|  |  |  |  |
| --- | --- | --- | --- |
|  | Points Allowed | Comment | Points Allocated |
| OVERALL | This is very interesting and with some more work on alternate analytic methods and presenting the main effect results as well I think this might be worth trying to publish, even if the null result for mediation holds. | | |
| Introduction | 20 | I still think that some discussion about how race/ethnicity, physical activity, hormone replacement/birth control pills (and what about injectable or patches?), mental health indicator, etc. might be confounders would be useful as I could see some of these as being mediators as well (i.e. mental health). A DAG might also be helpful. | 18 |
| Methods | 20 | You cannot delete observations from the data set (e.g. if <20 years old) because that would invalidate the weight variable. Instead you need to create an indicator for inclusion (versus exclusion) in your final sample based on all the criteria you are using and then use that variable in a domain statement for all analyses and only look at the include strata.  Those missing data on a variable should be either excluded or recoded into a valid response if possible (e.g. if missing info on hormone replacement and are under age 50 probably can recode as “no”). Did you include the missing in the regression models? I hope not.  You might also try categorizing inflammation into high vs low-med as it would be that the relationships are not linear.  And, maybe try a combined poor sleep outcome (poor quality or less than 6 hours) as the exposure because looking at one adjusted for the other might reduce the association if they are overlapping. And/or try categorizing sleep hours into <5 instead or into 3 categories (8+, 6-7, <=5)?  And for the confounders, consider collapsing some categories (e.g. Hispanic and Mexican ethnicity) for easier interpretation.  You also need to mention that you cannot adjust for the sampling and weights in the mediation analyses (so your SE might be wrong). | 17 |
| Results | 20 | Table 1 needs p-values for each sleep outcome.  It is unclear what you are reporting as the measure of association for the mediation analysis (are these betas, ORs or something else?). What would the null result be? Zero or 1?  I would suggest that in addition to the mediation analysis, you also present the regular regression model results (crude and adjusted). So what are the crude and adjusted association between SES indicators and sleep and inflammation? What are the crude and adjusted associations between SES and sleep? And how are the confounders associated with those outcomes. Then, after discussion the main regression results, you can test mediation. | 17 |
| Discussion | 20 | I think that a number of the limitations you mention can be assessed in your data (e.g. combining sleep variables into one, trying more extreme sleep deprivation definitions, categorizing the outcome variable).  If you add the regression tables (in addition to the mediation analysis), you might have more to discuss in the paper. | 18 |
| Other (endnote codes, grammar, SAS code included, etc.) | 20 | Good. | 20 |
|  |  |  |  |
| GRADE |  |  | 90% |

Sleep duration and quality as mediators of socioeconomic disparities in inflammatory burden

Renson, A.

# Introduction

Sleep deficiency, which includes insufficient and poor quality sleep, represents a growing public health problem in the United States. Nearly 30% of adults in the U.S. report sleeping 6 or fewer hours per night,1 20% report excessive daytime sleepiness, and 20-30% experience insomnia symptoms.2 A growing body of literature links poor sleep duration and quality to a number of health outcomes, including all-cause mortality,3,4 incidence of type 2 diabetes,5,6 hypertension,7 coronary heart disease,8 and stroke9. Meta-analyses suggest a “U-shaped” association in which both short and long sleep (generally <6 and >8 hours, respectively) are related to elevated all-cause mortality risk.3,4

An important factor linking sleep and many chronic diseases may be low-grade, systemic inflammation, commonly measured by plasma concentrations of the immune markers interleukin-6 (IL-6), fibrinogen, tumor necrosis factor-a, and c-reactive protein (CRP). The most extensively studied biomarker of inflammation is c-reactive protein (CRP), an acute phase reactant (chemicals accompanying inflammatory pathway activation), for which high sensitivity assays are widely available.10 Based on Mendelian randomization studies, CRP itself is unlikely to be a causal risk factor for metabolic syndrome11 or ischemic vascular disease,12 although limited human experimental evidence suggests it has an etiologic role in atherosclerosis.13 CRP has a complex role in inflammation and its primary function may be anti-inflammatory;14 nonetheless, it is a useful biomarker corresponding to general, potentially subclinical risk.

CRP is best characterized in relation to cardiovascular disease (CVD), as it is a strong predictor of cardiovascular events.15-17 Extensive experimental and observational evidence ties inflammatory processes marked by CRP to atherogenesis, the primary pathogenic process underlying coronary heart disease (CHD).18 CRP is also a potent risk factor for all-cause mortality,19 and is associated with incidence of metabolic syndrome,16 colorectal cancer,20 and end stage renal disease,21 indicating inflammation may be an underlying pathogenic process shared by many chronic diseases. Short (<6 hours) and poor quality sleep have been shown to affect inflammation in experimental studies22,23 and to be associated with CRP and IL-6 in observational studies.24-26 Sleep restriction induces changes in glucose tolerance, thyrotropin concentration, evening cortisol concentrations, and sympathetic nervous activity, alterations which have implications in inflammation.27

A central challenge in public health is tackling socioeconomic disparities in health outcomes. Graded, inverse associations between socioeconomic status (SES) and a broad array of health outcomes, including CVD, diabetes, hypertension, a number of cancers, and all-cause mortality, have been extensively documented by a long history of research.28,29 More recently, a number of studies have observed socioeconomic disparities in inflammatory burden, with CRP, IL-6, and fibrinogen being consistently elevated in lower SES categories.30-33

Commonly hypothesized pathways for the impact of SES on inflammation are health status, behavioral (smoking, physical activity) and psychosocial (stress etc.) factors,31,34 and sleep may represent an underexplored link in this causal chain. Sleep restriction35 and poor quality sleep36,37 have been found to be more prevalent among individuals of low SES. Low income and low education are associated with adverse social and environmental conditions that impede adequate sleep38 and a growing number of lower-paid jobs involve precarious shift work and non-standard hours.39 Sleep is a modifiable risk factor for which efficacious non-pharmacological interventions exist.40 However, to our knowledge, no study has examined whether sleep mediates the relationship between SES and inflammation. The purpose of this study was to assess the role of short duration (<6 hours per night) and poor quality sleep as potential mediators between SES measures such as income and education, and inflammatory burden marked by plasma CRP.

# Methods

## Datasets

We used data from the continuous National Health and Nutritional Examination Survey (NHANES), an ongoing cross-sectional survey of the civilian non-institutionalized population in the United States. Data were collected by the National Center for Health Statistics and the Centers for Disease Control and Prevention (CDC) and involve a questionnaire, physical exam, and laboratory measures. Detailed descriptions of the survey methodology and operations are published elsewhere.41 In brief, NHANES uses a stratified, multistage, probability sample, with oversampling for Hispanics, non-Hispanic Blacks, low-income whites, and persons age 70 and over (1999-2006) or 80 and over (2007-2010). Individuals agreeing to participate completed an in-home, computer-assisted interview conducted by trained personnel, with physical examinations and laboratory sample collection conducted at the Mobile Examination Centers (MECs). Approximately 12,000 people were approached each two-year cycle, of whom an average of 10,000 ultimately completed the household interview and data collection at the MEC, for a response rate of approximately 83.3%.

We used questionnaire, physical exam, and laboratory data from 3 waves spanning 2005-2010. We selected all respondents aged 20 years and older, who had complete data for CRP and answered questions on sleep duration and quality. We excluded individuals who had CRP concentrations greater than 10 mg/L, which indicate acute infection or insult.17 We also excluded pregnant women, who demonstrate elevated and/or unstable CRP.17

## Measures

### Exposure Variables

In addition to raw family income, NHANES also reports the poverty income ratio (PIR), a ratio of family income to federal poverty level (FPL), which was chosen for this analysis because it takes into account family size and more accurately represents available financial resources. We categorized PIR as poor (below FPL), nearly poor (100-199% FPL), and middle and high income (≥200% FPL), according to the CDC’s Healthy People 2020 guidelines (<https://www.healthypeople.gov/2020/disparities-user-guide>).

In addition to family income, the most commonly used measure of SES, we also used highest educational level achieved, a measure that is more stable throughout the life course and a stronger predictor of inflammation than income.42 NHANES measures education with the question, “What is the highest grade or level of school [you have/spouse has] completed or the highest degree [you have/s/he has] received?”, with the options “Less than 9th Grade”, “9-11th Grade (Includes 12th grade with no diploma)”, “High School Grad/GED or Equivalent”, “Some College or AA degree”, “College Graduate or above”.

### Mediator Variables

Sleep quality was operationalized according to the method used by Bansil et al.:7 participants were characterized as having poor sleep quality if they reported 5 or more episodes in the previous month of one or more of the following events: (i) having trouble falling asleep; (ii) waking up during the night and having trouble getting back to sleep; (iii) waking up too early in the morning and being unable to get back to sleep; (iv) feeling unrested during the day, no matter how many hours of sleep he/she had; or (v) feeling excessively or overly sleepy during the day. Short sleep was categorized based on an answer to the question, “How much sleep [do you/does SP] usually get at night on weekdays or workdays?”, with participants coded as having short sleep if they reported sleeping less than 6 hours, similarly to other population-based studies.25

### Outcome Variables

C-reactive protein is measured from blood collected during the physical exam and processed, stored, and shipped to a Johns Hopkins University laboratory. Plasma CRP concentrations are quantified by high sensitivity assay using latex-enhanced nephelometry, with a lower limit of detection of 0.1 mg/L.41 We transformed c-reactive protein using the natural logarithm, as CRP values have been observed to be right skewed and heteroskedastic with a mean-variance relationship (Pollitt 2008, Phillips 2009, Matthews 2016).

### Confounding Variables

We considered a number of potential confounders of the relationship between sleep and CRP, based on being a potential common cause (or proxy to a common cause) of both sleep and CRP. All final models were adjusted for age (in 5-year categories), sex (male or female), race/ethnicity (non-Hispanic White, non-Hispanic Black, Mexican American, Other Hispanic, and Other Race including Multi-Racial), physical activity (number of times per week exercising enough to sweat or breathe hard), current tobacco use indicated by serum cotinine > 3 ng/mL43, obesity (body mass index (BMI) >= 30 kg/m2, measured in the physical exam), psychosocial stress (number of days in the past 30 when mental health was not good), use of birth control pills or hormone replacement therapy, and use of sleep medications often or almost always (5 or more times per month).

We separately considered potential confounders of the relationship between SES and CRP, which included only age. Although previous studies of this relationship have adjusted for serious chronic conditions,31,32 we chose to consider this variable a potential collider and not adjust for it. Final models were adjusted for all variables considered confounders of the SES → CRP and/or sleep → CRP relationships.

## Data Analysis

We summarized all variables in the total sample as well as stratified by sleep duration and sleep quality. All variables are presented as unweighted n, as well as weighted percent for categorical variables, and weighted median [range or interquartile range (IQR)] for continuous variables. C-reactive protein is summarized as a geometric mean and log transformed in all analyses. We tested crude associations between each of the exposure, mediator, and confounding variables and geometric mean CRP using one-way ANOVA with log-transformed CRP as the response variable.

### Assessment of Mediation

We sought to assess whether sleep duration and quality were intermediate variables in the causal pathway between SES and inflammation. Therefore, data analysis focused on assessment of total indirect effect (TIE),44 or the proportion of inflammation that would be prevented if SES did not cause poor sleep.44 We determined that potential mediation existed if (a) the exposure was associated with the outcome, (b) the exposure was associated with the mediator, and (c) the mediator was associated with the outcome, each after adjusting for all potential confounders, based on a significant likelihood ratio test using logistic regression for binary variables, and type III sum of squares f-test from multi-way ANOVA for continuous variables.

If these conditions were met, we then tested for mediation using the product-of-coefficients method that allows for interaction between the exposure and the mediator, detailed by VanderWheel (2016).45 This was accomplished by fitting two least squares linear regression models for each hypothesized exposure-mediator combination: (1) we regressed the mediator on the exposure and all potential confounders, and (2) we regressed the outcome on the exposure, mediator, exposure-mediator product, and all potential confounders. We estimated the TIE by the formula (β1θ2 + β1θ3a)(a – a\*), where β1 is the exposure term in (1), θ2 is the mediator term in (2), θ3 is the exposure-mediator product in model (2), a is the observed value of the exposure and a\* is the counterfactual value of the exposure. In this case, the formula reduces to (β1θ2 + β1θ3), as exposures are dummy coded, so both a and (a—a\*) = 1. We present results in terms of crude total, adjusted total, and adjusted total indirect effects. For the indirect effect, both the mediator and outcome model were adjusted for all potential confounders. Ninety-five percent confidence intervals for indirect effects were calculated via bootstrap with 1000 replications, a method which is limited by not accounting for the complex sampling design.46 Two-sided statistical significance was determined for all tests at α<0.05. All analyses were conducted in SAS v. 9.4 and adjusted for the complex survey design.

# Results

Key characteristics of sample participants are displayed in table 1. The median (range) age in years was 45.4 (20—85). The sample was just over half male (51.2%) and 70% Non-Hispanic White, 11.3% Non- Hispanic Black, 8.1% Mexican American, 4.4% other Hispanic, and 6.1% other/multi-race. (Table 1)

The median (IQR) plasma CRP for the entire sample was 0.17 (0.06--0.41). Approximately half the sample reported sleeping less than 6 hours per night, and 13.8% reported poor quality sleep represented by 5 or more sleep disturbances in the past month. In SES measures, reported income 0-100% and 100-199% of the federal poverty level each reflected 19% of the sample. Twenty-six point three percent had a college degree, 30.2% had completed some college or an associate’s degree, 24.5% had a high school diploma, GED, or equivalent, 12.5% had completed 9-11th grade, and 6.6% had less than 9th grade education.

Table 2 provides one-way ANOVA comparisons in geometric mean CRP by each covariate entered into final models. Higher CRP was related to lower education, lower income, poor sleep, short sleep (<6 hours), not being physically active, female gender, Non-Hispanic Black or Mexican American race/ethnicity, older age, currently being on hormonal birth control, tobacco exposure reflected by serum cotinine 3 or more ng/mL, currently using hormone replacement therapy, and using a sleep medication (p < 0.0001 for all comparisons).

When examining whether each mediator was associated with each exposure and the outcome, we found that education was associated with short sleep (p<0.0001) but not poor sleep (p=0.33), and that income was associated with both short (p<0.0001) and poor (p=0.003) sleep. Both poor sleep (p=0.03) and short sleep (p<0.0001) were associated with higher mean CRP (see supplementary table 1 for details on these results.) Therefore, we tested for mediation of income by both short and poor sleep, and mediation of education by short sleep only.

Table 3 provides estimates of the crude and adjusted total effects, estimated with least squares linear regression. In unadjusted models estimating total effects, the arithmetic mean ratio (AMR) for 100-199% FPL was 1.21 (95% CI, 1.12—1.30), 1.21 (95% CI, 1.14—1.24) for 0-100% FPL, 1.17 (95% CI, 1.07-1.27) for some college or AA degree, 1.11 (95% CI, 1.03—1.19) for high school diploma or GED, 1.18 (95% CI, 1.07—1.29) for 9-11th grade, and 1.17 (95% CI, 1.07—1.27) for 9th grade. After adjusting the total effect models for age, gender, race/ethnicity, physical activity, birth control use, HRT use, sleep mediation use, plasma cotinine, and obesity, the AMR for 100-199% FPL was 1.11 (95% CI, 1.05—1.18), 1.17 (95% CI, 1.10—1.24) for 0-100% FPL, 1.2 (95% CI. 1.1—1.31) for some college or AA degree, 1.24 (95% CI, 1.16—1.32) for high school diploma or GED, 1.27 (95% CI, 1.17—1.39) for 9-11th grade, and 1.2 (95% CI, 1.1—1.31) for 9th grade.

Total indirect effect (TIE) estimates are also presented in table 3, adjusted for age, gender, race/ethnicity, physical activity, birth control use, HRT use, sleep mediation use, plasma cotinine, and obesity. The AMR for the TIE via poor sleep was 0.99 (95% CI, 0.99-1) for 100-199% FPL, 0.99 (95% CI, 0.98-1) for 0-100% FPL, and 0.99 (95% CI, 0.98-1) for all TIEs of education via poor sleep. The AMR for the TIE via short sleep was 1.0 (95% CI, 1—1.01) for 100-199% FPL, and 1.01 (95% CI, 1-1.01) for 0-100% FPL. TIEs were not estimated for education via short sleep as education was not associated with short sleep in the adjusted model (supplemental table 1).

# Discussion

Similarly to other studies, our study found that both lower income47-49 and lower education30,31,42,47 are associated with higher c-reactive protein, indicating higher inflammatory burden in lower SES groups. Additionally, our findings reflect the results of other observational24,25 and experimental22,23 studies showing that poor quality and short duration of sleep are associated with higher CRP. However, our primary finding was that all indirect effects tested were approximately null (i.e., all mean ratios were approximately 1 and 95% confidence intervals contained the null value of 1) This finding suggests that the effects of both education and income on plasma CRP are not mediated by poor sleep quality or short sleep. This supports findings from a prospective study that restricted (<5 hours) and restless sleep do not mediate SES disparities in a number of chronic diseases.35

Our findings are potentially attributable to a number of factors. First, it is possible that the connection between SES and CRP is entirely mediated by other causal pathways, such as behavioral factors identified by previous literature. For instance, one study found that 56% of the total effect of poverty and 88% of the total effect of education on CRP was mediated by exercise, cigarette smoking, poor diet, and heavy alcohol use.31

Our finding of no mediation by sleep parameters may also be explained by measurement error. Self-reported sleep duration and quality are limited by poor recall, leading many recent studies in this area to utilize objective measurements such as polysomnography (considered the ‘gold standard’) and actigraphy.50 Objective and subjective sleep measures have been shown to have a relatively weak correlation (r=0.28 to 0.68),51 and are suggested to be used in combination for best accuracy as they measure different aspects of sleep.52 However, NHANES does not record objective sleep measures, so we were unable to examine these in our study. A recent simulation study showed that non-differential misclassification of a mediator biases the indirect effect towards the null much more powerfully than misclassification of the exposure.53 Therefore, the null results of our study are unable to rule out true mediation and may be the result of misclassification.

Our study is limited by a number of other factors. Despite utilizing data from a large population-based sample, we may have had limited power to detect effects related to elevated CRP, as out of 16,654, only 188 (1.3%) had CRP between 3 and 10 mg/L, the level considered to be clinically elevated and not reflective of acute infection.17 We were limited to cross-sectional measures of SES; mediation effects may be present with respect to life course SES that are not present in current SES. Being an observational study, unmeasured confounding may have altered our results. Lastly, while the indirect effect measures themselves accounted the sampling design, their respective standard errors did not, and may have misrepresented the precision of the measure. However, given the near null effect of all indirect effect estimates (i.e. all approximately 1), it is unlikely that a standard error accounting for the complex design would have changed the conclusion.

Despite these limitations, this study adds to the literature by being the first, to our knowledge, to formally test whether socioeconomic disparities in CRP-marked inflammatory burden are mediated by sleep duration or quality by generating indirect effect estimates. Because of the limitations of our study, we were not able to conclusively rule out mediation by sleep length and quality, and this topic warrants further investigation. Future studies examining mediation of SES health disparities by sleep parameters would be improved by prospectively examining potential mediation of life-course socioeconomic status by sleep parameters, and by including objective measurements such as polysomnography and actigraphy to avoid bias towards the null. Interventions are needed to reduce socioeconomic disparities in inflammatory burden, and the development of effective interventions necessitates the elucidation of modifiable mediators such as sleep.

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| Table 1. Descriptive statistics. | | | | | | | |
|  |  | Overall | | Short Sleep | | Poor Sleep | |
|  |  | Raw n | Weighted % | Raw n | Weighted % | Raw n | Weighted % |
| Total | | 16654 | 100.0% | 7322 | 50.2% | 2593 | 13.8% |
| Age - median (range) | | 45.4 | (20--85) | 45.2 | (20--85) | 45.1 | (20--85) |
| Plasma C-Reactive Protein (mg/L) -- median (IQR) | | 0.17 | (0.06--0.41) | 0.20 | (0.07--0.49) | 0.18 | (0.07--0.43) |
| Education | |  |  |  |  |  |  |
|  | 9-11th Grade (Includes 12th grade with no diploma) | 2629 | 12.5% | 502 | 43.3% | 1185 | 16.4% |
|  | College Graduate or above | 3135 | 26.3% | 319 | 47.7% | 1419 | 7.7% |
|  | High School Grad/GED or Equivalent | 3840 | 24.5% | 672 | 26.2% | 1830 | 7.8% |
|  | Less Than 9th Grade | 2059 | 6.6% | 356 | 93.8% | 841 | 35.1% |
|  | Some College or AA degree | 4382 | 30.2% | 739 | 22.3% | 2040 | 6.5% |
| Gender | |  |  |  |  |  |  |
|  | Female | 8073 | 51.2% | 1297 | 14.4% | 3840 | 3.7% |
|  | Male | 7999 | 48.8% | 1296 | 14.6% | 3482 | 4.3% |
| Race/ethnicity | |  |  |  |  |  |  |
|  | Mexican American | 2895 | 8.1% | 377 | 101.3% | 1166 | 29.8% |
|  | Non-Hispanic Black | 3295 | 11.3% | 851 | 33.4% | 1527 | 19.0% |
|  | Non-Hispanic White | 7779 | 70.0% | 987 | 12.4% | 3817 | 2.7% |
|  | Other Hispanic | 1371 | 4.4% | 246 | 138.8% | 519 | 54.1% |
|  | Other Race - Including Multi-Racial | 732 | 6.1% | 132 | 98.3% | 293 | 36.6% |
| Birth Control | |  |  |  |  |  |  |
|  | Missing | 1004 | 5.7% | 192 | 104.1% | 389 | 40.9% |
|  | N/A (Male) | 7999 | 48.8% | 1296 | 14.6% | 3482 | 4.3% |
|  | No | 6545 | 41.1% | 1037 | 18.1% | 3188 | 4.6% |
|  | Yes | 524 | 4.3% | 68 | 218.5% | 263 | 39.4% |
| Plasma Cotinine | |  |  |  |  |  |  |
|  | 3+ ng/mL | 4191 | 26.7% | 840 | 20.1% | 2022 | 7.1% |
|  | <3 ng/mL | 11881 | 73.3% | 1753 | 11.3% | 5300 | 2.8% |
| Hormone Replacement Therapy | | | |  |  |  |  |
|  | Missing | 1191 | 7.1% | 212 | 88.5% | 486 | 30.9% |
|  | N/A (Male) | 7999 | 48.8% | 1296 | 14.6% | 3482 | 4.3% |
|  | No | 6616 | 42.0% | 1053 | 17.8% | 3190 | 4.5% |
|  | Yes | 266 | 2.1% | 32 | 523.6% | 164 | 73.8% |
| BMI > 30 | |  |  |  |  |  |  |
|  | No | 10262 | 65.9% | 1499 | 12.0% | 4702 | 3.0% |
|  | Yes | 5810 | 34.1% | 1094 | 18.2% | 2620 | 5.9% |
| Vigorous physical activity at least 10 minutes per week | | | | | |  |  |
|  | Missing | 4442 | 32.4% | 695 | 22.9% | 3270 | 4.0% |
|  | No | 3409 | 15.9% | 594 | 40.7% | 1188 | 17.5% |
|  | Yes | 8221 | 51.7% | 1304 | 14.3% | 2864 | 5.1% |
| Income (% FPL) | |  |  |  |  |  |  |
|  | 0-100% | 4316 | 19.0% | 839 | 28.2% | 1778 | 11.6% |
|  | 100-199% | 3962 | 19.0% | 683 | 31.1% | 1794 | 10.4% |
|  | 200%+ | 7794 | 62.0% | 1071 | 14.2% | 3750 | 3.1% |
| Used sleep medication 5 or more times in last month | | | | | |  |  |
|  | Missing | 612 | 4.1% | 153 | 115.0% | 548 | 27.3% |
|  | No | 14659 | 90.2% | 2246 | 8.5% | 6013 | 2.4% |
|  | Yes | 801 | 5.7% | 194 | 81.6% | 761 | 18.1% |

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| Table 2. Geometric mean plasma c-reactive protein (CRP). | | |  |
|  |  |  | |
|  |  | Geometric meanⱡ CRP (mg/L) | P-value\* |
| Total | | 0.17 |  |
| Education | |  | <0.0001 |
|  | 9-11th Grade (Includes 12th grade with no diploma) | 0.21 |  |
|  | College Graduate or above | 0.13 |  |
|  | High School Grad/GED or Equivalent | 0.19 |  |
|  | Less Than 9th Grade | 0.20 |  |
|  | Some College or AA degree | 0.17 |  |
| Income (% FPL) | |  | <0.0001 |
|  | 0-100% | 0.19 |  |
|  | 100-199% | 0.19 |  |
|  | 200%+ | 0.16 |  |
| Vigorous physical activity at least once per week | |  | <0.0001 |
|  | Missing | 0.18 |  |
|  | No | 0.23 |  |
|  | Yes | 0.15 |  |
| Gender | |  | <0.0001 |
|  | Female | 0.20 |  |
|  | Male | 0.15 |  |
| Race/ethnicity | |  | <0.0001 |
|  | Mexican American | 0.20 |  |
|  | Non-Hispanic Black | 0.22 |  |
|  | Non-Hispanic White | 0.17 |  |
|  | Other Hispanic | 0.18 |  |
|  | Other Race - Including Multi-Racial | 0.11 |  |
| Age (yrs) | |  | <0.0001 |
|  | 20-24 | 0.12 |  |
|  | 25-29 | 0.14 |  |
|  | 30-34 | 0.15 |  |
|  | 35-39 | 0.15 |  |
|  | 40-44 | 0.17 |  |
|  | 45-49 | 0.19 |  |
|  | 50-54 | 0.18 |  |
|  | 55-59 | 0.19 |  |
|  | 60-64 | 0.22 |  |
|  | 65-69 | 0.21 |  |
|  | 70-74 | 0.23 |  |
|  | 75-79 | 0.21 |  |
|  | 80+ | 0.21 |  |
| Birth control | |  | <0.0001 |
|  | Missing | 0.18 |  |
|  | N/A (Male) | 0.15 |  |
|  | No | 0.19 |  |
|  | Yes | 0.30 |  |
| Serum Cotinine | |  | <0.0001 |
|  | 3+ ng/mL | 0.18 |  |
|  | <3 ng/mL | 0.17 |  |
| Hormone Replacement Therapy | |  | <0.0001 |
|  | Missing | 0.19 |  |
|  | N/A (Male) | 0.15 |  |
|  | No | 0.19 |  |
|  | Yes | 0.30 |  |
| Obesity (BMI > 30) | |  | <0.0001 |
|  | No | 0.12 |  |
|  | Yes | 0.34 |  |
| Poor sleep | |  | <0.0001 |
|  | No | 0.16 |  |
|  | Yes | 0.18 |  |
| Short sleep (<6 hours) | |  | <0.0001 |
|  | No | 0.17 |  |
|  | Yes | 0.20 |  |
| Used sleep medication 5 or more times in past month | |  | <0.0001 |
|  | Missing | 0.25 |  |
|  | No | 0.17 |  |
|  | Yes | 0.19 |  |
| \*Type III sum of squares F-test from ANOVA models fit using CRP transformed by the natural logarithm.  ⱡ Geometric mean values are calculated by exponentiating the regression coefficients of a linear regression model with log-transformed CRP as the response and no intercept. | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 3.** Total and indirect effects estimates of income and education on natural logarithm-transformed c-reactive protein, mediated by poor sleep and short sleep. | | | | | | | | | |
|  |  | C-Reactive Protein (natural logarithm)\* | | | | | |  |  |
|  |  |  |  |  |  | Via Poor Sleep | | Via Short Sleep | |
|  |  | Total Effect  (crude) | 95% CI | Total Effect  (adjusted) | 95% CI | Adjusted TIEǂ | 95% CI | Adjusted TIE | 95% CI |
| Income (% of FPL) (n=15,125) | | | |  |  |  |  |  |  |
|  | 0-100% | 1.21 | 1.14--1.29 | 1.17 | 1.10--1.24 | 0.99 | 0.98--1.00 | 1.01 | 1.00--1.02 |
|  | 100-199% | 1.21 | 1.12--1.30 | 1.11 | 1.05--1.18 | 0.99 | 0.99--1.00 | 1.00 | 1.00--1.01 |
|  | 200%+ | 1.00 | - | 1.00 | - | - | - | - | - |
| Education (n=15,103) | | |  |  |  |  |  |  |  |
|  | Less than 9th Grade | 1.17 | 1.07--1.27 | 1.20 | 1.10--1.31 | 0.99 | 0.98--1.00 |  |  |
|  | 9-11th Grade | 1.18 | 1.07--1.29 | 1.27 | 1.17--1.39 | 0.99 | 0.98--1.00 |  |  |
|  | High School Grad / GED | 1.11 | 1.03--1.19 | 1.24 | 1.16--1.32 | 0.99 | 0.98--1.00 |  |  |
|  | Some College or AA Degree | 1.17 | 1.07--1.27 | 1.20 | 1.10--1.31 | 0.99 | 0.98--1.00 |  |  |
|  | College Graduate or Above | 1.00 | - | 1.00 | - | - | - |  |  |
|  |  |  |  |  |  |  |  |  |  |
| Estimates are presented as *e* raised to the β power, and represent arithmetic mean ratios (AMRs). These are ratios and as such the null value is 1. 95% confidence intervals (CIs) are computed for indirect effect estimates using bootstrap resampling with 1000 replications.  \*Models fit using least squares linear regression adjusted for the survey design. Adjusted model include terms for age (continuous), gender, race/ethnicity, physical activity, birth control use, HRT use, sleep medication use, plasma cotinine, and obesity (BMI > 30). | | | | | | | | | |
| ǂ TIE = Total indirect effect, or the relative increase in CRP as a result of the fact that SES affects sleep. | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Supplementary table 1.** Results of examining whether each hypothesized mediator was associated with each exposure and the outcome. | | | | | | | | |
|  | Short Sleep | | | | Poor Sleep | | | |
|  | Χ2 |  | DF | P-value | Χ2 |  | DF | P-value |
| Education | 78.7 |  | 4 | <0.0001 | 4.6 |  | 4 | 0.33 |
| Income | 59.2 |  | 2 | <0.0001 | 11.6 |  | 2 | 0.003 |
| C-reactive protein | 6.4 | \* | 1 | 0.014 | 5.1 | \* | 1 | 0.028 |
|  |  |  |  |  |  |  |  |  |
| \*Values are F statistic, rather than X2. | | | |  |  |  |  |  |

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libname dat 'H:\Personal\NHANES SES-sleep-CRP';

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libname bmx\_e Xport 'C:\Users\Audrey\Google Drive\CUNY SPH Coursework\EPID622 Applied Research- Data Management\NHANES SES sleep CRP\data\bmx\_e.xpt';

libname bmx\_f Xport 'C:\Users\Audrey\Google Drive\CUNY SPH Coursework\EPID622 Applied Research- Data Management\NHANES SES sleep CRP\data\bmx\_f.xpt';

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libname crp\_f Xport 'C:\Users\Audrey\Google Drive\CUNY SPH Coursework\EPID622 Applied Research- Data Management\NHANES SES sleep CRP\data\crp\_f.xpt';

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libname paq\_e Xport 'C:\Users\Audrey\Google Drive\CUNY SPH Coursework\EPID622 Applied Research- Data Management\NHANES SES sleep CRP\data\paq\_e.xpt';

libname paq\_f Xport 'C:\Users\Audrey\Google Drive\CUNY SPH Coursework\EPID622 Applied Research- Data Management\NHANES SES sleep CRP\data\paq\_f.xpt';

\*vertically merge years for each dataset;

data bmx; set bmx\_d.bmx\_d bmx\_e.bmx\_e bmx\_f.bmx\_f; run;

data crp; set crp\_d.crp\_d crp\_e.crp\_e crp\_f.crp\_f; run;

data demo; set demo\_d.demo\_d demo\_e.demo\_e demo\_f.demo\_f; run;

data slq; set slq\_d.slq\_d slq\_e.slq\_e slq\_f.slq\_f; run;

data rhq; set rhq\_d.rhq\_d rhq\_e.rhq\_e rhq\_f.rhq\_f; run;

data cot; set cot\_d.cot\_d cotnal\_e.cotnal\_e cotnal\_f.cotnal\_f; run;

data paq; set paq\_d.paq\_d paq\_e.paq\_e paq\_f.paq\_f; run;

data dat.nhanes; \*horizontally merge datasets and create 6-year weights, save physical file;

merge bmx crp demo slq cot rhq paq;

by seqn;

WTMEC6YR = 1/3 \* WTMEC2YR;

label WTMEC6YR = "Full Sample 6 Year MEC Exam Weight";

WTINT6YR = 1/3 \* WTINT2YR;

label WTINT6YR = "Full Sample 6 Year Interview Weight";

run;

proc contents data=dat.nhanes;

run;

proc format library=dat; \* all formats;

value yesno 3="No" 1="Yes" 2="Missing";

value crpbin 0="<3" 1="3 to 10" 2=">10";

value sleepdur 0="7" 1="6" 2="<6" 3="8" 4=">8";

value pir 3="200%+" 1="100-199%" 2="0-100%";

value edu 1="Less Than 9th Grade" 2="9-11th Grade (Includes 12th grade with no diploma)"

3="High School Grad/GED or Equivalent" 4="Some College or AA degree"

5="College Graduate or above";

value age\_5yr 0="20-24" 1="25-29" 2="30-34"

3="35-39" 4="40-44" 5="45-49" 6="50-54" 7="55-59"

8="60-64" 9="65-69" 10="70-74" 11="75-79" 12="80+";

value cot 0="<3 ng/mL" 1="3+ ng/mL";

value gender 1="Male" 2="Female";

value race 1="Mexican American" 2="Other Hispanic" 3="Non-Hispanic White"

4="Non-Hispanic Black" 5="Other Race - Including Multi-Racial";

value hrt 1="Yes" 0="No" 3="N/A (Male)" 4="Missing";

run;

options fmtsearch=(dat.formats);

data nhanes; \* grab from physical file, coding exposures, outcomes, mediators;

set dat.nhanes;

crp\_bin = .;

if LBXCRP < 3 then crp\_bin = 0;

else if 3 <= LBXCRP < 10 then crp\_bin = 1;

else if LBXCRP >= 10 then crp\_bin = 2;

format crp\_bin crpbin.;

crp\_log = log(LBXCRP);

sleep\_dur = .;

if SLD010H > 12 then sleep\_dur = .; \*deleting 77 and 99, these are missing;

else if SLD010H = 7 then sleep\_dur = 0;

else if SLD010H = 6 then sleep\_dur = 1;

else if SLD010H < 6 then sleep\_dur = 2;

else if SLD010H = 8 then sleep\_dur = 3;

else if SLD010H > 8 then sleep\_dur = 4;

format sleep\_dur sleepdur.;

label sleep\_dur="How much sleep do you get (hours)?";

short\_sleep = 3;

if sleep\_dur = 2 then short\_sleep = 1;

else if sleep\_dur = . then short\_sleep = .;

format short\_sleep yesno.;

label short\_sleep="Short Sleep (<6 hours per night)";

poor\_sleep = .;

if 2 le SLQ080 le 4 then poor\_sleep = 1;

else if 2 le SLQ090 le 4 then poor\_sleep = 1;

else if 2 le SLQ100 le 4 then poor\_sleep = 1;

else if 2 le SLQ110 le 4 then poor\_sleep = 1;

else if 2 le SLQ120 le 4 then poor\_sleep = 1;

else if SLQ080 < 2 and SLQ090 < 2 and SLQ100 < 2 and SLQ110 < 2 and SLQ120 < 2 then poor\_sleep = 3;

format poor\_sleep yesno.;

pir\_cat = .;

if INDFMPIR > 2 then pir\_cat = 3;

else if INDFMPIR > 1 then pir\_cat = 1;

else if INDFMPIR <= 1 then pir\_cat = 2;

format pir\_cat pir.;

label pir\_cat="Poverty income ratio";

format DMDEDUC2 edu.;

if DMDEDUC2 > 6 then DMDEDUC2 = .;

run;

proc freq data=nhanes; \*check for correct coding of exposures, outcomes, and mediators;

tables LBXCRP\*crp\_bin SLD010H\*sleep\_dur

SLQ080\*poor\_sleep

SLQ090\*poor\_sleep

SLQ100\*poor\_sleep

SLQ110\*poor\_sleep

SLQ120\*poor\_sleep

INDFMPIR\*pir\_cat;

run;

data nhanes; \*Coding age;

set nhanes;

agecat = .;

if RIDAGEYR < 20 then delete;

else if RIDAGEYR <25 then agecat = 0;

else if RIDAGEYR <30 then agecat = 1;

else if RIDAGEYR <35 then agecat = 2;

else if RIDAGEYR <40 then agecat = 3;

else if RIDAGEYR <45 then agecat = 4;

else if RIDAGEYR <50 then agecat = 5;

else if RIDAGEYR <55 then agecat = 6;

else if RIDAGEYR <60 then agecat = 7;

else if RIDAGEYR <65 then agecat = 8;

else if RIDAGEYR <70 then agecat = 9;

else if RIDAGEYR <75 then agecat = 10;

else if RIDAGEYR <80 then agecat = 11;

else agecat = 12;

format agecat age\_5yr.;

label agecat = "Age (5yr categories)";

run;

proc freq data=nhanes; \*check for correct coding of age;

tables RIDAGEYR\*agecat;

run;

data nhanes; \*Coding cotinine;

set nhanes;

cotinine\_cat = .;

if LBXCOT < 3 then cotinine\_cat = 0;

else if LBXCOT >= 3 then cotinine\_cat = 1;

format cotinine\_cat cot.;

label cotinine\_cat = "Cotinine level, two categories";

run;

proc freq data=nhanes; tables LBXCOT\*cotinine\_cat; run; \*Checking for correct cotinine coding;

proc freq data=nhanes; \*hrt missingness?;

tables RHQ558 RHQ566 RHQ574 RHQ584 RHQ600;

run;

data nhanes; \*coding other covariates;

set nhanes;

hrt = 4;

if RIAGENDR = 1 then hrt = 3;

else if RHQ540 = 2 then hrt = 0;

else if RHQ558 = 1 or RHQ566 = 1 or RHQ574 = 1 or RHQ584 = 1 or RHQ600 = 1 then hrt = 1;

else if RHQ558 = 2 or RHQ566 = 2 or RHQ574 = 2 or RHQ584 = 2 or RHQ600 = 2 then hrt = 0;

format hrt hrt.;

label hrt = "Using any HRT now (y/n)";

obese = 2;

if BMXBMI ge 30 then obese=1;

else if BMXBMI lt 30 then obese=3;

format obese yesno.;

label obese = "BMI 30+ (y/n)";

sleep\_med = 2;

if SLQ140=2 or SLQ140=3 then sleep\_med = 1;

else if SLQ140 le 2 then sleep\_med = 3;

format sleep\_med yesno.;

label sleep\_med = "Used sleep medications 5 or more times in the last 30 days";

birth\_control = 4;

if RIAGENDR = 1 then birth\_control = 3;

else if RHD442 = 1 or RHQ520 = 1 then birth\_control = 1;

else if RHQ420 = 2 or RHQ510 = 2 then birth\_control = 0;

else if RHD442 = 2 or RHQ520 = 2 then birth\_control = 0;

format birth\_control hrt.;

phys\_act = 3;

if PAQ605 = 1

OR PAQ620 = 1

OR PAQ635 = 1

OR PAQ650 = 1

OR PAQ665 = 1

then phys\_act = 1;

else if (PAQ605 ge 7 or PAQ605 = . )

AND (PAQ620 ge 7 or PAQ620 = . )

AND (PAQ635 ge 7 or PAQ635 = . )

AND (PAQ650 ge 7 or PAQ650 = . )

AND (PAQ665 ge 7 or PAQ665 = . )

then phys\_act = 2;

format phys\_act yesno.;

label phys\_act="Vigorous or moderate work, recreational, or transportation activity at least once per week.";

format RIAGENDR gender. RIDRETH1 race.;

run;

proc freq data=nhanes; \*check for correct coding of HRT, obese, sleepmed, birthcontrol;

tables hrt\*RHQ558 hrt\*RHQ566 hrt\*RHQ574 hrt\*RHQ584 hrt\*RHQ600

BMXBMI\*obese SLQ140\*sleep\_med RHD442\*birth\_control;

run;

data nhanes; \*dropping 22 observations due to crp >10;

set nhanes;

if crp\_bin = 2 then delete;

run;

proc freq data=nhanes; tables RHD143\*RIDEXPRG; run; \*check for pregnancies;

data nhanes; \*dropping 456 observations due to currently pregnant (at exam);

set nhanes;

if RIDEXPRG = 1 then delete;

run;

data nhanes; \*renaming survey design variables;

set nhanes;

weight=WTMEC6YR;

strata=SDMVSTRA;

cluster=SDMVPSU;

run;

\*save full dataset;

data dat.nhanes;

set nhanes;

run;

\*save final dataset with only relevant variables;

data dat.final (keep=SEQN weight strata cluster LBXCRP crp\_bin crp\_log sleep\_dur short\_sleep poor\_sleep pir\_cat DMDEDUC2 agecat RIDAGEYR

cotinine\_cat LBXCOT hrt obese sleep\_med birth\_control phys\_act RIAGENDR RIDRETH1 PAD200);

set nhanes;

run;

proc contents data=dat.final;

run;

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\* PAPER TABLE 1 \*/

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\* One-way frequencies \*/

ods output OneWay=oneway\_dmdeduc2;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables DMDEDUC2; run;

ods output OneWay=oneway\_pir\_cat;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables pir\_cat; run;

ods output OneWay=oneway\_short\_sleep;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables short\_sleep; run;

ods output OneWay=oneway\_poor\_sleep;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables poor\_sleep; run;

ods output OneWay=oneway\_riagendr;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables riagendr; run;

ods output OneWay=oneway\_ridreth1;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables ridreth1; run;

ods output OneWay=oneway\_birth\_control;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables birth\_control; run;

ods output OneWay=oneway\_cotinine\_cat;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables cotinine\_cat; run;

ods output OneWay=oneway\_hrt;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables hrt; run;

ods output OneWay=oneway\_obese;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables obese; run;

ods output OneWay=oneway\_sleep\_med;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables sleep\_med; run;

ods output OneWay=oneway\_phys\_act;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables phys\_act; run;

data oneway\_dmdeduc2(keep=table value frequency percent); set oneway\_dmdeduc2;

value= vvalue(dmdeduc2); run;

data oneway\_pir\_cat (keep=table value frequency percent); set oneway\_pir\_cat;

value= vvalue(pir\_cat); run;

data oneway\_short\_sleep(keep=table value frequency percent); set oneway\_short\_sleep;

value= vvalue(short\_sleep); run;

data oneway\_poor\_sleep(keep=table value frequency percent); set oneway\_poor\_sleep;

value= vvalue(poor\_sleep); run;

data oneway\_RIAGENDR (keep=table value frequency percent); set oneway\_RIAGENDR ;

value= vvalue(RIAGENDR) ; run;

data oneway\_RIDRETH1 (keep=table value frequency percent); set oneway\_RIDRETH1 ;

value= vvalue(RIDRETH1) ; run;

data oneway\_birth\_control(keep=table value frequency percent); set oneway\_birth\_control;

value= vvalue(birth\_control); run;

data oneway\_cotinine\_cat(keep=table value frequency percent); set oneway\_cotinine\_cat;

value= vvalue(cotinine\_cat); run;

data oneway\_hrt(keep=table value frequency percent); set oneway\_hrt;

value= vvalue(hrt); run;

data oneway\_obese (keep=table value frequency percent); set oneway\_obese ;

value= vvalue(obese) ; run;

data oneway\_sleep\_med(keep=table value frequency percent); set oneway\_sleep\_med;

value= vvalue(sleep\_med); run;

data oneway\_phys\_act(keep=table value frequency percent); set oneway\_phys\_act;

value= vvalue(phys\_act); run;

data oneway;

set oneway\_dmdeduc2 oneway\_pir\_cat oneway\_short\_sleep oneway\_poor\_sleep

oneway\_RIAGENDR oneway\_RIDRETH1 oneway\_birth\_control oneway\_cotinine\_cat

oneway\_hrt oneway\_obese oneway\_sleep\_med oneway\_phys\_act;

where percent < 100;

percent = percent / 100;

table= STRIP( TRANWRD(table, "Table ", "") );

run;

/\* Two-way frequencies by poor sleep \*/

ods output crosstabs=ps\_DMDEDUC2;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables DMDEDUC2\*poor\_sleep; run;

ods output crosstabs=ps\_pir\_cat;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables pir\_cat\*poor\_sleep; run;

ods output crosstabs=ps\_short\_sleep;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables short\_sleep\*poor\_sleep; run;

ods output crosstabs=ps\_riagendr;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables riagendr\*poor\_sleep; run;

ods output crosstabs=ps\_ridreth1;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables ridreth1\*poor\_sleep; run;

ods output crosstabs=ps\_birth\_control;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables birth\_control\*poor\_sleep; run;

ods output crosstabs=ps\_cotinine\_cat;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables cotinine\_cat\*poor\_sleep; run;

ods output crosstabs=ps\_hrt;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables hrt\*poor\_sleep; run;

ods output crosstabs=ps\_obese;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables obese\*poor\_sleep; run;

ods output crosstabs=ps\_sleep\_med;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables sleep\_med\*poor\_sleep; run;

ods output crosstabs=ps\_phys\_act;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables phys\_act\*poor\_sleep; run;

data ps\_dmdeduc2 (keep=table value frequency percent); set ps\_dmdeduc2;

value=vvalue(dmdeduc2); table="DMDEDUC2"; where poor\_sleep=1; run;

data ps\_pir\_cat (keep=table value frequency percent); set ps\_pir\_cat;

value= vvalue(pir\_cat); table="pir\_cat"; where poor\_sleep = 1; run;

data ps\_short\_sleep (keep=table value frequency percent); set ps\_short\_sleep;

value=vvalue(short\_sleep);table="short\_sleep"; where poor\_sleep=1; run;

data ps\_riagendr (keep=table value frequency percent); set ps\_riagendr ;

value=vvalue(riagendr ); table="RIAGENDR"; where poor\_sleep=1; run;

data ps\_ridreth1(keep=table value frequency percent); set ps\_ridreth1;

value=vvalue(ridreth1); table="RIDRETH1"; where poor\_sleep=1; run;

data ps\_birth\_control(keep=table value frequency percent); set ps\_birth\_control;

value=vvalue(birth\_control); table="birth\_control"; where poor\_sleep=1; run;

data ps\_cotinine\_cat(keep=table value frequency percent); set ps\_cotinine\_cat;

value=vvalue(cotinine\_cat); table="cotinine\_cat"; where poor\_sleep=1; run;

data ps\_hrt(keep=table value frequency percent); set ps\_hrt;

value=vvalue(hrt); table="hrt"; where poor\_sleep=1; run;

data ps\_obese(keep=table value frequency percent); set ps\_obese;

value=vvalue(obese); table="obese"; where poor\_sleep=1; run;

data ps\_sleep\_med(keep=table value frequency percent); set ps\_sleep\_med;

value=vvalue(sleep\_med); table="sleep\_med"; where poor\_sleep=1; run;

data ps\_phys\_act(keep=table value frequency percent); set ps\_phys\_act;

value=vvalue(phys\_act); table="phys\_act"; where poor\_sleep=1; run;

data ps (keep=table value ps\_freq ps\_perc);

set ps\_dmdeduc2 ps\_pir\_cat ps\_short\_sleep ps\_riagendr ps\_hrt

ps\_ridreth1 ps\_birth\_control ps\_cotinine\_cat ps\_obese ps\_sleep\_med ps\_phys\_act;

where frequency < 7310;

ps\_freq = frequency;

ps\_perc = 1/percent;

run;

/\* Two-way frequencies by short sleep \*/

ods output crosstabs=ss\_DMDEDUC2;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables DMDEDUC2\*short\_sleep; run;

ods output crosstabs=ss\_pir\_cat;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables pir\_cat\*short\_sleep; run;

ods output crosstabs=ss\_poor\_sleep;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables poor\_sleep\*short\_sleep; run;

ods output crosstabs=ss\_riagendr;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables riagendr\*short\_sleep; run;

ods output crosstabs=ss\_ridreth1;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables ridreth1\*short\_sleep; run;

ods output crosstabs=ss\_birth\_control;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables birth\_control\*short\_sleep; run;

ods output crosstabs=ss\_cotinine\_cat;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables cotinine\_cat\*short\_sleep; run;

ods output crosstabs=ss\_hrt;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables hrt\*short\_sleep; run;

ods output crosstabs=ss\_obese;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables obese\*short\_sleep; run;

ods output crosstabs=ss\_sleep\_med;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables sleep\_med\*short\_sleep; run;

ods output crosstabs=ss\_phys\_act;

proc surveyfreq data=dat.final; strata strata; cluster cluster; weight weight; tables phys\_act\*short\_sleep; run;

data ss\_dmdeduc2 (keep=table value frequency percent); set ss\_dmdeduc2;

value=vvalue(dmdeduc2); table="DMDEDUC2"; where short\_sleep=1; run;

data ss\_pir\_cat (keep=table value frequency percent); set ss\_pir\_cat;

value= vvalue(pir\_cat); table="pir\_cat"; where short\_sleep = 1; run;

data ss\_poor\_sleep (keep=table value frequency percent); set ss\_poor\_sleep;

value=vvalue(poor\_sleep); table="poor\_sleep"; where short\_sleep=1; run;

data ss\_riagendr (keep=table value frequency percent); set ss\_riagendr ;

value=vvalue(riagendr ); table="RIAGENDR"; where short\_sleep=1; run;

data ss\_ridreth1(keep=table value frequency percent); set ss\_ridreth1;

value=vvalue(ridreth1); table="RIDRETH1"; where short\_sleep=1; run;

data ss\_birth\_control(keep=table value frequency percent); set ss\_birth\_control;

value=vvalue(birth\_control); table="birth\_control"; where short\_sleep=1; run;

data ss\_cotinine\_cat(keep=table value frequency percent); set ss\_cotinine\_cat;

value=vvalue(cotinine\_cat); table="cotinine\_cat"; where short\_sleep=1; run;

data ss\_hrt(keep=table value frequency percent); set ss\_hrt;

value=vvalue(hrt); table="hrt"; where short\_sleep=1; run;

data ss\_obese(keep=table value frequency percent); set ss\_obese;

value=vvalue(obese); table="obese"; where short\_sleep=1; run;

data ss\_sleep\_med(keep=table value frequency percent); set ss\_sleep\_med;

value=vvalue(sleep\_med); table="sleep\_med"; where short\_sleep=1; run;

data ss\_phys\_act(keep=table value frequency percent); set ss\_phys\_act;

value=vvalue(phys\_act); table="phys\_act"; where short\_sleep=1; run;

data ss (keep = table value ss\_freq ss\_perc);

set ss\_dmdeduc2 ss\_pir\_cat ss\_poor\_sleep ss\_riagendr ss\_hrt

ss\_ridreth1 ss\_birth\_control ss\_cotinine\_cat ss\_obese ss\_sleep\_med ss\_phys\_act;

where frequency < 2588;

ss\_freq = frequency;

ss\_perc = 1/percent;

run;

/\* combine all into table1 \*/

proc datasets lib=work nolist;

save oneway ss ps;

run;

proc sort data=oneway; by table value; run;

proc sort data=ss; by table value; run;

proc sort data=ps; by table value; run;

data table1;

merge oneway ss ps;

by table value;

run;

proc export

data=table1

dbms=xlsx

outfile="C:\Users\Audrey\Google Drive\CUNY SPH Coursework\EPID622 Applied Research- Data Management\NHANES SES sleep CRP\table1.xlsx"

replace;

run;

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\* PAPER TABLE 2 \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\*Mean CRP (log) by each variable & f test \*/

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=edu";

strata strata; cluster cluster; weight weight;

class DMDEDUC2;

model crp\_log = DMDEDUC2 /solution noint;

run;

data p; set p; effect='DMDEDUC2'; run; data e; set e; where not(effect='Model'); run;

data edu (keep=effect parameter estimate probF); merge e p; by effect; run;

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=pir\_cat";

strata strata; cluster cluster; weight weight;

class pir\_cat;

model crp\_log = pir\_cat /solution noint;

run;

data p; set p; effect='pir\_cat'; run; data e; set e; where not(effect='Model'); run;

data pir (keep=effect parameter estimate probF); merge e p; by effect; run;

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=activity";

strata strata; cluster cluster; weight weight;

class phys\_act;

model crp\_log = phys\_act/solution noint;

lsmeans phys\_act;

run;

data p; set p; effect='phys\_act'; run; data e; set e; where not(effect='Model'); run;

data phys (keep=effect parameter estimate probF); merge e p; by effect; run;

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=gender";

strata strata; cluster cluster; weight weight;

class RIAGENDR;

model crp\_log = RIAGENDR /solution noint;

run;

data p; set p; effect='RIAGENDR'; run; data e; set e; where not(effect='Model'); run;

data gender (keep=effect parameter estimate probF); merge e p; by effect; run;

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=race";

strata strata; cluster cluster; weight weight;

class RIDRETH1;

model crp\_log = RIDRETH1 /solution noint;

run;

data p; set p; effect='RIDRETH1'; run; data e; set e; where not(effect='Model'); run;

data race(keep=effect parameter estimate probF); merge e p; by effect; run;

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=age";

strata strata; cluster cluster; weight weight;

class agecat;

model crp\_log = agecat /solution noint;

run;

data p; set p; effect='agecat'; run; data e; set e; where not(effect='Model'); run;

data age (keep=effect parameter estimate probF); merge e p; by effect; run;

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=birth control";

strata strata; cluster cluster; weight weight;

class birth\_control;

model crp\_log = birth\_control /solution noint;

run;

data p; set p; effect='birth\_control'; run; data e; set e; where not(effect='Model'); run;

data birth (keep=effect parameter estimate probF); merge e p; by effect; run;

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=cotinine";

strata strata; cluster cluster; weight weight;

class cotinine\_cat;

model crp\_log = cotinine\_cat /solution noint;

run;

data p; set p; effect='cotinine\_cat'; run; data e; set e; where not(effect='Model'); run;

data cotinine (keep=effect parameter estimate probF); merge e p; by effect; run;

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=hrt";

strata strata; cluster cluster; weight weight;

class hrt;

model crp\_log = hrt /solution noint;

run;

data p; set p; effect='hrt'; run; data e; set e; where not(effect='Model'); run;

data hrt (keep=effect parameter estimate probF); merge e p; by effect; run;

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=obese";

strata strata; cluster cluster; weight weight;

class obese;

model crp\_log = obese /solution noint;

run;

data p; set p; effect='obese'; run; data e; set e; where not(effect='Model'); run;

data obese (keep=effect parameter estimate probF); merge e p; by effect; run;

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=poor sleep";

strata strata; cluster cluster; weight weight;

class poor\_sleep;

model crp\_log = poor\_sleep /solution noint;

run;

data p; set p; effect='poor\_sleep'; run; data e; set e; where not(effect='Model'); run;

data poor (keep=effect parameter estimate probF); merge e p; by effect; run;

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=sleep duration";

strata strata; cluster cluster; weight weight;

class short\_sleep;

model crp\_log = short\_sleep /solution noint;

run;

data p; set p; effect='short\_sleep'; run; data e; set e; where not(effect='Model'); run;

data short (keep=effect parameter estimate probF); merge e p; by effect; run;

ods output parameterestimates=p effects=e;

proc surveyreg data=dat.final; title "univariable crp=sleep meds";

strata strata; cluster cluster; weight weight;

class sleep\_med;

model crp\_log = sleep\_med /solution noint;

run;

data p; set p; effect='sleep\_med'; run; data e; set e; where not(effect='Model'); run;

data sleep\_med (keep=effect parameter estimate probF); merge e p; by effect; run;

/\* combine into table 2 \*/

data table2 (keep=effect parameter estimate exp\_estimate pval);

set edu pir phys gender race age birth cotinine hrt obese poor short sleep\_med;

if probF < 0.0001 then pval = "<0.0001";

else pval = input(probF, 1.4);

parameter = STRIP( TRANWRD(parameter, effect, "") );

exp\_estimate = exp(estimate);

run;

\*get total geometric mean crp;

ods output statistics=mean\_crp\_log;

proc surveymeans data=dat.final;

strata strata; cluster cluster; weight weight;

var crp\_log;

run;

data geom\_mean\_crp (keep=geom\_mean); set mean\_crp\_log;

geom\_mean = exp(mean);

run;

proc print data=geom\_mean\_crp; title 'Geometric mean CRP (total)'; run;

proc export

data=table2

dbms=xlsx

outfile="h:\personal\NHANES SES sleep CRP\table2.xlsx"

replace;

run;

/\* Checking residuals

ods graphics on;

proc glm data=dat.final order=INTERNAL PLOTS=DIAGNOSTICS;

class DMDEDUC2 phys\_act poor\_sleep

RIAGENDR RIDRETH1 agecat

birth\_control cotinine\_cat hrt

obese sleep\_med;

model crp\_log = DMDEDUC2 poor\_sleep phys\_act RIAGENDR RIDRETH1 agecat birth\_control

cotinine\_cat hrt obese sleep\_med;

run; quit;

\*/

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\* Supplemental Table 1 \*\*\*\*\*\*\*\*\*\*/

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\* CHECKING IF EXPOSURE->MEDIATOR, MEDIATOR->OUTCOME \*/

/\* EXPOSURE->MEDIATOR \*/

/\* edu->short\_sleep YES \*/

ods output type3=edu\_ss;

proc surveylogistic data=dat.final order=INTERNAL;

strata strata; cluster cluster; weight weight;

class sleep\_med DMDEDUC2 RIAGENDR RIDRETH1 birth\_control cotinine\_cat hrt obese;

model short\_sleep = DMDEDUC2 RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med;

run;

/\* edu->poor\_sleep NO \*/

ods output type3=edu\_ps;

proc surveylogistic data=dat.final order=INTERNAL;

strata strata; cluster cluster; weight weight;

class sleep\_med DMDEDUC2 RIAGENDR RIDRETH1 birth\_control cotinine\_cat hrt obese;

model poor\_sleep = DMDEDUC2 RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med;

run;

/\* inc->short\_sleep YES \*/

ods output type3=inc\_ss;

proc surveylogistic data=dat.final order=INTERNAL;

strata strata; cluster cluster; weight weight;

class sleep\_med pir\_cat RIAGENDR RIDRETH1 birth\_control cotinine\_cat hrt obese;

model short\_sleep = pir\_cat RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med;

run;

/\* inc->poor\_sleep YES \*/

ods output type3=inc\_ps;

proc surveylogistic data=dat.final order=INTERNAL;

strata strata; cluster cluster; weight weight;

class sleep\_med pir\_cat RIAGENDR RIDRETH1 birth\_control cotinine\_cat hrt obese;

model poor\_sleep = pir\_cat RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med;

run;

/\* MEDIATOR->OUTCOME \*/

/\* short\_sleep->CRP YES \*/

ods output effects=ss\_crp;

proc surveyreg data=dat.final order=INTERNAL;

strata strata; cluster cluster; weight weight;

class short\_sleep sleep\_med RIAGENDR RIDRETH1 birth\_control cotinine\_cat hrt obese;

model crp\_log = short\_sleep RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med /solution CLPARM;

run;

/\* poor\_sleep->CRP \*/

ods output effects=ps\_crp;

proc surveyreg data=dat.final order=INTERNAL;

strata strata; cluster cluster; weight weight;

class sleep\_med poor\_sleep RIAGENDR RIDRETH1 birth\_control cotinine\_cat hrt obese;

model crp\_log = poor\_sleep RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med /solution CLPARM;

run;

data edu\_ps (keep=effect ps\_x2 ps\_df ps\_p); set edu\_ps;

ps\_x2 = waldchisq; ps\_df=df; ps\_p=probchisq;

where effect="DMDEDUC2";

run;

data edu\_ss (keep=effect ss\_x2 ss\_df ss\_p); set edu\_ss;

ss\_x2 = waldchisq; ss\_df=df; ss\_p=probchisq;

where effect="DMDEDUC2";

run;

data inc\_ps (keep=effect ps\_x2 ps\_df ps\_p); set inc\_ps;

ps\_x2 = waldchisq; ps\_df=df; ps\_p=probchisq;

where effect="pir\_cat";

run;

data inc\_ss (keep=effect ss\_x2 ss\_df ss\_p); set inc\_ss;

ss\_x2 = waldchisq; ss\_df=df; ss\_p=probchisq;

where effect="pir\_cat";

run;

data ss\_crp (keep=effect ss\_x2 ss\_df ss\_p); set ss\_crp;

where effect="short\_sleep";

ss\_x2=fvalue; ss\_df=numdf; ss\_p=probf;

run;

data ps\_crp(keep=effect ps\_x2 ps\_df ps\_p); set ps\_crp;

where effect="poor\_sleep";

ps\_x2=fvalue; ps\_df=numdf; ps\_p=probf;

run;

data ps\_crp; set ps\_crp; effect="crp"; run;

data ss\_crp; set ss\_crp; effect="crp"; run;

data ss; set edu\_ss inc\_ss ss\_crp; run;

data ps; set edu\_ps inc\_ps ps\_crp; run;

proc sort data=ss; by effect; run;

proc sort data=ps; by effect; run;

data suppl\_table1; merge ss ps; by effect; run;

proc export

data=suppl\_table1

dbms=xlsx

outfile="c:\users\audrey\documents\nhanes\_ses\_sleep\_crp\suppl\_table1.xlsx"

replace;

run; quit;

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\* PAPER TABLE 3 \*\*\*\*\*\*\*\*\*\*\*\*\*/

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\* creating a bootstrap sample of 1000 replicates \*/

%let reps=1000;

proc surveyselect data=dat.final out=outboot

seed=1

method=urs

samprate=1

outhits

rep=&reps;

run;

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\* 0. CRUDE TOTAL EFFECTS \*/

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\* income \*/

ods output parameterestimates=te\_crude\_pir;

proc surveyreg data=dat.final;

strata strata; cluster cluster; weight weight;

class pir\_cat;

model crp\_log = pir\_cat /solution CLPARM;

run;

/\* education \*/

ods output parameterestimates=te\_crude\_edu;

proc surveyreg data=dat.final;

strata strata; cluster cluster; weight weight;

class DMDEDUC2;

model crp\_log = DMDEDUC2 /solution CLPARM;

run;

data te\_crude (keep=param est\_TE\_crude lwr\_TE\_crude upr\_TE\_crude); set te\_crude\_edu te\_crude\_pir;

param=parameter; est\_TE\_crude=estimate; lwr\_TE\_crude=LowerCL; upr\_TE\_crude=UpperCL;

run;

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\* 1. EXPOSURE=INCOME, MEDIATOR=POOR SLEEP (with interaction) \*/

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\*total effect\*/

ods output parameterestimates=p;

proc surveyreg data=dat.final;

strata strata; cluster cluster; weight weight;

class sleep\_med pir\_cat RIAGENDR RIDRETH1 birth\_control cotinine\_cat hrt obese;

model crp\_log = pir\_cat RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med /solution CLPARM;

run;

data total\_effect\_pir (keep=parameter estimate probt lowercl uppercl);

set p (firstobs=2 obs=4);

run;

/\*outcome regression\*/

proc surveyreg data=outboot order=INTERNAL;\* 1. outcome model;

by replicate;

strata strata; cluster cluster; weight weight;

class poor\_sleep sleep\_med pir\_cat

RIAGENDR RIDRETH1

birth\_control cotinine\_cat hrt obese;

model crp\_log = pir\_cat poor\_sleep pir\_cat\*poor\_sleep RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med /solution;

ods select none;

ods output ParameterEstimates = outcome\_model;

run;

data poorsleep (keep = replicate poorsleep); set outcome\_model;

where parameter = 'poor\_sleep Yes';

poorsleep = estimate;

run;

data poorsleep\_pir0100 (keep = replicate poorsleep\_pir0100); set outcome\_model;

where parameter = 'poor\_sleep\*pir\_cat Yes 0-100%';

poorsleep\_pir0100 = estimate;

run;

data poorsleep\_pir199 (keep = replicate poorsleep\_pir199); set outcome\_model;

where parameter = 'poor\_sleep\*pir\_cat Yes 100-199%';

poorsleep\_pir199 = estimate;

run;

/\*mediator regression \*/

proc surveyreg data=outboot order=INTERNAL;

by replicate;

strata strata; cluster cluster; weight weight;

class poor\_sleep sleep\_med pir\_cat

RIAGENDR RIDRETH1

birth\_control cotinine\_cat hrt obese;

model poor\_sleep = pir\_cat RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med /solution;

ods select none;

ods output ParameterEstimates = mediator\_model;

run;

data pir0100 (keep = replicate pir0100); set mediator\_model;

where parameter = 'pir\_cat 0-100%';

pir0100 = estimate;

run;

data pir199 (keep = replicate pir199); set mediator\_model;

where parameter = 'pir\_cat 100-199%';

pir199 = estimate;

run;

/\* combine and calculate the indirect effect \*/

data combine;

merge poorsleep poorsleep\_pir0100 pir0100 poorsleep\_pir199 pir199;

by replicate;

indirect\_pir0100 = (pir0100\*poorsleep) + (pir0100\*poorsleep\_pir0100);

indirect\_pir199 = (pir199\*poorsleep) + (pir199\*poorsleep\_pir199);

run;

/\* get confidence intervals from percentiles of the bootstrap estimates \*/

proc univariate data=combine noprint;

var indirect\_pir199 indirect\_pir0100;

output out=result\_income\_poorsleep mean=estimate199 estimate100 pctlpre=P\_199\_ p\_100\_ pctlpts= 2.5, 97.5;

run;

data dat.result\_income\_poorsleep; set result\_income\_poorsleep; run;

proc print data=result\_income\_poorsleep;

title "Indirect Effect Estimates for Income Mediated by Poor Sleep.";

ods select all;

run;

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\* 2. EXPOSURE=INCOME, MEDIATOR=SHORT SLEEP (no interaction) \*/

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\*outcome regression\*/

proc surveyreg data=outboot order=INTERNAL;\* 1. outcome model;

by replicate;

strata strata; cluster cluster; weight weight;

class short\_sleep sleep\_med pir\_cat

RIAGENDR RIDRETH1

birth\_control cotinine\_cat hrt obese;

model crp\_log = pir\_cat short\_sleep RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med /solution;

ods select none;

ods output ParameterEstimates = outcome\_model;

run;

data short\_sleep (keep = replicate short\_sleep); set outcome\_model;

where parameter = 'short\_sleep Yes';

short\_sleep = estimate;

run;

/\*mediator regression \*/

proc surveyreg data=outboot order=INTERNAL;

by replicate;

strata strata; cluster cluster; weight weight;

class short\_sleep sleep\_med pir\_cat

RIAGENDR RIDRETH1

birth\_control cotinine\_cat hrt obese;

model short\_sleep = pir\_cat RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med /solution;

ods select none;

ods output ParameterEstimates = mediator\_model;

run;

data pir0100 (keep = replicate pir0100); set mediator\_model;

where parameter = 'pir\_cat 0-100%';

pir0100 = estimate;

run;

data pir199 (keep = replicate pir199); set mediator\_model;

where parameter = 'pir\_cat 100-199%';

pir199 = estimate;

run;

/\* combine and calculate the indirect effect \*/

data combine;

merge short\_sleep pir0100 pir199;

by replicate;

indirect\_pir0100 = (pir0100\*short\_sleep);

indirect\_pir199 = (pir199\*short\_sleep) ;

run;

/\* get confidence intervals from percentiles of the bootstrap estimates \*/

proc univariate data=combine noprint;

var indirect\_pir199 indirect\_pir0100;

output out=result\_income\_shortsleep mean=estimate199 estimate100 pctlpre=P\_199\_ p\_100\_ pctlpts= 2.5, 97.5;

run;

data dat.result\_income\_shortsleep; set result\_income\_shortsleep; run;

proc print data=result\_income\_shortsleep;

title "Indirect Effect Estimates for Income Mediated by Short Sleep.";

ods select all;

run;

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\* 3. EXPOSURE=EDUCATION, MEDIATOR=SHORT SLEEP (no interaction) \*/

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/

/\*total effect of education \*/

ods output parameterestimates=p;

proc surveyreg data=dat.final order=INTERNAL;

strata strata; cluster cluster; weight weight;

class sleep\_med DMDEDUC2 RIAGENDR RIDRETH1 birth\_control cotinine\_cat hrt obese;

model crp\_log = DMDEDUC2 RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med /solution CLPARM;

run;

data total\_effect (keep=parameter estimate probt lowercl uppercl est\_exp lwr\_exp upr\_exp);

set total\_effect\_pir p (firstobs=2 obs=6);

est\_exp = exp(estimate);

lwr\_exp = exp(lowercl);

upr\_exp = exp(uppercl);

run;

proc print data=total\_effect; run;

/\*outcome regression\*/

proc surveyreg data=outboot order=INTERNAL;\* 1. outcome model;

by replicate;

strata strata; cluster cluster; weight weight;

class short\_sleep sleep\_med DMDEDUC2

RIAGENDR RIDRETH1

birth\_control cotinine\_cat hrt obese;

model crp\_log = DMDEDUC2 short\_sleep RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med /solution;

ods select none;

ods output ParameterEstimates = outcome\_model;

run;

data short\_sleep (keep = replicate short\_sleep); set outcome\_model;

where parameter = 'short\_sleep Yes';

short\_sleep = estimate;

run;

/\*mediator regression \*/

proc surveyreg data=outboot order=INTERNAL;\* 1. outcome model;

by replicate;

strata strata; cluster cluster; weight weight;

class short\_sleep sleep\_med DMDEDUC2

RIAGENDR RIDRETH1

birth\_control cotinine\_cat hrt obese;

model short\_sleep = DMDEDUC2 RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med /solution;

ods select none;

ods output ParameterEstimates = mediator\_model;

run;

data LessThan9th (keep = replicate LessThan9th); set mediator\_model; where parameter = 'DMDEDUC2 Less Than 9th Grade';

LessThan9th = estimate; run;

data From9to11 (keep = replicate From9to11); set mediator\_model; where parameter = 'DMDEDUC2 9-11th Grade (Includes 12th grade with no diploma)';

From9to11 = estimate; run;

data HighSchool (keep = replicate HighSchool); set mediator\_model; where parameter = 'DMDEDUC2 High School Grad/GED or Equivalent';

HighSchool = estimate; run;

data SomeCollege (keep = replicate SomeCollege); set mediator\_model; where parameter = 'DMDEDUC2 Some College or AA degree';

SomeCollege = estimate; run;

/\* combine and calculate the indirect effect \*/

data combine;

merge short\_sleep LessThan9th From9to11 HighSchool SomeCollege;

by replicate;

indirect\_LessThan9th = (LessThan9th\*short\_sleep);

indirect\_From9to11 = (From9to11\*short\_sleep);

indirect\_HighSchool = (HighSchool\*short\_sleep);

indirect\_SomeCollege = (SomeCollege\*short\_sleep);

run;

/\* get confidence intervals from percentiles of the bootstrap estimates \*/

proc univariate data=combine noprint;

var indirect\_LessThan9th indirect\_From9to11 indirect\_HighSchool indirect\_SomeCollege;

output

out=result\_edu\_shortsleep

mean=est\_LessThan9th est\_From9to11 est\_HighSchool est\_SomeCollege

pctlpre=LessThan9th\_ From9to11\_ HighSchool\_ SomeCollege\_

pctlpts= 2.5, 97.5;

run;

data dat.result\_edu\_shortsleep; set result\_edu\_shortsleep; run;

proc print data=result\_edu\_shortsleep;

title "Indirect Effect Estimates for Education Mediated by Short Sleep.";

ods select all;

run;

/\* COMBINING ALL THE RESULTS INTO TABLE 3 \*/

/\* edu / ss \*/

data edu\_9to11 (keep=param est\_ss lwr\_ss upr\_ss); set dat.result\_edu\_shortsleep ;

param="DMDEDUC2 9-11th Grade (Includes 12th grade w"; est\_ss=est\_from9to11; lwr\_ss=from9to11\_2\_5; upr\_ss=from9to11\_97\_5;

run;

data edu\_hs (keep=param est\_ss lwr\_ss upr\_ss); set dat.result\_edu\_shortsleep ;

param="DMDEDUC2 High School Grad/GED or Equivalent"; est\_ss=est\_highschool; lwr\_ss=highschool\_2\_5; upr\_ss=highschool\_97\_5;

run;

data edu\_les9 (keep=param est\_ss lwr\_ss upr\_ss); set dat.result\_edu\_shortsleep ;

param="DMDEDUC2 Less Than 9th Grade"; est\_ss=est\_lessthan9th; lwr\_ss=lessthan9th\_2\_5; upr\_ss=lessthan9th\_97\_5;

run;

data edu\_some (keep=param est\_ss lwr\_ss upr\_ss); set dat.result\_edu\_shortsleep ;

param="DMDEDUC2 Some College or AA degree"; est\_ss=est\_SomeCollege; lwr\_ss=SomeCollege\_2\_5; upr\_ss=SomeCollege\_97\_5;

run;

data table3; set edu\_9to11 edu\_hs edu\_les9 edu\_some; run;

/\* income / ss \*/

data pir100 (keep=param est\_ss lwr\_ss upr\_ss); set dat.result\_income\_shortsleep;

param="pir\_cat 0-100%"; est\_ss=estimate100; lwr\_ss=p\_100\_2\_5; upr\_ss=p\_100\_97\_5;

run;

data pir199 (keep=param est\_ss lwr\_ss upr\_ss); set dat.result\_income\_shortsleep;

param="pir\_cat 100-199%"; est\_ss=estimate199; lwr\_ss=p\_199\_2\_5; upr\_ss=p\_199\_97\_5;

run;

data table3; set table3 pir100 pir199; run;

/\* income / ps \*/

data pir100\_ps (keep=param est\_ps lwr\_ps upr\_ps ); set dat.result\_income\_poorsleep;

param="pir\_cat 0-100%"; est\_ps =estimate100; lwr\_ps =p\_100\_2\_5; upr\_ps =p\_100\_97\_5;

run;

data pir199\_ps (keep=param est\_ps lwr\_ps upr\_ps ); set dat.result\_income\_poorsleep;

param="pir\_cat 100-199%"; est\_ps =estimate199; lwr\_ps =p\_199\_2\_5; upr\_ps =p\_199\_97\_5;

run;

data ps; set pir199\_ps pir100\_ps ; run;

proc sort data=ps; by param; run;

proc sort data=table3; by param; run;

data te (keep=param est\_TE lwr\_TE upr\_TE); set total\_effect;

param=parameter; est\_TE=estimate; lwr\_TE=LowerCL; upr\_TE=UpperCL;

run;

proc sort data=te; by param; run;

data table3; merge te table3 ps; by param; run;

proc sort data=te\_crude; by param; run;

data table3; merge table3 te\_crude; by param; if not(param="Intercept"); run;

proc export

data=table3

dbms=xlsx

outfile="H:\Personal\NHANES SES sleep CRP\table3.xlsx"

replace;

run;