Male sleep duration and fecundability in a North American preconception cohort study

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Objective: To evaluate prospectively the association between male sleep duration and fecundability.
Design: Pregnancy Online Study (PRESTO), a Web-based prospective cohort study of North American couples enrolled during the preconception period (2013–2017).
Setting: Not applicable.
Patient(s): Male participants were aged ≥21 years; female participants were aged 21–45 years.
Intervention(s): None.
Main Outcome Measure(s): At enrollment, men reported their average nightly sleep duration in the previous month. Pregnancy status was updated on female follow-up questionnaires every 8 weeks for up to 12 months or until conception. Analyses were restricted to 1,176 couples who had been attempting to conceive for up to six cycles at enrollment. Proportional probabilities regression models were used to estimate fecundability ratios (FRs) and 95% confidence intervals (CIs), adjusting for potential confounders.
Result(s): Relative to 8 hours per night of sleep, multivariable-adjusted FRs for <6, 6, 7, and ≥9 hours per night of sleep were 0.62 (95% CI 0.45–0.87), 1.06 (95% CI 0.87–1.30), 0.97 (95% CI 0.81–1.17), and 0.73 (95% CI 0.46–1.15), respectively. The association between short sleep duration (<6 hours per night) and fecundability was similar among men not working nights or rotating shifts (FR 0.60, 95% CI 0.41–0.88) and among men without a history of infertility (FR 0.62, 95% CI 0.44–0.87) and was stronger among fathers (FR 0.46, 95% CI 0.28–0.76).
Conclusion(s): Short sleep duration in men was associated with reduced fecundability. Because male factor accounts for 50% of couple infertility, identifying modifiable determinants of infertility could provide alternatives to expensive fertility workups and treatments. (Fertil Steril® 2018;109:453–9. ©2017 by American Society for Reproductive Medicine.)
Key Words: Cohort studies, fertility, preconception, sleep, time to pregnancy

Sleep deprivation is prevalent and increasing in North America. The Institute of Medicine has estimated that 50–70 million adults in the United States have chronic sleep and wakefulness disorders. The percentage of US adults reporting <7 hours of sleep on average nearly doubled from 1985 to 2012, reaching approximately 33% (1). Previous studies have reported U-shaped associations between sleep duration and obesity (2), cardiovascular disease (3), and all-cause mortality (4), with those sleeping 7–9 hours per night exhibiting the lowest risk of adverse health outcomes (5). Most epidemiologic studies have focused on the health effects of sleep duration, rather than sleep quality, although some evidence indicates that poor sleep quality is associated with higher mortality (6).

The American Academy of Sleep Medicine and the Sleep Research Society released a consensus statement in 2015 on the recommended amount of sleep to promote optimal health (5). Experts concluded that 7.0–9.0 hours of sleep were optimal for health in adults (aged 18–60 years), whereas fewer than 6.0 hours of sleep was

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insufficient (5). Approximately 50% of experts agreed that sleep duration in the 6.0–7.0-hour range was suboptimal, but no consensus was reached on the value or harm of sleeping more than 9.0 hours (5).

The extent to which sleep duration influences male fecundity is unclear, but ecologic data suggest that the increase in sleep deprivation over the last several decades (1) has coincided with declining sperm counts among Western men (7). In addition, epidemiologic studies have shown a positive association between sleep quality and T (8), which is critical for male sexual behavior and reproduction. In men, most T released daily occurs during sleep (9–11). Some, but not all (12), studies have indicated that shorter sleep duration (13–15) and poor sleep quality (as measured by sleep fragmentation or obstructive sleep apnea) (8) are associated with reduced T levels. An experimental study reported a 10%–15% decrease in serum T levels among college-aged men exposed to sleep restriction (5 hours of sleep for 8 consecutive nights) relative to a rested sleep pattern (10 hours of sleep for 3 consecutive nights) (16).

Regarding semen quality, a cross-sectional study of 953 Danish men reported that sleep disturbance, as measured by the Karolinska Sleep Questionnaire, was associated with lower sperm concentration, total sperm count, and percentage of normal morphologic spermatozoa (17). In a longitudinal study of 592 Japanese college-aged men, an inverted U-shaped pattern was observed between sleep duration and both semen volume and total sperm count (18). No clear association was observed between sleep and serum reproductive hormones in either study (17, 18).

Given the recent trend toward reduced total sleep duration among Americans, the potential importance of sleep to T production, and the dearth of prospective data on sleep and fertility, we evaluated the association of male sleep duration with fecundability in a prospective cohort study of North American pregnancy planners. Fecundability, the average probability of conception in a given menstrual cycle of regular unprotected intercourse, provides a direct measure of couple fecundity.

MATERIALS AND METHODS

Pregnancy Study Online (PRESTO) is an ongoing Web-based preconception cohort study of pregnancy planners. The study methods have been described in detail elsewhere (19). Briefly, women aged 21–45 years residing in the Unites States or Canada who are in a stable relationship with a male partner and who are not using contraception or fertility treatment are eligible for participation. Female participants complete an online baseline questionnaire with items on demographics, behavioral factors, medical and reproductive histories, and medication use. After completion of the baseline questionnaire, women are given the option to invite their male partners to participate. Men aged $\geq$21 years are eligible. Male participation involves completion of a baseline questionnaire similar to the female baseline questionnaire. Women complete follow-up questionnaires every 8 weeks for up to 12 months to update pregnancy status. The study was approved by the institutional review board at Boston Medical Center, and online informed consent was obtained from all participants.

From June 2013 through July 2017, 5,601 eligible women completed the baseline questionnaire. We excluded 149 women whose baseline date of last menstrual period (LMP) was >6 months before study entry, 47 women who were pregnant at study entry, and 41 women with missing/implausible LMP data. We then excluded 1,019 women who had been trying to achieve pregnancy for more than six cycles at enrollment, to reduce potential for differential exposure misclassification (i.e., subfertility causing changes in behavior). Of the 4,345 remaining female participants, 2,393 (55%) invited their male partners to participate; 1,176 men (49%) enrolled.

Assessment of Exposure

On the male baseline questionnaire, participants were asked, "In the last month, on average how many hours of sleep did you get each night? (If you work a night shift and sleep during day, please think about the amount of sleep you get in a given 24-hour period)." Response categories were <5, 5, 6, 7, 8, 9, and 10 or more hours. In addition, an item in the Major Depression Inventory (MDI) asked male participants how often they had "trouble sleeping at night" during the past 2 weeks. Response categories were "all the time," "most of the time," "slightly more than half the time," "slightly less than half the time," "some of the time," and "at no time." The MDI was added to the male questionnaire in January 2015.

Assessment of Outcome

At baseline, women reported their LMP date, usual menstrual cycle length, and the number of cycles they had attempted conception. On each follow-up questionnaire, they reported their most recent LMP date and whether they had become pregnant since the previous questionnaire. Total discrete cycles at risk were calculated as follows: cycles of attempt at study entry + [(LMP from most recent follow-up questionnaire − date of baseline questionnaire completion)/usual cycle length] +1. Women contributed observed cycles to the analysis from baseline until reported conception, loss to follow-up, withdrawal, initiation of fertility treatment, or 12 cycles, whichever came first.

Assessment of Covariates

At enrollment, both partners reported their age; race/ethnicity; education; use of multivitamins or folate supplements; height; weight; smoking history; physical activity; intakes of alcohol, coffee, tea, and soda; reproductive history; history of physician-diagnosed medical conditions (major depressive disorder, anxiety disorder, hypertension, type 2 diabetes, and gastroesophageal reflux disease); employment status; average work-hours per week; daily number of hours of laptop use on one's lap; and stress using the 10-item version of the perceived stress scale (PSS-10) (20). Men were asked, "What time of day do you mainly work?," with response options of "daytime," "evening," "night," or