUSSION

To our knowledge, this study is the first to investigate the relationship between school-aged children’s sleep patterns and aspects of the home’s social environment as measured by the MC-HOME. In support of our hypothesis, results indicated that a parenting style that encourages social maturity in children is linked to healthier sleep patterns for children, as defined by an increase in average nightly sleep, decreased night-to-night variability in sleep (for girls), and a bedtime before 11:00 PM. Specifically, better sleep habits appear to be associated with parental encouragement of the child following consistent routines. Perhaps this parenting style fosters positive self-regulation skills in children. Our results are consistent with those of the few existing studies examining parenting style and children’s sleep, in which a more “active” parenting style may positively influence children’s sleep habits. Because children increasingly set their own bedtimes as they enter adolescence, a parenting style that successfully helps preadolescent children establish a healthy sleep routine could set these children up for healthier sleep outcomes as they enter adolescence and assume more responsibility for their daily lives. Although the degree to which parents can change their parenting style is not clear, pediatricians can encourage parents of preadolescent children that their attempts to foster self-care routines and enforce family rules may make a difference in their children’s sleep behavior.

We also demonstrated that the association between the home social environment and sleep patterns varied among different groups of children. The relationship between the overall social
environment in the home and good sleep hygiene (in terms of mean sleep duration) was strongest in African-American children, while a parental style encouraging social maturity was most strongly linked to decreased nightly variation in sleep among girls. The reasons for the observed differences by ethnicity or sex are unclear. Concerning the sex difference, perhaps girls and boys respond differently to the effort by parents to develop routines. Concerning the differences among ethnic groups, overall, African-American children had lower MC-HOME total and Physical Environment subscale scores, indicating a less advantageous (as measured by the MC-HOME) environment. Perhaps, in these less advantageous settings, even small changes in aspects of the home environment such as promoting consistent routines can result in significant improvements in sleep outcomes. Pediatricians of children living in more disadvantageous settings should help parents to monitor their children’s behavior to ensure that their children are getting enough sleep.

It is possible that the observed interaction between MC-HOME scores and ethnicity may have been an artifact of greater variability in the predictor and outcome variables among African-American children; the range and standard deviation of mean sleep duration was greater among African-American children. Additionally, because a broad range of sociocultural factors may correlate with ethnicity, it is possible that other unmeasured aspects of the home and social environment that vary by ethnicity might modify the effect of factors identified in the MC-HOME on sleep patterns. For example, in homes of greater socioeconomic status, children who are encouraged to be more self-reliant also may be encouraged to be more involved with extracurricular activities that reduce the time available for sleeping.

The observed changes in sleep parameters associated with a 1-unit change in either the MC-HOME total or Encouragement of Maturity subscale score appear small (1-4 minutes for mean sleep duration). However, the differences in mean sleep duration between children scoring the minimum versus maximum observed MC-HOME total and Encouragement of Maturity scores are similar or greater in magnitude to modest changes in sleep time (≥ 30 minutes) shown to affect children’s neurobehavioral functioning.53

Contrary to our hypothesis, results consistently showed that the quality of the physical environment as measured by the MC-HOME’s physical environment subscale (e.g., cluttered, noisy, overcrowded, dark interiors) was not related to sleep outcomes in this sample of children. Several factors might be responsible for the lack of an association. One possibility is that the range of subscale scores observed in this sample (i.e., the range of physical environments “represented” by the study participants) was not great enough to show a difference in the study’s sleep outcomes. In other words, perhaps even the least-favorable physical environments, as reflected by the lowest subscale scores observed, were not sufficiently problematic to affect sleep. For example, examination of the subscale’s individual items revealed that 97% of the sample’s households were not “overly noisy” (item 57) and 92% had adequate living space per person (item 56). Thus, largely missing from this sample were the noisy crowded households that might be expected to disrupt children’s sleep patterns. Moreover, 17% of families were administered the MC-HOME in a research setting instead of the family domicile, which may have resulted

Table 2—Unadjusted and Adjusted* Linear Regression Predicting Sleep Outcomes

<table>
<thead>
<tr>
<th>HOME Predictor</th>
<th>Mean sleep duration</th>
<th>Night-to-Night Variability (mean CV)</th>
<th>Bedtime After 11 pm*</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Unadjusted β (SE)</td>
<td>Adjusted β (SE)</td>
<td>OR (95% CI)</td>
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<tr>
<td></td>
<td>β (SE)</td>
<td>β (SE)</td>
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<td></td>
<td>Interaction</td>
<td>Interaction</td>
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<tr>
<td></td>
<td></td>
<td>Boys -.059 (.032)</td>
<td>-.011 (.032)**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls -.113 (.032)**</td>
<td>.88 (.70-1.15)</td>
</tr>
<tr>
<td>Encourage maturity</td>
<td>.067 (.030)*</td>
<td>.063 (.030)**</td>
<td>-.030 (.023)</td>
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<td>Physical environment</td>
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<td>-.023 (.039)</td>
<td>-.026 (.029)</td>
</tr>
<tr>
<td>HOME total scale</td>
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<td>-.012 (.005)*</td>
<td>-.009 (.006)</td>
</tr>
<tr>
<td>Family companionship</td>
<td>.041 (.036)</td>
<td>.020 (.038)</td>
<td>-.021 (.028)</td>
</tr>
<tr>
<td>Enrichment</td>
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<td>.009 (.024)</td>
<td>-.029 (.022)</td>
</tr>
<tr>
<td>Learning materials</td>
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<td>.015 (.030)</td>
<td>-.021 (.026)</td>
</tr>
<tr>
<td>Emotional climate</td>
<td>.022 (.034)</td>
<td>.012 (.034)</td>
<td>-.024 (.026)</td>
</tr>
<tr>
<td>Responsivity</td>
<td>.045 (.034)</td>
<td>.010 (.034)</td>
<td>-.021 (.026)</td>
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<tr>
<td>Paternal involvement</td>
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<td>.031 (.031)</td>
<td>-.052 (.021)*</td>
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<td>Learning materials</td>
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<td>Physical environment</td>
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<td>-.021 (.028)</td>
</tr>
<tr>
<td>Paternal involvement</td>
<td>.051 (.028)</td>
<td>.031 (.031)</td>
<td>-.052 (.021)*</td>
</tr>
</tbody>
</table>

*Controlling for age, sex, ethnicity, preterm, health conditions, vacation, caregiver education, and median annual income in census tract of residence.

**P < .01
***P < .001

CV refers to coefficient of variation; CI, confidence interval.

*SLEEP, Vol. 28, No. 11, 2005

Effects of Home Environment on Children’s Sleep—Spilsbury et al
in an underestimation of the physical problems in the highest risk homes.

Exploratory analyses of other MC-HOME subscales suggested that an additional characteristic of the household social environment (an accepting, supportive emotional climate) might be linked with children's sleep patterns. In our sample, this domain was associated with an earlier bedtime (before 11:00 AM). Parental warmth is viewed as a component of the authoritative parenting style that has been linked with other positive health outcomes.29,31,54 Perhaps such a parenting style is also effective in promoting good sleep hygiene, at least among school-aged children.

Limitations of the study should be acknowledged. We recognize that 17% of children were excluded from analyses because of incomplete sleep-journal data. We suspect that families with children who have more highly variable sleep patterns may have experienced greater difficulty completing the journal. The opportunity to include data from these children into the analyses may have strengthened associations between the less-favorable MC-HOME predictors and less-desirable sleep-outcome measures. Second, our sleep data were self reported, and use of a more objective measure, such as actigraphy, might have added greater precision to sleep estimates. Third, the HOME was designed to assess the presence of household characteristics linked to improved developmental outcomes in children and was not designed to specifically measure parenting style or assess sleep outcomes. Furthermore, the relevance of individual HOME items may vary somewhat across ethnic groups or socioeconomic strata.25 Indeed, the instrument has been modified in various studies in the effort to better gauge specific types of families: eg, United States families living in impoverished urban environments,56 rural villagers of St. Vincent,57 and Ugandan families.58 Although the overall HOME score is considered highly reliable, its subscores are less reliable, and thus these subscales may be more limited in their discriminative properties. Finally, because our data were cross-sectional, we cannot exclude the possibility that reverse causality was operating, ie, that the parents of children with better sleep habits (which may be a surrogate for other behaviors) assumed more positive parenting styles than parents "reacting" to children with poorer health habits.

This study joins other investigations in demonstrating the influence of parenting characteristics on a range of children's health outcomes.29-31,54,59,60 In the case of sleep, existing research suggests that children's sleep patterns are affected by factors such as family functioning and maternal depression. This study extends that literature by implicating parenting style, specifically encouragement of maturity, and general aspects of the home environment as additional influences on children's sleep. Future research should be conducted to elucidate what specific aspects of parenting style or strategies lead to better sleep outcomes for school-aged children. For example, to what degree is parental monitoring effective? How vigilant? What produces the best sleep outcomes? An overly coercive, controlling style has shown negative or mixed results in other child-health outcomes.27,33 What effect would a coercive parenting style have on sleep?

Moreover, the literature suggests that there are ethnic, sex, and class differences in parenting and the household social environment as measured by instruments like the HOME. Future research should be conducted to understand the origins of these differences, as well as to investigate whether certain parenting strategies are more effective for specific subgroups of the population. Based on this information, interventions could be conducted in which parents utilize a specific strategy (or strategies) and researchers examine resulting effects on children's sleep.

Related to the limitation of study measures described earlier, more research on study instruments is needed. For example, the items comprising the HOME may not be sufficiently sensitive (or even relevant) to capture the variation in specific aspects of the family home environment that shape children's sleep. For this reason, future research efforts should focus on the development of a "sleep environment questionnaire" or modification of an existing instrument of the household environment to permit accurate measurement of sleep promoters or facilitators and disruptors or inhibitors in the home. Qualitative studies may first be necessary to identify actual disruptors and promoters of children's sleep and how best to measure them. However, the research literature,27,31,54 as well as the experience of clinicians who deal with sleep issues,12 already points to domains likely to be included in such an instrument, eg, light levels in the bedroom, household and neighborhood noise levels, adequate bedding; presence or composition of bedtime routines and bedroom activities, household work routines, and family stress levels. Observational studies as well as objective measurements of physical characteristics such as room light and sound levels coupled with subjective (self-reports) and objective (actigraphy) measures of sleep could be used to develop and validate the instrument.

Finally, parenting styles and monitoring strategies are but components of the large, complex social environment we call "the home." Further research should be conducted to assess the influence of other aspects of the home environment on sleep. Such knowledge could help us understand how and why excessive sleepiness occurs. Based on this information, we could begin to develop interventions that are realistic and effective in promoting healthy sleep patterns in children's home environments.

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SLEEP, Vol. 28, No. 11, 2005


SLEEP, Vol. 28, No. 11, 2005


