



Original Contribution

The Sleep-Time Cost of Parenting: Sleep Duration and Sleepiness Among Employed Parents in the Wisconsin Sleep Cohort Study

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Insufficient sleep is associated with poor health and increased mortality. Studies on whether parenthood (including consideration of number and ages of children) is associated with sleep duration or sleep problems are scant and inconclusive. Using data collected in the Wisconsin Sleep Cohort Study ($n=4,809$) between 1989 and 2008, we examined cross-sectional associations of number and ages of children with self-reported parental sleep duration, daytime sleepiness, and dozing among employed adults. Longitudinal change in sleep duration over 19 years was examined to evaluate changes in parental sleep associated with children transitioning into adulthood ($n=833$). Each child under age 2 years was associated with 13 fewer minutes of parental sleep per day (95% confidence interval (CI): 5, 21); each child aged 2–5 years was associated with 9 fewer minutes of sleep (95% CI: 5, 13); and each child aged 6–18 years was associated with 4 fewer minutes (95% CI: 2, 6). Adult children were not associated with shorter parental sleep duration. Parents of children over age 2 years were significantly more likely to experience daytime sleepiness and dozing during daytime activities. Parents of minor children at baseline had significantly greater increases in sleep duration over 19 years of follow-up. Parenting minor children is associated with shorter sleep duration. As children age into adulthood, the sleep duration of parents with more children approaches that of parents with fewer children.

adult; cohort studies; humans, middle aged; parents; sleep; sleep duration

Short sleep duration, generally defined as sleeping less than 7–8 hours over a 24-hour period, has been associated with higher risk of mortality (1) and poor health outcomes, including cardiovascular disease (2), diabetes and impaired glucose tolerance (3), lower bone mineral density (4), and higher body mass index (5, 6). Short sleep has also been associated with traffic (7) and workplace (8) accidents, as well as with learning and memory problems (9, 10).

Investigations into the effects of parenthood on sleep have been limited. Cross-sectional studies comparing parents with childless adults have yielded conflicting results, have been mostly restricted to women, and have been subject to confounding—including the “healthy mother bias” (11), whereby adverse health conditions might affect both sleep duration and parity. Some studies have found a positive association between having children and self-reported fatigue, daytime sleepiness, or sleep problems (11), but others have found no association (12, 13). Leonhard and Randler (14) found that having children was associated with small decrements in

total sleep time among nonpregnant women but small increments among pregnant women (neither finding was statistically significant).

It is unclear to what degree children’s ages or number of children might affect parental sleep. Having children has been associated with shorter total nap time (15), more daytime sleepiness (11), and a lower likelihood of abnormally long sleep (16).

A small number of studies have followed parents longitudinally but have focused on the pregnancy and postpartum period (17–20). Additionally, some studies have compared sleep among parents of children with special needs and parents of healthy children, but they captured the parental impact of coping with specific conditions rather than the effect of parenting per se (21).

Using data from the Wisconsin Sleep Cohort Study, we investigated whether the number and ages of children were associated with sleep outcomes cross-sectionally and longitudinally. We hypothesized that parents of young children

would have shorter sleep durations and more sleepiness and dozing than parents of older children or nonparents; that having a greater number of young children would be associated with shorter sleep duration and more sleepiness; and that as children grew up, parents' sleep duration would increase.

MATERIALS AND METHODS

Sample and data collection

The Wisconsin Sleep Cohort Study is an ongoing longitudinal study of sleep habits and sleep disorders in the general population (22). Informed consent documents and study protocols (23) were approved by the University of Wisconsin-Madison Health Sciences Institutional Review Board.

All employees of 5 state agencies in south central Wisconsin aged 30–60 years were mailed a survey (“survey 1”) on sleep habits, health, and demographic factors in 1989. Of the 6,947 state employees who were mailed the first survey, 5,091 (73%) completed and returned it. Among respondents, 4,895 (96%) had complete data for this analysis. In 1994, a second survey (“survey 2”) was mailed to respondents of survey 1 with known addresses ($n=5,006$) and was returned by 3,490 (70%). Among respondents, 3,109 (89%) had complete data on all study variables.

A stratified random sample of respondents to survey 1 was recruited for an initial overnight protocol including polysomnography ($n=2,884$). Stratification was based on risk for sleep-disordered breathing. In 2008, survey 3 was mailed to volunteers who had completed at least 1 in-laboratory sleep study ($n=1,545$). Survey 3 was received from 1,150 respondents (74%). The sample was restricted to respondents whose usual sleep duration was 4–12 hours (survey 1: $n=4,809$; survey 2: $n=3,006$; survey 3: $n=833$), because it has been shown that people with sleep durations farthest from typical have the most error in reporting duration (24).

Variables

Outcome variables. Sleep duration. Usual sleep duration was estimated on each survey from the following question: “How many hours of sleep do you usually get (a) on a workday night? (b) on a weekend or nonwork night? (c) in a typical week from daytime or evening naps?” Daily average sleep duration was calculated as $(5 \times \text{workday sleep} + 2 \times \text{weekend sleep} + \text{weekly naps})/7$.

Short sleep. Respondents were considered short sleepers if their usual sleep duration was 6 hours or less per night.

Daytime sleepiness. From the Epworth Sleepiness Scale (25), respondents were asked how often they experienced “feelings of excessive daytime sleepiness.” They were considered to have daytime sleepiness if they answered “often” (5–15 times/month) or “almost always” (16–30 times/month).

Propensity to doze. From the Epworth Sleepiness Scale (25), respondents were asked how often they 1) “fall asleep or doze momentarily—watching TV, reading, etc.” and

2) “fall asleep or doze momentarily—at meetings, church, etc.” They were considered to have a propensity to doze if they responded “often” (5–15 times/month) or “almost always” (16–30 times/month) for either question.

Change in sleep duration. Change in usual sleep duration between surveys 1 and 3 was calculated as average daily sleep from survey 3 minus average daily sleep from survey 1.

Children. On survey 1, respondents were asked for the age (in years) of each of their children. Children's ages were calculated on the basis of survey 1 responses and the amount of time between surveys for the survey 2 and survey 3 time points. Age was categorized as follows: “infant,” 0–23 months; “preschool,” 2–5 years; “school age,” 6–18 years; “adult,” 19 years or older. We expected that sleep duration among parents of very young infants would be qualitatively different from that among parents of older babies. However, our data allowed only for categorizing children as finely as less than 12 months and 12–23 months. The sample sizes of parents in these 2 groups were relatively small ($n=81$ and $n=105$, respectively) and the average sleep durations among parents of children in these 2 groups were very similar (means of 7.17 hours and 7.18 hours, respectively), so they were grouped into 1 category. The child age-group variables represent the number of children in each age category at the time of the surveys.

Covariates. The following variables were associated with both having children and usual sleep duration and thus were controlled for in our models: educational level, age, body mass index, sex, current smoking status, and amount of weekly exercise. We also included marital status, since we were interested in whether nonmarried parents' sleep was affected differently than the sleep of those who were married. The number of work hours per day was not associated with having minor children and thus was not included in our models.

Respondents were asked for their highest level of completed education on survey 1. Response categories included less than 8th grade, 9th–11th grade, high school graduation, some college, bachelor's degree, and postgraduate degree. These categories were coded 1–6 and analyzed as an ordinal variable. Respondents' ages were calculated from birth and survey dates and modeled as a continuous variable. Height and weight were self-reported on each survey, and body mass index was calculated as $\text{weight (kg)}/\text{height (m)}^2$. Marital status was dichotomized as married/unmarried. Current smoking status was dichotomized as yes/no. Respondents reported the number of hours per week of regular, planned exercise on survey 1.

Statistical analysis

Analyses were performed with SAS, release 9.1 (SAS Institute Inc., Cary, North Carolina). The distribution of the number of children in each age group at the time of survey 1 was determined. Descriptive statistics are reported for survey 1 overall and for persons who had any minor children (age <19 years), persons with no minor children, and persons who had survey 3 follow-up data.

Survey 1 data were used to evaluate the cross-sectional relationship between number of children and sleep duration using ordinary linear regression. An additional model grouped all minor children together for comparison with longitudinal results. Logistic regression was used to evaluate the relationship between the number of children in each age group and short sleeper status. Using data from survey 1, the relationship between number of children and the outcomes daytime sleepiness and propensity to doze were ambiguous (i.e., the odds ratio did not reach statistical significance for some age groups). We therefore combined observations from surveys 1 and 2, taking into account the correlated data (generalized estimating equations with an unstructured correlation matrix). Odds ratios remained very similar but were significant. Thus, the results of these models are presented. All models were adjusted for potential confounders.

Respondents to surveys 1 and 3 were included in the longitudinal analysis of number of children and sleep duration. Ordinary linear regression was used to evaluate the association between change in sleep duration between surveys 1 and 3 and the number of minor children and the number of adult children in the household at baseline. In the 19 years between these surveys, all (surviving) children who were minors at the time of survey 1 necessarily aged into adulthood. Thus, the coefficient for number of minor children estimated how much parental sleep duration changed, per child, as children aged into adulthood. We reweighted this model by the inverse probability of participation in survey 3 to determine whether participation bias may have affected the results.

Quadratic terms for education and each of the child age group categories were entered into the model. These variables were not significantly associated with any of the sleep outcomes, nor did they improve model fit, so they were not included in the final models. A sensitivity analysis that included both the group of persons who reported a usual sleep duration of <4 hours and the group that reported a usual sleep duration of >12 hours did not substantially change any of the results, so these models are not presented. Interactions between the child age categories and respondent sex, age, and marital status were evaluated. The statistical significance (2-tailed *P* values: <0.05 for main effects and <0.01 for interactions) of regression coefficients was assessed by means of *t* tests.

RESULTS

The number of children in each age category at the time of survey 1 is shown in Table 1. The mean daily sleep duration was 7.3 (standard deviation, 0.9) hours, and approximately 8% of the sample was characterized as short sleepers. Approximately 15% of the sample had daytime sleepiness, and 32% had a high propensity to doze (Table 1).

Sleep duration, daytime sleepiness, and propensity to doze

Being a parent of minor children was associated with significantly shorter sleep duration, and being a parent of

younger children was associated with greater decrements in sleep duration than being a parent of older children. Having adult children was not significantly associated with shorter sleep duration (Table 2). Each child under age 2 years was associated with an average of 13 fewer minutes of parental sleep per day; each child aged 2–5 years was associated with 9 fewer minutes of sleep; and each child aged 6–18 years was associated with about 4 fewer minutes of sleep (Figure 1). When all minor children were grouped together, each child was associated with approximately 5 (95% confidence interval: 3, 6) fewer minutes of sleep per day.

Parents of children aged 2–5 years were significantly more likely to be short sleepers than respondents without children (each child aged 2–5 years was associated with 70% higher odds of short sleep). While there were no significant associations between having children in the other age groups and short sleep, having a child under age 2 years was borderline-significantly associated with short sleep (odds ratio = 1.4, 95% confidence interval: 0.8, 2.4) (Table 2). Parents of children aged 2 years or older were more likely to have daytime sleepiness and a propensity to doze (Table 3).

The interactions between each of the child age categories and respondent sex, marital status, and age were tested for each of the sleep outcomes. None of the interactions were significant (data not shown).

Change in sleep duration

Cohort members who responded to survey 3 had slightly fewer children under age 2 years and more children aged 6–18 years at baseline than the total sample at survey 1 (Table 1). Change in usual total sleep time between surveys 1 and 3 was significantly associated with the number of minor children in the household at the time of survey 1, but not with the number of adult children (Table 4). Parents of minor children at baseline slept about 7 minutes longer per child at follow-up. Parents of adult children at baseline did not report significantly longer sleep times at follow-up. Weighting models by the inverse probability of participation in survey 3 did not affect the findings for the relationship between the number of minor children at baseline and change in sleep duration over the follow-up period.

DISCUSSION

Insufficient sleep is associated with myriad health consequences, including increased rates of mortality (1), cardiovascular disease (2), and diabetes (3) and a higher body mass index (5, 6, 26). Our study found that being the parent of minor children was associated with significantly shorter sleep duration and that younger minor children were associated with even shorter sleep than older minor children. Each child under 2 years of age was associated with an average of 13 fewer minutes of sleep per day; each child aged 2–5 years was associated with 9 fewer minutes of sleep; and each child aged 6–18 years was associated with 4 fewer minutes of sleep. Parents who had minor children at baseline increased their sleep time by 7 minutes per child

Table 1. Characteristics at the Time of Survey 1 of Wisconsin State Employees With 4–12 Hours of Sleep Per Day Who Responded to Mailed Surveys (n = 4,809), Wisconsin Sleep Cohort Study, 1989

Characteristic	All Subjects (n = 4,809)			Subjects With Any Minor Children (n = 2,301)			Subjects With No Minor Children (n = 2,508)			Subjects With Survey 3 Data Available (n = 833)		
	No.	%	Mean (SD)	No.	%	Mean (SD)	No.	%	Mean (SD)	No.	%	Mean (SD)
No. of children, by age group												
<2 years												
0	4,626	96.2		2,118	92.1		2,508	100		813	97.6	
≥1	183	3.8		183	7.9		0			20	2.4	
2–5 years												
0	4,242	88.2		1,734	75.4		2,508	100		734	88.1	
1	470	9.8		470	20.4		0			75	9.0	
≥2	97	2.0		97	4.2		0			24	2.9	
6–18 years												
0	2,863	59.5		355	15.4		2,508	100		455	54.6	
1	935	19.4		935	40.6		0			150	18.0	
2	802	16.7		802	34.9		0			183	22.0	
≥3	209	4.3		209	9.1		0			45	5.4	
>18 years												
0	3,072	63.9		1,714	74.5		1,358	54.2		524	62.9	
1	520	10.8		340	14.8		180	7.2		94	11.3	
2	564	11.7		156	6.8		408	16.3		113	13.6	
3	322	6.7		52	2.3		270	10.8		42	5.0	
≥4	331	6.9		39	1.7		292	11.6		60	7.2	
Female sex	2,582	53.7		1,110	48.2		1,472	58.7		413	49.6	
Education ^a												
≤8th grade	13	0.3		5	0.2		8	0.3		3	0.4	
9th–11th grade	60	1.3		27	1.2		33	1.4		8	1.0	
High school graduation	1,343	28.6		602	26.8		741	30.3		190	22.8	
Some college	1,417	30.2		728	32.5		689	28.1		235	28.2	
Bachelor's degree	978	20.8		455	20.3		523	21.4		167	20.1	
Postgraduate work	881	18.8		426	19.0		455	18.6		230	27.6	
Married	3,196	66.7		1,881	81.8		1,315	52.7		564	67.7	
Current smoker	1,042	21.7		514	22.4		528	21.1		141	16.9	
Age, years			43.1 (7.8)			40.9 (6.1)			45.1 (8.7)			43.9 (7.2)
Body mass index ^b			26.5 (5.3)			26.5 (5.4)			26.5 (5.2)			27.0 (5.5)
Exercise, hours/week			2.2 (2.7)			2.0 (2.6)			2.4 (2.8)			2.2 (2.8)
Sleep duration, hours/day			7.3 (0.9)			7.3 (0.9)			7.3 (0.9)			7.4 (0.9)
Short sleeper ^c	396	8.2		189	8.2		207	8.3		65	7.8	
Daytime sleepiness	716	15.1		337	14.9		379	15.4		159	19.4	
Propensity to doze	1,534	32.2		727	31.9		807	32.5		298	36.0	

Abbreviation: SD, standard deviation.

^a Data on education were available for 4,692 subjects.

^b Weight (kg)/height (m)².

^c Respondents were considered short sleepers if their usual sleep duration was 6 hours or less per night.

between baseline and follow-up 19 years later. That is, over a nearly 2-decade time span, as their children aged into adulthood, parents of more (initially minor) children experienced relative increases in sleep duration compared with those with fewer or no children; this yielded convergent

sleep duration experiences of parents (and nonparents) as children aged. This longitudinal observation was consistent with our cross-sectional estimates indicating that being a parent of adults was not significantly associated with shorter sleep duration.

Table 2. Difference in Daily Sleep Duration and Odds of Short Sleep Per Child in Specific Age Groups and According to Other Covariates Among Adults ($n=4,809$), Wisconsin Sleep Cohort Study, 1989

Factor	Difference in Sleep Duration, minutes ^a	95% CI	Odds Ratio for Short Sleep ^{a,b}	95% CI
Change per child, by age group				
0–1 years	-12.7**	-20.8, -4.6	1.4	0.8, 2.4
2–5 years	-8.7****	-12.7, -4.6	1.7****	1.3, 2.1
6–18 years	-3.6****	-5.5, -1.8	1.1	0.9, 1.2
>18 years	-1.1	-2.7, 0.5	1.0	0.9, 1.1
Female sex	5.7***	2.7, 8.9	0.9	0.7, 1.1
Education ^c	1.2	-0.3, 2.6	0.9*	0.8, 1.0
Age, years	-0.6****	-0.9, -0.3	1.0**	1.0, 1.0
Body mass index ^d	-0.3	-0.6, 0.1	1.0**	1.0, 1.0
Married	7.5****	3.9, 11.1	0.6***	0.5, 0.8
Exercise, hours/week	-1.2****	-1.8, -0.6	1.1***	1.0, 1.1
Current smoker	-3.2	-7.0, 0.7	1.2	0.9, 1.6

Abbreviation: CI, confidence interval.

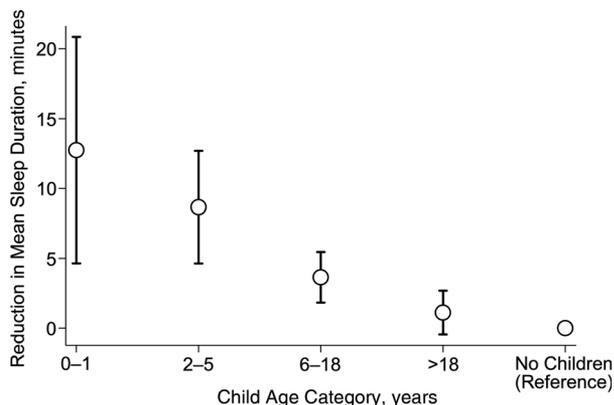
* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; **** $P < 0.0001$ (t test for sleep duration and Wald χ^2 test for short sleep).

^a Results were adjusted for all other variables in the model.

^b Respondents were considered short sleepers if their usual sleep duration was 6 hours or less per night.

^c Education was coded 1–6 and analyzed as an ordinal variable (1=less than 8th grade, 2=9th–11th grade, 3=high school graduation, 4=some college, 5=bachelor's degree, and 6=post-graduate degree).

^d Weight (kg)/height (m)².

**Figure 1.** Estimated decrement in daily parental sleep duration (linear regression estimates) associated with each additional child, by child age group ($n=4,809$), Wisconsin Sleep Cohort Study, 1989. Bars, 95% confidence interval.**Table 3.** Odds Ratios for Daytime Sleepiness and Propensity to Doze Among Adults ($n=7,815$), According to Number of Children in Specific Age Groups, Wisconsin Sleep Cohort Study, 1989 and 1994

Factor	Daytime Sleepiness ^a		Propensity to Doze ^a	
	OR	95% CI	OR	95% CI
Change per child, by age group				
0–1 years	1.24	0.82, 1.87	0.82	0.57, 1.19
2–5 years	1.31*	1.07, 1.60	1.19*	1.01, 1.40
6–18 years	1.12*	1.02, 1.23	1.13*	1.05, 1.21
>18 years	1.17*	1.08, 1.28	1.21*	1.15, 1.28
Female sex	1.05	0.88, 1.24	0.88*	0.78, 0.99
Education ^b	0.96	0.89, 1.04	0.86*	0.81, 0.91
Age, years	0.94*	0.92, 0.95	0.97*	0.96, 0.98
Body mass index ^c	1.03*	1.02, 1.05	1.03**	1.02, 1.04
Married	0.62**	0.52, 0.74	1.02	0.90, 1.17
Exercise, hours/week	0.97	0.93, 1.00	0.99	0.97, 1.02
Current smoker	1.30	1.08, 1.57	0.83**	0.72, 0.96

Abbreviations: CI, confidence interval; OR, odds ratio.

* $P < 0.01$; ** $P < 0.0001$ (Wald χ^2 test).

^a Results were adjusted for all other variables in the model.

^b Education was coded 1–6 and analyzed as an ordinal variable (1=less than 8th grade, 2=9th–11th grade, 3=high school graduation, 4=some college, 5=bachelor's degree, and 6=post-graduate degree).

^c Weight (kg)/height (m)².

Based on our results, raising a child from infancy through the end of the 18th year results in approximately 645 hours of “lost sleep” relative to not having a child. Moreover, approximately 41% of parents of minor children slept for 7 hours or less each night, and about 8% slept 6 hours or less. (For adults without children, approximately 33% slept 7 hours or less and 7% slept 6 hours or less.) These parents with short sleep durations, in particular, are susceptible to the consequences of too little sleep.

Few studies have investigated parents' sleep duration longitudinally, and those focused on the narrow period of time surrounding pregnancy and postpartum (17–20). In our study, all children who were minors at baseline had transitioned to adulthood by the time of the follow-up survey. Parents of these children slept longer at follow-up, despite reported population trends toward less sleep over time (27, 28). This study further extended previous findings by evaluating the association with both the number of children and the ages of children, evaluating several sleep outcomes, and investigating the effect of parenthood among both mothers and fathers. Furthermore, the longitudinal results address concerns about potential confounding due to a “healthy parent” bias, such that people who become parents have different sleep needs than those who do not become parents. The convergence of sleep times between parents who initially had young children and parents of adult

Table 4. Change in Daily Sleep Duration Over a 19-Year Period Among Adults ($n = 833$), According to Numbers of Minor and Adult Children and Other Covariates, Wisconsin Sleep Cohort Study, 1989–2008

Factor	Difference in Sleep Duration, minutes ^a	95% Confidence Interval
Change per child		
Per minor child (age <19 years)	6.6*	1.7, 11.6
Per adult child (age ≥19 years)	2.1	−3.0, 7.2
Female sex	1.8	−2.7, 6.3
Education ^b	0.8	−0.1, 1.8
Age, years	0.0	−0.9, 0.9
Body mass index ^c	4.8	−6.5, 16.1
Married	0.8	−0.9, 2.6
Exercise, hours/week	1.4	−8.7, 11.5
Current smoker	0.6	−12.6, 13.8

* $P < 0.01$ (t test).

^a Results were adjusted for all other variables in the model.

^b Education was coded 1–6 and analyzed as an ordinal variable (1 = less than 8th grade, 2 = 9th–11th grade, 3 = high school graduation, 4 = some college, 5 = bachelor's degree, and 6 = post-graduate degree).

^c Weight (kg)/height (m)².

children and nonparents suggests that, given the opportunity (i.e., as their children grow up), parents have longer sleep durations. Thus, it seems that there are no differences in the sleep needs or preferences of persons who become parents and those who do not.

Consistent with our results, Krueger and Friedman (29) found that parents who had any children under age 2 years were significantly more likely to sleep for 5 or 6 hours per night than for 7 hours, and that parents who had any children aged 2–18 years were significantly less likely to sleep for 8 or more hours per day. To our knowledge, this study is the only other study to have included children beyond the first few months postpartum and up to age 18 years. However, Krueger and Friedman did not investigate the effect of the number of children in each age category or other sleep problems.

We found that having children aged 2 years or older was associated with both daytime sleepiness and propensity to doze. There have been few studies of the relationship between having children and daytime sleepiness, with inconsistent results. One study of Swedish women found no relationship between number of children or children's ages and sleepiness (13); another study of Swedish women found that both having children and having greater numbers of children were associated with higher odds of fatigue (11). Our results for the relationship between having children under age 24 months and daytime sleepiness did not reach statistical significance, but they do suggest that these parents may be more sleepy. The lack of

significance may be a statistical power problem (there were fewer children in this category than in the other age categories), or it could be that additional children could have been born between the 2 surveys, so that some parents may have had another child under age 2 years that would not have been represented by this variable. Alternately, it may be that parents of younger children do, in fact, feel sleepy but have an expectation that they will feel tired during the day. If this is the case, their responses could indicate that they are not more tired than they expect they will be or think they "should" be.

We did not find strong evidence for interactions between any of our sleep outcomes and respondent age, sex, or marital status. However, our results hinted that having young children was associated with more daytime sleepiness and dozing among older parents than among younger parents.

Limitations

The sleep duration data in this study came from self-reports. Self-reported sleep duration is generally an overestimate of objectively measured duration as recorded by wrist actigraphy (29, 30). However, the bias differs by how much measured sleep people obtain. People who sleep longer, as measured by actigraphy, overestimate their sleep duration less, while people who sleep less overestimate their sleep duration more. For example, Lauderdale et al. (24) reported that people who slept for 5 hours, as measured by actigraphy, reported sleeping, on average, 6.3 hours, while those who slept for 7 hours reported sleeping 7.3 hours. Thus, the actual difference between shorter and longer sleepers in our sample is likely to be even larger than our results suggest. Our results, then, may underestimate the amount of sleep lost per child.

Another limitation is that respondents were not asked again about how many children they had after survey 1. This omission affected only the longitudinal analyses. However, we did have information from women seen in the sleep laboratory between October 1993 and September 2009, at which time they were asked about any pregnancies subsequent to survey 1. Of the 600 women who responded, only 16 reported additional pregnancies. Given the small number of estimated missing children, our conclusions would be unlikely to change. Moreover, excluding these children biases our results toward the null, suggesting that our results may underestimate the true association between having minor children and sleep duration.

In addition, we did not obtain information about whether respondents lived with their children or were their children's primary caregivers. Additionally, there was no follow-up to determine whether any children died after survey 1. While we think it is likely that most parents both lived with their children and provided care for their children and that the death of a child happened very rarely, if at all, it is possible that some parents in our sample may not have had daily child-care responsibilities that affected their sleep, which again would have biased our results toward the null.

Additionally, persons with children, especially young children, may have been less likely to come in for an in-laboratory assessment than those without children or those

with older or adult children. As a result, these parents would not have been sent survey 3 and were not represented in the follow-up sample. However, the omission of these respondents at follow-up would have biased our results toward the null, suggesting that the relationship between being a parent and change in sleep duration over time may be even stronger than our results indicate.

Finally, all respondents in the sample, at least at the time of recruitment, were employed. Our results may not be generalizable to unemployed parents or previously employed parents who left the workforce to stay home and care for their children. These parents may make different trade-offs between sleep time and other activities. Additionally, we did not collect employment information about participants' spouses or partners; spouses' employment status might have been associated both with the presence of children in households and the sleep duration of the study participants, and thus represents a potential unmeasured confounding factor.

Qualitative work in the sociology literature suggests that people's social roles can affect their sleep (31, 32). Our study adds quantitative evidence to the literature suggesting that the parenting role is significantly associated with shorter sleep duration. Because sleep is associated with many health outcomes, parents' health can be affected by their caregiving responsibilities. As such, it may be important to encourage parents to recognize the association between their caregiving roles and their health and to encourage them to make space within their daily activities for adequate sleep.

Conclusion

Few studies have evaluated the effect of having children, ranging in age from infancy through adulthood, on sleep duration and sleep problems among mothers and fathers. We found that parents of minor children slept less than adults without children, while parents of adult children did not have different sleep times than childless adults. As children transitioned from minors to adults, parents obtained more sleep. In order to obtain adequate sleep while their children are young, parents may need to be encouraged to balance their roles as caregivers with time spent on other daily activities. Future work on sleep duration should consider parenting and other caregiving roles when evaluating changes or trends in sleep duration across the life course.

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REFERENCES

- Gallicchio L, Kalesan B. Sleep duration and mortality: a systematic review and meta-analysis. *J Sleep Res.* 2009; 18(2):148–158.
- Ayas NT, White DP, Mason JE, et al. A prospective study of sleep duration and coronary heart disease in women. *Arch Intern Med.* 2003;163(2):205–209.
- Gottlieb DJ, Punjabi NM, Newman AB, et al. Association of sleep time with diabetes mellitus and impaired glucose tolerance. *Arch Intern Med.* 2005;16(8):863–867.
- Fu X, Zhao X, Lu H, et al. Association between sleep duration and bone mineral density in Chinese women. *Bone.* 2011;49(5):1062–1066.
- Taheri S, Lin L, Austin D, et al. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. *PLoS Med.* 2004;1(3):e62.
- St-Onge MP, Roberts AL, Chen J, et al. Short sleep duration increases energy intakes but does not change energy expenditure in normal-weight individuals. *Am J Clin Nutr.* 2011;94(2):410–416.
- Connor J, Norton R, Ameratunga S, et al. Driver sleepiness and risk of serious injury to car occupants: population based case control study. *BMJ.* 2002;324(7436):1125.
- Lombardi DA, Folkard S, Willets JL, et al. Daily sleep, weekly working hours, and risk of work-related injury: US National Health Interview Survey (2004–2008). *Chronobiol Int.* 2010;27(5):1013–1030.
- Ferrie JE, Shipley JM, Akbaraly TN, et al. Change in sleep duration and cognitive function: findings from the Whitehall II Study. *Sleep.* 2011;34(5):565–573.
- Kronholm E, Sallinen M, Suutama T, et al. Self-reported sleep duration and cognitive functioning in the general population. *J Sleep Res.* 2009;18(4):436–446.
- Floderus B, Hagman M, Aronsson G, et al. Self-reported health in mothers: the impact of age, and socioeconomic conditions. *Women Health.* 2008;47(2):63–86.
- Baker FC, Wolfson AR, Lee KA. Association of sociodemographic, lifestyle, and health factors with sleep quality and daytime sleepiness in women: findings from the 2007 National Sleep Foundation “Sleep in America Poll.” *J Womens Health.* 2009;18(6):841–849.
- Theorell-Haglow J, Lindberg E, Janson C. What are the important risk factors for daytime sleepiness and fatigue in women? *Sleep.* 2006;29(6):751–757.
- Leonhard C, Randler C. In sync with the family: children and partners influence the sleep-wake circadian rhythm and social habits of women. *Chronobiol Int.* 2009;26(3):510–525.
- Cottrell L, Karraker KH. Correlates of nap taking in mothers of young infants. *J Sleep Res.* 2002;11(3):209–212.
- Patel SR, Malhotra A, Gottlieb DJ, et al. Correlates of long sleep duration. *Sleep.* 2006;29(7):881–889.
- Lee KA, Zaffke ME, McEnany G. Parity and sleep patterns during and after pregnancy. *Obstet Gynecol.* 2000;95(1):14–18.
- Gay CL, Lee Ka, Lee S-Y. Sleep patterns and fatigue in new mothers and fathers. *Biol Res Nurs.* 2004;5(4):311–318.

19. Signal TL, Gander PH, Sangalli MR, et al. Sleep duration and quality in healthy nulliparous and multiparous women across pregnancy and post-partum. *Aust N Z J Obstet Gynaecol.* 2007;47(1):16–22.
20. Viilka S, Unkila-Kallio L, Punamaki RL, et al. Mental health of mothers and fathers of twins conceived via assisted reproduction treatment: a 1-year prospective study. *Hum Reprod.* 2009;24(2):367–377.
21. Meltzer LJ, Moore M. Sleep disruptions in parents of children and adolescents with chronic illnesses: prevalence, causes, and consequences. *J Pediatr Psychol.* 2008;33(3):279–291.
22. Young T, Palta M, Dempsey J, et al. The occurrence of sleep-disordered breathing among middle-aged adults. *N Engl J Med.* 1993;328(17):1230–1235.
23. Peppard PE, Young T, Palta M, et al. Prospective study of the association between sleep-disordered breathing and hypertension. *N Engl J Med.* 2000;342(19):1378–1384.
24. Lauderdale DS, Knutson KL, Yan LL, et al. Sleep duration: how well do self-reports reflect objective measures? The CARDIA Sleep Study. *Epidemiology.* 2008;19(6):838–845.
25. Johns MW. A new method for measuring daytime sleepiness: the Epworth Sleepiness Scale. *Sleep.* 1991;14(6):540–545.
26. Patel SR, Hu FB. Short sleep duration and weight gain: a systematic review. *Obesity (Silver Spring).* 2008;16(3):643–653.
27. Kronholm E, Partonen T, Laatikainen T, et al. Trends in self-reported sleep duration and insomnia-related symptoms in Finland from 1972 to 2005: a comparative review and re-analysis of Finnish population samples. *J Sleep Res.* 2008;17(1):54–62.
28. National Health Interview Survey. QuickStats: percentage of adults who reported an average of <6 hours of sleep per 24-hour period, by sex and age group—United States, 1985 and 2004. *MMWR Morb Mortal Wkly Rep.* 2005;54(37):933.
29. Krueger PM, Friedman EM. Sleep duration in the United States: a cross-sectional population-based study. *Am J Epidemiol.* 2009;169(9):1052–1063.
30. Regestein QR, Friebeley J, Shifren JL, et al. Self-reported sleep in postmenopausal women. *Menopause.* 2004;11(2):198–207.
31. Venn S, Arber S, Meadows R, et al. The fourth shift: exploring the gendered nature of sleep disruption among couples with children. *Br J Sociol.* 2008;59(1):79–98.
32. Hislop J, Arber S. Sleepers wake! The gendered nature of sleep disruption among mid-life women. *Sociology.* 2003;37(4):695–711.