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## Sleep duration and diet quality among women within 5 years of childbirth in the United States- a cross-sectional study

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### Abstract

**Objective**—Only 9% of women with young children consume a high quality diet. The association between sleep duration and health may be U-shaped. We examined diet quality in relation to sleep duration among U.S. women within 5 years of childbirth.

**Methods**—Data were from non-pregnant women aged 20-44 years within 5 years of childbirth who completed two 24-hour dietary recalls (N=896) in the National Health and Nutrition Examination Survey (NHANES) 2005-2012. Self-reported weekday/workday sleep duration was categorized as short (< 6 hours), adequate (7-8 hours), or long (> 9 hours). The Healthy Eating Index (HEI-2010, range: 0-100) estimated overall and components of diet quality. Multivariable-adjusted linear regression models estimated the association between sleep duration and diet quality, adjusting for age, race/ethnicity, and education.

**Results**—Thirty-four percent of women reported short, 57.1% adequate, and 8.6% long sleep duration. The average diet quality total score was 47.4 out of 100. Short sleep duration was not associated with diet quality. Long sleep duration was associated with lower quality diet ( $\beta = -4.3$ ; 95% CI: -8.1 - -0.4), lower consumption of total fruit ( $\beta = -0.7$ ; 95% CI: -1.3 - -0.1), whole fruit ( $\beta = -0.9$ ; 95% CI: -1.6 - -0.2), and total protein ( $\beta = -0.7$ ; 95% CI: -1.3 - -0.03), and higher consumption of empty calories ( $\beta = 2.2$ ; 95% CI: -4.3 - -0.1).

**Conclusions for Practice**—Future studies should examine the longitudinal association between sleep duration and diet quality among women following childbirth and whether interventions to improve sleep can enhance diet quality.

## Keywords

sleep duration; diet quality; women; childbearing

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## INTRODUCTION

Diet quality is a measure of how individuals' diets aligns with national recommendations.<sup>1</sup> High diet quality reduces risk of several chronic diseases<sup>2,3</sup> and mortality.<sup>4</sup> In particular, the intake of whole grains and fiber,<sup>5</sup> and fruit and vegetables<sup>6</sup> reduce chronic disease risk, while the intake of saturated fat,<sup>7</sup> sodium,<sup>8</sup> and sugar-sweetened beverages<sup>9</sup> may increase disease risk.

Diet quality is particularly important for women with young children. Food preferences and eating habits are established at a young age,<sup>10</sup> and women's food preferences influence their children's preferences, and the quality of their diet is a significant contributor to their children's diet quality.<sup>10,11</sup> However, only 9% of women with young children have a diet quality score of at least 80/100 meeting national recommendations.<sup>11</sup> Understanding and intervening upon what women with young children eat have the potential to impact the long-term health of both women and their children.

Sleep duration may be risk factor for poor diet quality. A recent study observed a U-shaped association between sleep duration and eating behaviors among middle-aged and older women; women with short or long sleep duration were more likely to eat during unconventional hours and replace meals with snacks than women with adequate sleep duration.<sup>12</sup> Sleep deprivation occurs frequently among women with young children<sup>13</sup> and short sleep duration has been associated with poor diet quality among young women,<sup>14</sup> including skipped meals, higher energy intake from snacks and beverages and greater sugar consumption.<sup>15</sup> Women with long and short sleep duration report similar eating patterns, which were less healthy than women with adequate sleep.<sup>12</sup>

No published studies have examined the association between sleep duration and diet quality among women with young children. This information is essential to inform lifestyle interventions that target challenges to healthy eating in this population. The purpose of this study was to examine the association between sleep duration and diet quality among U.S. women within 5 years of childbirth. We hypothesized that women with either short or long sleep duration would have poorer diet quality compared to women with adequate sleep duration.

## METHODS

### Study design and participants

The National Health and Nutrition Examination Surveys (NHANES) are cross-sectional surveys including nationally representative samples of non-institutionalized Americans. Details of the NHANES sampling methodology and procedures have previously been published.<sup>16,17</sup> NHANES employs a complex multi-stage probability cluster design to enroll a sample that represents the total non-institutionalized civilian U.S. population.<sup>16</sup> In the first

stage, the primary sampling units (mostly counties) from a frame of all counties were selected. A sample of area segments, including census blocks or combination of blocks, was selected in the second stage. Dwelling units were then selected in the third stage, including non-institutional group quarters, such as dormitories. Finally, persons within occupied dwelling units or household were selected in the fourth stage. All eligible members within a household were listed, and a subsample of individuals was selected based on sex, age, race/ethnicity, and income.<sup>16</sup> Participants were interviewed by trained, mostly bilingual, interviewers at their homes or at a Mobile Examination Center (MEC) and were followed-up on the phone. Since information on sleep duration was first collected in 2005-2006, we combined four waves of NHANES: 2005-2006, 2007-2008, 2009-2010, and 2011-2012. Our analytic sample included non-pregnant women aged 20 to 44 years who delivered their youngest child within the past 5 years and completed two dietary recalls. We limited the study sample to women aged 20 to 44 years because reproductive data including results of the pregnancy test were released for women only within this age range. The University of Massachusetts Medical School Institutional Review Board deemed this study exempt from human subject research oversight.

### **Sleep duration**

Women were asked: “How much sleep do you usually get at night on weekdays or workdays?” NHANES coded women who reported having 12 hours or more sleep as having 12 hours of sleep. We categorized the continuous variable of sleep duration as short ( < 6 hours), adequate (7-8 hours), and long ( ≥ 9 hours), consistent with previous studies.<sup>15</sup> Women with missing information on sleep duration were excluded from analyses.

### **Diet quality**

Women completed two 24-hour dietary recalls, the first at the MEC, and the second via phone 3-10 days later. During both interviews, women listed types and amounts of foods and beverages they consumed from midnight to midnight on the previous day. We used the Healthy Eating Index (HEI)-2010, a valid and reliable measure of diet quality index that assesses adherence to the Dietary Guidelines for Americans 2010.<sup>18</sup> It includes 12 components, resulting in a total score of 100 points, where a higher score indicates better compliance with dietary guidelines and better overall diet quality. Nine components assess adequacy of the diet, where higher scores indicate greater consumption: total fruit (including fruit juice), whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and the ratio of poly- and mono-unsaturated fatty acids to saturated fatty acids. For the other three dietary components (refined grains, sodium, and empty calories from solid fats, alcohol, and added sugars), higher scores indicate lower consumption. Intakes between the minimum and maximum standards were scored proportionately. We used average intake across the two recalls to calculate HEI-2010 scores using SAS code available at <http://www.cnpp.usda.gov/healthy-eating-index-support-files-07-08>.

### **Potential confounders**

We considered age, race/ethnicity, education level, marital status, poverty income ratio (PIR), weight status, years after recent childbirth, smoking status, physical activity level,

depressive symptoms, history of breastfeeding, and diagnoses of several chronic diseases (e.g., hypertension, diabetes, gestational diabetes, and asthma) as potential confounders. Except for height and weight, these data were self-reported during the interview. We categorized race/ethnicity as non-Hispanic White, non-Hispanic Black, Mexican-American/Hispanic, and other race/ethnicity (including multi-racial). We categorized education level as less than high school, high school graduate/GED, some college/Associate's degree, and college graduate or higher. We categorized marital status as married or living with partner, widowed/separated/divorced, and never married. Household poverty income ratio (PIR) is the ratio of household income to poverty threshold for a household of that size and was categorized as <100% Federal Poverty Level (FPL), 100-300% FPL, and >300% FPL. Body mass index (BMI;  $\text{kg}/\text{m}^2$ ) calculated from measured height and weight was categorized as underweight ( $<18.5 \text{ kg}/\text{m}^2$ ), normal weight ( $18.5 \leq \text{BMI} < 25 \text{ kg}/\text{m}^2$ ), overweight ( $25.0 \leq \text{BMI} < 30 \text{ kg}/\text{m}^2$ ), and obese ( $\text{BMI} \geq 30 \text{ kg}/\text{m}^2$ ). Women were asked "Have you smoked at least 100 cigarettes in your entire life?" and those who replied "no" were classified as never smokers. Women who replied "yes" were asked, "Do you now smoke cigarettes?" Those who responded with "every day" or "on some days" were classified as current smokers. Those who replied "no" were classified as former smokers. Women were asked about the frequency and duration of various physical activities over the past 30 days or in a typical week. Women were categorized as following physical activity guidelines if they engaged in 150 minutes or more of moderate-intensity activity per week. Depressive symptoms were assessed at the MEC using the Patient Health Questionnaire (PHQ-9), a nine-item self-reported measure that has been widely used among post-partum women in primary care settings.<sup>19</sup> The scale contains 9 questions about the frequency of symptoms of depression over the past 2 weeks, which are summed to produce a global score (range: 0-27), with higher scores indicating greater depressive symptoms. Scores of 10 or higher were considered to indicate an increased risk of clinical depression<sup>19</sup>. Women reported whether they had ever breastfed any child for at least a month and whether they had been diagnosed with several chronic diseases, including hypertension, diabetes, gestational diabetes mellitus, and asthma.

### Statistical analyses

All statistical analyses accounted for sample weights and the complex survey design; results are representative of childbearing women aged 20-44 years nationally. As recommended in the NHANES analytic guidelines ([http://www.cdc.gov/nchs/nhanes/analytic\\_guidelines.htm](http://www.cdc.gov/nchs/nhanes/analytic_guidelines.htm)), we created a combined 8-year weight by assigning one-fourth of the 2-year weight for each survey cycle (2005-06, 2007-08, 2009-10, and 2011-12).

We compared the characteristics of women within 5 years of childbirth in relation to sleep duration using chi-square tests for categorical variables and ANOVA for continuous variables. We used linear regression models to estimate the association between sleep duration and overall diet quality, with women with adequate sleep duration (7-8 hours) as the reference group. Potential confounders associated with overall diet quality with a p value of  $< 0.25$  were included and retained in the adjusted model if their inclusion changed the regression coefficient for diet quality by 10% or more, suggesting that they meaningfully confounded the association under study. We constructed multivariable-adjusted linear

regression models to estimate the association between sleep duration and each HEI-2010 component score, adjusting for these covariates for consistency of interpretation.

We conducted three sensitivity analyses. First, because the Healthy People 2020 suggests sleep duration of a minimum of 8 hours for those aged 18 to 21 years as adequate,<sup>20</sup> we categorized short sleep duration as <8 hours among women aged 20 or 21 years old in our sample, and repeated our analyses of diet quality in relation to sleep duration using this alternative definition. Second, altered sleep duration (either short or long sleep) is common among adults diagnosed with major depressive disorders,<sup>21</sup> and in fact, is a symptom considered in the diagnosis of depression.<sup>19</sup> In addition to examining increased risk of clinical depression as a potential confounder, we also performed sensitivity analyses to examine whether sleep duration might be an intermediary between increased risk of clinical depression and diet quality. Third, we categorized sleep duration as very short (< 5 hours/night), short (6 hours/night), adequate (7-8 hours/night), and long (≥ 9 hours/night), and explored associations with diet quality. All analyses were conducted using SAS (Version 9.3, SAS Institute Inc., Cary, NC).

## RESULTS

NHANES 2005-2012 included 1,187 non-pregnant women aged 20 to 44 years old who delivered their youngest child within the past 5 years. We excluded women missing information on sleep duration (n=4), who did not complete the first (n=27) or the second dietary recall (n=171), and who had missing information on potential confounders (PIR [n=88], marital status [n=1], BMI [n=5], depression [n=3], breastfeeding history [n=53], or history of hypertension [n=1]), resulting in an analytic sample of 896 women. These women represent 11,593,696 women nationally.

Women were on average 30.7 years old (SE: 0.3). One third of women had given birth within the past year, 21.6% 1-2 years ago, 15.9% 2-3 years ago, 16.8% 3-4 years ago, and 12.1% 4-5 years ago. Women reported an average of 6.9 (SE: 0.06) hours of sleep on weekdays/workdays (median: 7.0 hours, range: 1-12 hours). Short sleep duration was reported by 34.3% of women (with 15.7% women reporting less than 6 hours of sleep), adequate sleep by 57.1%, and long sleep by 8.6% (Table 1). Compared to women with adequate sleep duration, women with short sleep were more likely to be younger than 35 years (78.4% vs. 66.9%), obese (37.8% vs. 31.9%), within 1 year of childbirth (42.8% vs. 29.6%), having greater depressive symptoms (4.2 (SE: 0.4) vs. 3.0 (SE: 0.3), and less likely to be non-Hispanic White (53.5% vs. 66.6%), and have an education above college (19.0% vs. 36.0%). Similar differences were observed between women with long and adequate sleep duration (Table 1).

The average diet quality score was 47.4 (SE: 0.8) among all women. Total diet quality was 45.5 (SE: 1.4) among women with short sleep duration, 49.2 (SE: 0.9) among women with adequate sleep duration, and 43.5 (SE: 2.5) among women with long sleep duration (Table 2). Nine women (1.4%) had an overall HEI-2010 score over 80, indicating that they followed the dietary guidelines; all of these women reported adequate sleep duration. Compared to women with adequate sleep duration, women with short and long sleep duration had lower

diet quality in the crude model (Table 2). After further adjusting for age, race/ethnicity, and education level, short sleep duration was not associated with diet quality; however, women with long sleep duration had lower quality diet ( $\beta = -4.3$ ; 95% CI:  $-8.1 - -0.4$ ), lower consumption of total fruit ( $\beta = -0.7$ ; 95% CI:  $-1.3 - -0.1$ ), whole fruit ( $\beta = -0.9$ ; 95% CI:  $-1.6 - -0.2$ ), total protein foods ( $\beta = -0.7$ ; 95% CI:  $-1.3 - -0.03$ ) and greater consumption of empty calories ( $\beta = -2.2$ ; 95% CI:  $-4.3 - -0.1$ ), compared to women with adequate sleep duration.

We performed a sensitivity analysis to examine the association between sleep duration and diet quality using Healthy People 2020's definition of short sleep duration for women aged 20-21 years. Seven women aged 20 to 21 years had 7 hours of sleep at night and were categorized as having short sleep duration using Healthy People 2020's definition. The association between sleep duration and diet quality were similar to the original analyses (data not shown). We also performed a sensitivity analysis to examine whether sleep duration is an intermediary between an increased risk of clinical depression and diet quality. The crude association between risk of clinical depression and diet quality was  $-5.1$  (95% CI:  $-8.7 - -1.6$ ). Adjustment for sleep duration did not change the coefficient for depression significantly ( $\beta = -4.7$ , 95% CI:  $-8.2 - -1.2$ ). Thus, our data does not support the idea that sleep duration might be an intermediary between increased risk of clinical depression and diet quality. Finally, we explored the association between sleep duration and overall diet quality using more fine-grained categories of sleep duration. Fourteen percent of women reported very short sleep duration ( $< 5$  hours/night), 20.1% short sleep duration (6 hours/night), 57.1% adequate sleep duration (7-8 hours/night), and 8.7% reported long sleep duration ( $> 9$  hours/night). Compared to women with adequate sleep duration, neither women with very short sleep duration ( $\beta = -2.5$ , 95% CI:  $-7.2$  to  $2.2$ ), nor women with short sleep duration ( $\beta = -1.6$ , 95% CI:  $-4.9$  to  $1.7$ ) had poorer diet quality after adjusting for age, race/ethnicity, and education.

## DISCUSSION

Within 5 years of childbirth, U.S. women, have, on average, poor diet quality and the majority fails to follow current recommendations for having a good quality diet. Diet quality did not differ between women with short and adequate sleep duration. Women with long sleep duration have poorer overall diet quality, and lower consumption of total fruit, whole fruit, total protein foods, and greater consumption of empty calories from solid fats, added sugar, and alcohol compared to women with adequate sleep duration.

Our finding that diet quality was not different between women with short and adequate sleep duration was inconsistent with the results of prior studies, which have reported a U-shaped association between sleep duration with diet quality and eating behaviors in the general adult population.<sup>12,22</sup> There are several possibilities for this null finding. First, the association between short sleep duration and diet quality may be different among women with young children, compared to other populations. The significant association between short sleep duration and poor diet quality has been observed among female college students,<sup>14</sup> and postmenopausal women.<sup>23</sup> The transition to motherhood is a period of biological, psychosocial, and behavioral changes in women's lives,<sup>24</sup> all of which may impact women's

diet quality. Second, this null finding may be subject to residual confounding. Women with short sleep duration are more likely to be stressed,<sup>25</sup> and stressed women are more likely to have less healthful diets and lifestyles;<sup>26</sup> unfortunately, NHANES did not collect information about psychosocial stress. Third, we found a significant association between short sleep duration and poor diet quality in the unadjusted model, but the association was not significant adjusting for age and education level, suggesting that these characteristics may have explained the observed crude association between short sleep duration and diet quality.

Our finding that women with long sleep duration had poorer diet quality was consistent with the prior literature. Adult women with longer sleep duration have been shown to be more likely to eat at unconventional hours and have a greater degree of snack dominance over meals, compared to women with adequate sleep.<sup>12</sup> Postmenopausal women with longer sleep duration also had poorer diet quality compared to women with adequate sleep duration of 7-8 hours.<sup>23</sup> Long sleep duration has been associated with a greater risk of chronic diseases and mortality;<sup>27,28</sup> however, the mechanisms that underlie the association between long sleep duration and diet quality are incompletely understood. One interpretation is that women with long sleep duration may have limited time to prepare foods and are more likely to replace meals with snacks with greater energy-density and lower fiber, which may result in lower diet quality. Future studies are needed to explore the underlying physiological and behavioral mechanisms between long sleep duration and diet quality.

Altered sleep duration (either short or long sleep) is common among adults diagnosed with major depressive disorder,<sup>21</sup> and in fact, is a symptom considered in the diagnosis of depression.<sup>19</sup> We considered likelihood of clinical depression as a potential confounder and sleep duration as an intermediary between depression and diet quality. Depressive symptoms are risk factors for insomnia and other sleep disorders after childbirth,<sup>29</sup> and have been associated with consumption of unhealthful diet among post-partum women.<sup>26</sup> While we found that women with short and long sleep duration were more likely to meet criteria for depression (13.8% and 13.8% versus 9.4% of women with adequate sleep, respectively), and clinical depression was associated with poorer diet quality, the inclusion of clinical depression in the multivariable model didn't change the coefficient for sleep duration by 10% or more, suggesting that depressive symptoms did not materially confound the association between sleep and diet quality. In a sensitivity analysis we found no evidence that sleep duration acts as an intermediary between depression and diet quality. It may be that within 5 years of childbirth, women's sleep duration is disrupted by their children,<sup>29</sup> rather than by chronic diseases or mental health conditions as may be the case in other populations. Future studies should explore the roles of sleep quality and depressive symptoms play in diet quality among women with young children.

Overall, we found that U.S. women within 5 years of childbirth had poor diet quality, with a total score below 50% of the maximum score. Most strikingly fewer than 2% of women achieved a diet quality score over 80, suggesting poor diet quality among U.S. women with young children. This finding was consistent with our previous research which found that U.S. women's diet quality was on average poor up to 10 years following childbirth.<sup>30</sup> In particular, women had suboptimal consumption of greens and beans, seafood and plant

protein, and whole grains, with the average score below 40% of the maximum. Beans and peas are great sources of protein, fiber, and many vitamins and minerals. Consuming more beans could improve the overall diet quality.<sup>31</sup> A recent randomized controlled trial reported that increasing fiber intake may lead to other healthy dietary changes and facilitate weight loss.<sup>32</sup> Greater whole grain consumption is also associated with a lower risk of adverse chronic conditions, including type 2 diabetes, cardiovascular diseases, and weight gain.<sup>5</sup> Thus, promoting the consumption of greens and beans and whole grains could improve overall diet quality among women with young children.

Women's diet quality contributes to their children's diet quality,<sup>10,11</sup> and mother's food intake is associated with children's intake of snacks, sweets, fruit, vegetables, and energy.<sup>33</sup> Given the importance of early-life diet,<sup>10</sup> improving women's diet quality may be a pathway to improve the entire family's diet. Our study highlights that diet quality is poor among women within young children, and we hypothesize that improvements in women's diets could have an important impact on diet quality and health of the entire family.

This study has strengths and limitations. Using data from a large nationally representative survey enabled us to generalize results to non-institutionalized US women with young children aged 20-44 years. The HEI-2010 is a valid and reliable measure of diet quality based on two dietary recalls,<sup>18</sup> which allows analysis of overall and component diet quality. In NHANES, only two recalls were available, fewer than the three recalls considered the gold standard for dietary assessment.<sup>34</sup> Another limitation is the measure of sleep duration, which was self-reported for weekdays/workdays; sleep duration on weekends may differ. Self-reported sleep duration is moderately correlated with sleep duration measured with actigraphy,<sup>35</sup> and self-reported sleep duration has been significantly associated with measures of health,<sup>15,22</sup> Only 61 women reported long sleep duration, limiting our ability to examine characteristics associated with diet quality in this subgroup. In NHANES, sleep duration was recorded as integer number of hours per night. Thus, the sleep duration of a woman who typically sleeps for 6.7 hours per night would be recorded as 7 hours of sleep due to rounding to integer hours, and be misclassified as obtaining adequate sleep duration when in fact their sleep duration was shorter than recommended. While there is no reason to believe that this misclassification differs by diet quality, it may bias our study findings towards the null. Lastly, our study was cross-sectional, precluding causal inference about sleep duration's impact on diet quality.

In conclusion, U.S. women within 5 years of childbirth have, on average, poor diet quality, with a mere 1.4% consuming high-quality diets. Given the important role of diet quality in the prevention of several chronic diseases,<sup>2,3</sup> and the association between women's and their children's diet quality,<sup>11</sup> our findings highlight the need to improve diet quality in this population. The USDA's [choosemyplate.gov](http://choosemyplate.gov) provides detailed dietary recommendation for pregnant and breastfeeding women, children, and preschoolers specifically.<sup>36-38</sup> These free, readily-available online resources may be useful to women with young children and health care providers counseling women about their diet and the importance of their diet on their children's health. Diet quality did not differ between women with short and adequate sleep duration. Women with long sleep duration have significantly lower overall diet quality and lower consumption of total fruit, whole fruit, total protein foods, and higher consumption of



empty calories. Future research should examine mechanisms linking long sleep duration and diet quality. Our findings also suggest the potential utility of examining other behavioral or psychosocial factors, which may impact maternal diet quality. Given the high prevalence of short sleep duration among women with young children, research is needed to understand what factors influence sleep duration among women with young children and how to promote adequate sleep duration among women in this population.

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## REFERENCES

1. Wirt A, Collins CE. Diet quality--what is it and does it matter? *Public Health Nutr.* 2009; 12(12): 2473–92. doi:10.1017/S136898000900531X. [PubMed: 19335941]
2. McCullough ML, Feskanich D, Stampfer MJ, et al. Diet quality and major chronic disease risk in men and women: moving toward improved dietary guidance. *Am J Clin Nutr.* 2002; 76(6):1261–71. [PubMed: 12450892]
3. Wolongevicz DM, Zhu L, Pencina MJ, et al. Diet quality and obesity in women: the Framingham Nutrition Studies. *Br J Nutr.* 2013; 103(8):1223–1229. doi:10.1017/S000711450992893. [PubMed: 19930766]
4. Kant AK, Leitzmann MF, Park Y, Hollenbeck A, Schatzkin A. Patterns of Recommended Dietary Behaviors Predict Subsequent Risk of Mortality in a Large Cohort of Men and Women in the United States. *J Nutr.* 2009; 139:1374–1380. doi:10.3945/jn.109.104505. [PubMed: 19474153]
5. Ye EQ, Chacko SA, Chou EL, Kugizaki M, Liu S. Greater Whole-Grain Intake Is Associated with Lower Risk of Type 2 Diabetes, Cardiovascular Disease, and Weight Gain. *J Nutr.* 2012; 142(7): 1304–1313. doi:10.3945/jn.111.155325. [PubMed: 22649266]
6. Carter P, Gray LJ, Troughton J, Khunti K, Davies MJ. Fruit and vegetable intake and incidence of type 2 diabetes mellitus: systematic review and meta-analysis. *Bmj.* Aug.2010 341:c4229–c4229. 18 4 doi:10.1136/bmj.c4229. [PubMed: 20724400]
7. Hu FB, Stampfer MJ, Rimm EB, et al. Dietary fat and coronary heart disease: a comparison of approaches for adjusting for total energy intake and modeling repeated dietary measurements. *Am J Epidemiol.* 1999; 149(6):531–540. [PubMed: 10084242]
8. Aburto NJ, Ziolkovska A, Hooper L, Elliott P, Cappuccio FP, Meerpohl JJ. Effect of lower sodium intake on health: systematic review and meta-analyses. *BMJ.* Apr.2013 346:f1326. doi:10.1136/bmj.f1326. [PubMed: 23558163]
9. Hu FB, Malik VS. Sugar-sweetened beverages and risk of obesity and type 2 diabetes: epidemiologic evidence. *Physiol Behav.* 2010; 100(1):47–54. doi:10.1016/j.physbeh.2010.01.036. [PubMed: 20138901]
10. Patrick H, Nicklas T a. A Review of Family and Social Determinants of Children's Eating Patterns and Diet Quality. *J Am Coll Nutr.* 2005; 24(2):83–92. doi:10.1080/07315724.2005.10719448. [PubMed: 15798074]
11. Laster LER, Lovelady C a, West DG, et al. Diet quality of overweight and obese mothers and their preschool children. *J Acad Nutr Diet.* 2013; 113(11):1476–83. doi:10.1016/j.jand.2013.05.018. [PubMed: 23871105]
12. Kim S, DeRoo L a, Sandler DP. Eating patterns and nutritional characteristics associated with sleep duration. *Public Health Nutr.* 2011; 14(5):889–95. doi:10.1017/S136898001000296X. [PubMed: 21029511]
13. National Sleep Foundation. Summary of Findings. 2004
14. Haghighatdoost F, Karimi G, Esmailzadeh A, Azadbakht L. Sleep deprivation is associated with lower diet quality indices and higher rate of general and central obesity among young female

- students in Iran. *Nutrition*. 2012; 28(11-12):1146–50. doi:10.1016/j.nut.2012.04.015. [PubMed: 22951155]
15. Kant AK, Graubard BI. Association of self-reported sleep duration with eating behaviors of American adults: NHANES 2005-2010. *Am J Clin Nutr*. 2014;938–947. doi:10.3945/ajcn.114.085191.938.
  16. Curtin LR, Mohadjer LK, Dohrmann SM, et al. The National Health and Nutrition Examination Survey: Sample Design, 1999-2006. *Natl Cent Heal Stat Vital Heal Stat*. 2012; 2(155):1–39.
  17. Johnson CL, Dohrmann SM, Burt VL, Mohadjer LK. National Health and Nutrition Examination Survey : Sample Design , 2011 – 2014. 2014; 2(162):1–33.
  18. Guenther PM, Kirkpatrick SI, Reedy J, et al. The Healthy Eating Index-2010 Is a Valid and Reliable Measure of Diet Quality According to the 2010 Dietary Guidelines for Americans. *J Nutr*. 2014; (C):1–9. doi:10.3945/jn.113.183079.The.
  19. Yawn BP, Pace W, Wollan PC, et al. Concordance of Edinburgh Postnatal Depression Scale (EPDS) and Patient Health Questionnaire (PHQ-9) to assess increased risk of depression among postpartum women. *J Am Board Fam Med*. 2009; 22(5):483–91. doi:10.3122/jabfm.2009.05.080155. [PubMed: 19734393]
  20. Office of Disease Prevention and Health Promotion. *Sleep Health | Healthy People 2020*. 2012. [HealthyPeople.gov](http://HealthyPeople.gov)
  21. Dørheim SK, Bondevik GT, Eberhard-Gran M, Bjorvatn B. Sleep and depression in postpartum women: a population-based study. *Sleep*. 2009; 32(7):847–55. [PubMed: 19639747]
  22. Grandner, M a; Jackson, N.; Gerstner, JR.; Knutson, KL. Dietary nutrients associated with short and long sleep duration. Data from a nationally representative sample. *Appetite*. 2013; 64:71–80. doi:10.1016/j.appet.2013.01.004. [PubMed: 23339991]
  23. Stern JH, Grant AS, Thomson C a, et al. Short sleep duration is associated with decreased serum leptin, increased energy intake and decreased diet quality in postmenopausal women. *Obesity (Silver Spring)*. 2014; 22(5):E55–61. doi:10.1002/oby.20683. [PubMed: 24347344]
  24. Boothe AS, Brouwer RJN, Carter-Edwards L, Ostbye T, Østbye T. Unmet social support for healthy behaviors among overweight and obese postpartum women: results from the Active Mothers Postpartum Study. *J women's Heal*. 2011; 20(11):1677–85. doi:10.1089/jwh.2010.2509.
  25. Lee S-Y, Hsu H-C. Stress and Health-related well-being among mothers with a low birth weight infant: The role of sleep. *Soc Sci Med*. 2012; 74(7):958–965. doi:10.1016/j.socscimed.2011.12.030.Stress. [PubMed: 22342365]
  26. George GC, Milani TJ, Hanss-Nuss H, Freeland-Graves JH. Compliance with dietary guidelines and relationship to psychosocial factors in low-income women in late postpartum. *J Am Diet Assoc*. 2005; 105(6):916–26. doi:10.1016/j.jada.2005.03.009. [PubMed: 15942541]
  27. Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Quantity and quality of sleep and incidence of type 2 diabetes: A systematic review and meta-analysis. *Diabetes Care*. 2010; 33(2):414–420. doi: 10.2337/dc09-1124. [PubMed: 19910503]
  28. Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Sleep duration and all-cause mortality: a systematic review and meta-analysis of prospective studies. *Sleep*. 2010; 33(5):585–592. [PubMed: 20469800]
  29. Hunter LP, Rychnovsky JD, Yount SM. A selective review of maternal sleep characteristics in the postpartum period. *J Obstet Gynecol Neonatal Nurs*. 2009; 38(1):60–8. doi:10.1111/j.1552-6909.2008.00309.x.
  30. Xiao RS, Simas TAM, Person SD, Goldberg RJ, Waring ME. Diet Quality and History of Gestational Diabetes Mellitus Among Childbearing Women, United States, 2007-2010. *Prev Chronic Dis*. 2015; 12(25):1–9.
  31. Mitchell DC, Lawrence FR, Hartman TJ, Curran JM. Consumption of dry beans, peas, and lentils could improve diet quality in the US population. *J Am Diet Assoc*. 2009; 109(5):909–13. doi: 10.1016/j.jada.2009.02.029. [PubMed: 19394480]
  32. Ma Y, Olendzki BC, Wang J, et al. Single-Component Versus Multicomponent Dietary Goals for the Metabolic Syndrome. *Ann Intern Med*. 2015; 162:248. doi:10.7326/M14-0611. [PubMed: 25686165]

33. van Ansem WJC, van Lenthe FJ, Schrijvers CTM, Rodenburg G, van de Mheen D. Socioeconomic inequalities in children's snack consumption and sugar-sweetened beverage consumption: the contribution of home environmental factors. *Br J Nutr.* 2014; 112(3):467–76. doi:10.1017/S0007114514001007. [PubMed: 24833428]
34. Ma Y, Olendzki BC, Pagoto SL, et al. Number of 24-Hour Diet Recalls Needed to Estimate Energy Intake. *Ann Epidemiol.* 2009; 19(8):553–559. doi:10.1016/j.annepidem.2009.04.010. [PubMed: 19576535]
35. Lauderdale DS, Knutson KL, Yan LL, Liu K, Rathouz PJ. Self-reported and measured sleep duration: how similar are they? *Epidemiology.* 2008; 19:838–845. doi:10.1097/EDE.0b013e318187a7b0. [PubMed: 18854708]
36. United States Department of Agriculture. ChooseMyPlate.gov Nutrition needs while breastfeeding. 2016. Available at: <http://www.choosemyplate.gov/moms-breastfeedingnutritional-needs>
37. United States Department of Agriculture. Health and Nutrition Information. 2015. [ChooseMyPlate.gov](http://www.choosemyplate.gov/health-and-nutrition-information) Available at: <http://www.choosemyplate.gov/health-and-nutrition-information>
38. United States Department of Agriculture. Myplate Kid's Place. 2015. Available at: <http://www.choosemyplate.gov/kids>

### SIGNIFICANCE

While short or long sleep duration is a risk factor for poor diet quality among middle-aged and older women, no studies have examined this association among women following childbirth. We found that only 1.4% of U.S. women within 5 years of childbirth consumed high quality diets. Women with longer sleep duration had poorer diet quality compared to women with adequate sleep duration. Short sleep duration was not associated with diet quality. This study adds to the literature by describing the association between sleep duration and diet quality among U.S. women following childbirth. Given the impact women's diet quality can have on their health and on their children's health, understanding determinants of dietary habits among childbearing women can inform interventions to improve diet quality among U.S. women with young children. Future research should examine mechanisms linking long sleep duration and diet quality, and explore other behavioral or psychosocial factors which may impact maternal diet quality, including sleep quality.

**Table 1**

Characteristics in relation to weekday/workday sleep duration, among US women within 5 years of childbirth, NHANES 2005-2012, Mean  $\pm$  SE or weighted % (95% CI)

	Short sleep duration ( 6 hours)	Adequate sleep duration (7-8 hours)	Long sleep duration ( 9 hours)
Sample Size	352	483	61
Weighted Sample Size	3,891,698	6,465,860	972,056
Age, Mean (SE)	29.8 $\pm$ 0.3	31.3 $\pm$ 0.5	30.4 $\pm$ 1.1
Years since most recent childbirth			
Within the past year	42.8 (36.4 – 49.1)	29.6 (24.0 – 35.2)	24.2 (8.1 – 40.3)
Within 1-2 years	19.2 (13.2 – 25.3)	22.8 (17.4 – 28.2)	22.5 (8.0 – 37.1)
Within 2-3 years	14.1 (8.4 – 19.8)	16.8 (12.2 – 21.4)	17.7 (5.2 – 30.1)
Within 3-4 years	13.7 (7.6 – 19.9)	18.3 (13.7 – 22.9)	19.2 (6.9 – 31.5)
Within 4-5 years	10.2 (5.9 – 14.5)	12.5 (7.6 – 17.4)	16.4 (1.4 – 31.4)
Race/ethnicity			
Non-Hispanic White	53.5 (44.7 – 62.2)	66.6 (59.9 – 73.2)	66.6 (49.7 – 83.4)
Non-Hispanic Black or African American	20.1 (14.9 – 25.3)	7.9 (4.7 – 11.1)	8.3 (2.2 – 14.3)
Hispanic/Latino/Spanish origin	23.1 (17.6 – 28.7)	18.8 (13.5 – 24.1)	19.2 (6.3 – 32.1)
Other race(s), including multi-racial	3.3 (0.9 – 5.6)	6.8 (3.9 – 9.6)	3.9 (0.0 – 13.8)
Education level			
Less than high school	20.9 (15.1 – 26.6)	15.3 (10.9 – 19.7)	25.4 (10.4 – 40.4)
High school graduate/GED	22.4 (16.1 – 28.8)	19.7 (14.5 – 25.0)	24.4 (9.2 – 39.6)
Some college /Associate's degree	37.7 (30.3 – 45.1)	29.0 (23.2 – 34.8)	27.2 (14.0 – 40.4)
College graduate or above	19.0 (12.2 – 25.9)	36.0 (28.7 – 43.2)	23.0 (9.1 – 36.9)
Poverty income ratio (PIR)			
<100% FPL	28.4 (22.9 – 34.0)	19.9 (15.8 – 24.1)	44.0 (27.7 – 60.3)
100-300% FPL	46.0 (38.8 – 53.2)	38.9 (33.0 – 44.8)	24.1 (7.3 – 41.0)
>300% FPL	25.6 (17.8 – 33.4)	41.2 (35.0 – 47.4)	31.9 (14.2 – 49.6)
Marital status			
Married or living with someone	74.7 (70.4 – 80.9)	82.9 (78.2 – 87.7)	84.3 (72.6 – 96.0)
Separated or widowed or divorced	10.2 (6.5 – 13.9)	5.5 (3.7 – 7.3)	1.5 (0.0 – 3.9)
Never married	14.1 (10.6 – 17.6)	11.6 (7.1 – 16.1)	14.1 (2.9 – 25.4)
Smoking status			
Never smoker	54.5 (45.7 – 63.2)	67.3 (61.8 – 72.8)	50.7 (33.2 – 68.1)
Past smoker	29.8 (21.4 – 38.1)	17.9 (13.7 – 22.1)	40.5 (22.7 – 58.2)
Current smoker	15.8 (9.3 – 22.3)	14.8 (9.9 – 19.7)	8.9 (0.0 – 19.2)
Weight status			

	Short sleep duration ( 6 hours)	Adequate sleep duration (7-8 hours)	Long sleep duration ( 9 hours)
Underweight	1.6 (1.1 – 2.1)	1.9 (1.5 – 2.3)	3.0 (1.8 – 4.1)
Normal weight	27.6 (25.7 – 29.6)	33.2 (31.4 – 34.9)	36.8 (33.1 – 40.4)
Overweight	33.0 (31.3 – 34.8)	33.0 (31.5 – 34.5)	29.1 (25.4 – 32.8)
Obese	37.8 (35.9 – 39.6)	31.9 (30.2 – 33.6)	31.2 (28.0 – 34.4)
Household food security *			
Full	66.8 (54.5 – 74.1)	74.7 (68.4 – 81.0)	81.9 (65.0 – 98.7)
Marginal	12.8 (8.6 – 17.0)	11.7 (7.5 – 15.8)	3.8 (0.0 – 8.4)
Low or very low	20.4 (14.8 – 26.1)	13.6 (9.1 – 18.1)	14.3 (0.0 – 30.9)
Household size	4.3 ± 0.1	4.2 ± 0.1	4.1 ± 0.2
Depressive symptoms	4.2 ± 0.4	3.0 ± 0.3	3.6 ± 0.9
Clinical diagnosis of depression	13.8 (8.0 – 19.7)	9.4 (5.3 – 13.5)	13.8 (0.1 – 27.6)
Meeting physical activity guideline	29.9 (22.6 – 37.3)	32.7 (25.7 – 39.6)	30.8 (14.2 – 47.5)
Ever breastfeeding for at least 1 month	74.0 (69.0 – 79.0)	73.2 (67.6 – 78.8)	72.0 (54.3 – 89.7)
Ever diagnosis of diabetes	1.8 (0.4 – 3.2)	2.6 (0.3 – 5.0)	--
Ever diagnosis of GDM	7.8 (4.0 – 11.7)	11.4 (7.2 – 15.7)	1.6 (0.0 – 4.3)
Ever diagnosis of hypertension	13.6 (8.0 – 19.1)	8.1 (4.8 – 11.4)	16.0 (1.6 – 30.4)
Ever diagnosis of asthma	22.8 (15.4 – 30.3)	13.9 (9.7 – 18.0)	21.5 (11.0 – 31.9)

\* Missing data due to collection in only some NHANES waves: household food security (n=211), household size (n=211), physical activity (n=150), diagnosis of gestational diabetes mellitus (n=158)

**Table 2**

Diet quality (HEI-2010) in relation to weekday/workday sleep duration, among U.S. women within 5 years post-childbirth, NHANES 2005-2012\*

HEI-2010 score (possible maximum score)	Adequate sleep duration (7-8 hours) <sup>*</sup>	Short sleep duration ( 6 hours)			Long sleep duration ( 9 hours)		
		M±SE	Crude beta (95% CI)	Adjusted <sup>**</sup> beta (95% CI)	M±SE	Crude beta (95% CI)	Adjusted <sup>**</sup> beta (95% CI)
Total diet quality (100)	49.2±0.9	45.4±1.4	<b>-3.7 (-6.8 - -0.7)</b>	-2.0 (-5.2 - 1.3)	43.5±2.5	<b>-5.7 (-10.5 - -0.9)</b>	<b>-4.3 (-8.1 - -0.4)</b>
Total fruit (5)	2.6±0.1	2.4±0.2	-0.2 (-0.6 - 0.2)	-0.1 (-0.5 - 0.3)	1.8±0.3	<b>-0.8 (-1.4 - -0.2)</b>	<b>-0.7 (-1.3 - -0.1)</b>
Whole fruit (5)	2.4±0.2	2.3±0.2	-0.1 (-0.5 - 0.3)	0.1 (-0.3 - 0.5)	1.3±0.3	<b>-1.1 (-1.8 - -0.3)</b>	<b>-0.9 (-1.6 - -0.2)</b>
Total vegetable (5)	3.5±0.1	3.2±0.1	<b>-0.3 (-0.5 - -0.02)</b>	-0.2 (-0.4 - 0.1)	3.0±0.4	-0.4 (-1.1 - 0.2)	-0.4 (-1.0 - 0.2)
Greens and beans (5)	1.7±0.1	1.4±0.2	-0.3 (-0.7 - 0.06)	-0.2 (-0.6 - 0.2)	1.9±0.4	0.2 (-0.6 - 1.0)	0.2 (-0.5 - 1.0)
Total protein foods (5)	4.4±0.1	4.2±0.1	-0.1 (-0.4 - 0.1)	-0.2 (-0.4 - 0.1)	3.7±0.3	<b>0.7 (-1.4 - -0.02)</b>	<b>-0.7 (-1.3 - -0.03)</b>
Seafood and plant protein (10)	2.3±0.1	1.8±0.1	<b>-0.5 (-0.9 - -0.2)</b>	-0.3 (-0.7 - 0.1)	2.1±0.3	-0.2 (-0.9 - 0.5)	0.04 (-0.4 - 0.5)
Whole grain (10)	2.4±0.2	1.8±0.2	<b>-0.7 (-1.3 - -0.1)</b>	-0.4 (-1.0 - 0.2)	1.4±0.4	<b>-1.0 (-1.8 - -0.2)</b>	-0.8 (-1.6 - 0.006)
Dairy (10)	6.3±0.2	5.6±0.3	-0.7 (-1.4 - 0.04)	-0.4 (-1.1 - 0.3)	5.6±0.7	-0.7 (-2.1 - 0.7)	-0.5 (-1.9 - 0.9)
Fatty acids (10)	4.4±0.2	4.5±0.3	0.1 (-0.5 - 0.8)	0.1 (-0.5 - 0.7)	4.1±0.5	-0.3 (-1.4 - 0.7)	-0.3 (-1.3 - 0.7)
Sodium (10)	4.0±0.2	4.1±0.2	0.1 (-0.5 - 0.7)	-0.08 (-0.7 - 0.5)	4.9±0.7	0.9 (-0.6 - 2.5)	0.8 (-0.6 - 2.2)
Refined grain (10)	5.0±0.2	5.2±0.3	0.2 (-0.5 - 0.9)	0.1 (-0.7 - 0.9)	6.1±0.7	1.1 (-0.3 - 2.6)	1.1 (-0.4 - 2.6)
Empty calories (20)	10.3±0.5	9.0±0.7	-1.3 (-2.7 - 0.1)	-0.5 (-2.1 - 1.0)	7.6±1.2	<b>-2.7 (-5.1 - -0.3)</b>	<b>-2.2 (-4.3 - -0.1)</b>

\* Adequate sleep duration = reference group

\*\* Adjusted for age, race/ethnicity, and education level