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

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# 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 as well as incidence of type 2 diabetes,5,6 hypertension,7 coronary heart disease,8 and stroke9. Specifically, meta-analyses support 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 of 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 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 Therefore, it seems possible that sleep parameters may in part mediated the relationship between SES and inflammation.

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.30,32,43

### Confounding Variables

Analysis of mediation requires consideration of confounders of the exposure-mediator, exposure-outcome, and mediator-outcome relationships. for this association44 (HRT)4546,47 and likely affects sleep through the same pathways as HRT. Smoking is known to impact multiple inflammatory markers and CVD risk48, and nicotine dependence appears to impact sleep quality, at least in young adults.49Sleep medications clearly influence sleep patterns, and many of them have been shown to have anti-inflammatory effects in rodents.50 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.

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/mL51, obesity (body mass index (BMI) >= 30 kg/m2, measured in the physical exam), use of birth control pills or hormone replacement therapy, and use of sleep medications often or almost always (5 or more times per month).

## Data Analysis

We summarized all variables in the overall sample as well as stratified by sleep duration and sleep quality, and examined associations between all covariates and sleep parameters using chi-square tests. 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),52 or the proportion of inflammation that would be prevented if SES did not cause poor sleep.52 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, using least squares linear regression.

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).53 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. Total and indirect effects are presented as a geometric mean ratio (GMR), which is the ratio of the geometric mean in the group of interest vs. that of the reference group, and has a null value of one. 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.54 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 race including multi-racial.

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).

We examined whether each exposure was associated with each mediator, and whether each mediator was associated with the outcome, using linear regression, both crude and adjusted for age, sex, race/ethnicity, physical activity, serum cotinine, obesity, use of birth control pills or hormone replacement therapy, and use of sleep medications. When income was 0-100% FPL, we found a lower prevalence of poor sleep (prevalence difference (PD) -0.06, 95% CI -0.10 to -0.02) and a higher prevalence of short sleep (PD 0.07, 95% CI 0.06 to 0.09). When income was 100-199% FPL, we found no difference in poor sleep and a higher prevalence of short sleep (PD 0.06, 95% CI 0.04 to 0.07). Associations between income and sleep did not change after adjusting for confounders. In education, no significant differences were found in poor sleep except a lower prevalence in less than 9th grade (PD -0.08, 95% -0.13 to -0.03), which disappeared after adjusting for confounders. Being a college graduate or above conferred a lower crude prevalence of short sleep (PD -0.07, 95% CI -0.09 to -0.05) and having a 9th-11th grade education conferred a higher crude prevalence of short sleep (PD 0.04, 95% CI 0.01 to 0.06), associations which did not change after adjustment for confounders. Poor sleep was associated higher mean CRP (geometric mean ratio (GMR) 1.09, 95% CI 1.01 to 1.19) which did not change after adjustment. Short sleep was also associated with a higher mean CRP in crude analysis (GMR 1.22, 95% CI 1.10 to 1.34) which was moderately attenuated after adjustment (GMR 1.12, 95% CI 1.03 to 1.22).

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 (GMR) 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 GMR 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 GMR 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 GMR 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 income55-57 and lower education30,31,42,55 are associated cross-sectionally with higher c-reactive protein, indicating higher inflammatory burden in lower SES groups. Additionally, our findings reflect 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 one and 95% confidence intervals contained the null value of one). 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.58 However, NHANES does not record objective sleep measures, so we were unable to examine these in our study. Objective and subjective sleep measures have been shown to have a relatively weak correlation (r=0.28 to 0.68),59 and are suggested to be used in combination for best accuracy as they measure different aspects of sleep.60 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.61 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 factors. Despite utilizing 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 for 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 % | P-value\* | Raw n | Weighted % | P-value\* |
| Total | | 16654 | 100.00% | 7322 | 50.2% |  | 2593 | 13.8% |  |
| Age - Median (range) | | 45 | (20--85) | 45 | (20--85) | 0.673 | 45 | (20--85) | 0.720 |
| Plasma C-Reactive Protein (mg/L) -- median (IQR) | | 0.17 | (0.06--0.41) | 0.20 | (0.07--0.49) | 0.014 | 0.18 | (0.07--0.43) | 0.028 |
| Education | |  |  |  |  | <.0001 |  |  | 0.0230 |
|  | 9-11th Grade (Includes 12th grade with no diploma) | 2629 | 12.5% | 502 | 18.5% |  | 1185 | 49.0% |  |
|  | College Graduate or above | 3135 | 26.3% | 319 | 8.0% |  | 1419 | 49.5% |  |
|  | High School Grad/GED or Equivalent | 3840 | 24.5% | 672 | 15.6% |  | 1830 | 52.4% |  |
|  | Less Than 9th Grade | 2059 | 6.6% | 356 | 16.2% |  | 841 | 43.1% |  |
|  | Some College or AA degree | 4382 | 30.2% | 739 | 14.9% |  | 2040 | 51.3% |  |
| Gender | |  |  |  |  | 0.4384 |  |  | <.0001 |
|  | Female | 8073 | 51.2% | 1297 | 13.5% |  | 3840 | 52.4% |  |
|  | Male | 7999 | 48.8% | 1296 | 14.1% |  | 3482 | 48.0% |  |
| Race/ethnicity | |  |  |  |  | <.0001 |  |  | 0.0040 |
|  | Mexican American | 2895 | 8.1% | 377 | 12.1% |  | 1166 | 41.3% |  |
|  | Non-Hispanic Black | 3295 | 11.3% | 851 | 26.4% |  | 1527 | 46.4% |  |
|  | Non-Hispanic White | 7779 | 70.0% | 987 | 11.6% |  | 3817 | 52.9% |  |
|  | Other Hispanic | 1371 | 4.4% | 246 | 16.2% |  | 519 | 41.7% |  |
|  | Other Race - Including Multi-Racial | 732 | 6.1% | 132 | 16.7% |  | 293 | 44.9% |  |
| Birth Control | |  |  |  |  | 0.0758 |  |  | 0.0014 |
|  | No | 15548 | 95.7% | 2525 | 13.9% |  | 7059 | 49.9% |  |
|  | Yes | 524 | 4.3% | 68 | 10.6% |  | 263 | 58.8% |  |
| Plasma Cotinine | |  |  |  |  | <.0001 |  |  | 0.0158 |
|  | 3+ ng/mL | 4191 | 26.7% | 840 | 18.7% |  | 2022 | 53.0% |  |
|  | <3 ng/mL | 11881 | 73.3% | 1753 | 12.0% |  | 5300 | 49.2% |  |
| Hormone Replacement Therapy | |  |  |  |  | 0.0582 |  |  | <.0001 |
|  | No | 15806 | 97.9% | 2561 | 13.9% |  | 7158 | 49.9% |  |
|  | Yes | 266 | 2.1% | 32 | 9.2% |  | 164 | 65.5% |  |
| BMI > 30 | |  |  |  |  | <.0001 |  |  | 0.2493 |
|  | No | 10262 | 65.9% | 1499 | 12.6% |  | 4702 | 50.7% |  |
|  | Yes | 5810 | 34.1% | 1094 | 16.1% |  | 2620 | 49.3% |  |
| Vigorous physical activity at least 10 minutes per week | | | |  |  | 0.3842 |  |  | <.0001 |
|  | No | 7851 | 48.3% | 1289 | 14.1% |  | 4458 | 63.4% |  |
|  | Yes | 8221 | 51.7% | 1304 | 13.5% |  | 2864 | 38.0% |  |
| Income (% FPL) | |  |  |  |  | <.0001 |  |  | 0.0029 |
|  | 0-100% | 4316 | 19.0% | 839 | 18.7% |  | 1778 | 45.5% |  |
|  | 100-199% | 3962 | 19.0% | 683 | 16.9% |  | 1794 | 50.7% |  |
|  | 200%+ | 7794 | 62.0% | 1071 | 11.3% |  | 3750 | 51.6% |  |
| Short Sleep (<6 hours per night) | |  |  |  |  | <.0001 |  |  |  |
|  | No | 8741 | 49.8% | 1143 | 10.8% |  |  |  |  |
|  | Yes | 7322 | 50.2% | 1448 | 16.7% |  |  |  |  |
| Poor sleep | |  |  |  |  |  |  |  | <.0001 |
|  | No | 13460 | 86.2% |  |  |  | 5862 | 48.5% |  |
|  | Yes | 2593 | 13.8% |  |  |  | 1448 | 61.0% |  |
| Used sleep medication 5 or more times in last month | | | |  |  | <.0001 |  |  | <.0001 |
|  | No | 15271 | 94.3% | 2399 | 13.3% |  | 6561 | 47.5% |  |
|  | Yes | 801 | 5.7% | 194 | 21.3% |  | 761 | 96.0% |  |
| \*P-values calculated via chi-square or ANOVA as appropriate. | | | | | | | | | |

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| Table 2. Mean plasma c-reactive protein (CRP). | | |  |
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|  |  | Mean CRP (mg/L) | P-value (ANOVA) |
| 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 |
|  | No | 0.20 |  |
|  | 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 |
|  | No | 0.17 |  |
|  | Yes | 0.30 |  |
| Serum Cotinine | |  | <0.0001 |
|  | 3+ ng/mL | 0.18 |  |
|  | <3 ng/mL | 0.17 |  |
| Hormone Replacement Therapy | |  | <0.0001 |
|  | No | 0.17 |  |
|  | 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 |
|  | No | 0.17 |  |
|  | Yes | 0.19 |  |

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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 geometric mean ratios (GMRs). 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. | | | | | | | | | | | | | |

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# SAS Syntax

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

\*libname dat 'C:\Users\Audrey\Google Drive\CUNY SPH Coursework\EPID622 Applied Research- Data Management\NHANES SES sleep CRP';

\*Create libraries for each xpt file;

libname bmx\_d Xport 'H:\personal\NHANES SES sleep CRP\data\bmx\_d.xpt';

libname bmx\_e Xport 'H:\personal\NHANES SES sleep CRP\data\bmx\_e.xpt';

libname bmx\_f Xport 'h:\personal\NHANES SES sleep CRP\data\bmx\_f.xpt';

libname crp\_d Xport 'h:\personal\NHANES SES sleep CRP\data\crp\_d.xpt';

libname crp\_e Xport 'h:\personal\NHANES SES sleep CRP\data\crp\_e.xpt';

libname crp\_f Xport 'h:\personal\NHANES SES sleep CRP\data\crp\_f.xpt';

libname demo\_d Xport 'h:\personal\NHANES SES sleep CRP\data\demo\_d.xpt';

libname demo\_e Xport 'h:\personal\NHANES SES sleep CRP\data\demo\_e.xpt';

libname demo\_f Xport 'h:\personal\NHANES SES sleep CRP\data\demo\_f.xpt';

libname slq\_d Xport 'h:\personal\NHANES SES sleep CRP\data\slq\_d.xpt';

libname slq\_e Xport 'h:\personal\NHANES SES sleep CRP\data\slq\_e.xpt';

libname slq\_f Xport 'h:\personal\NHANES SES sleep CRP\data\slq\_f.xpt';

libname RHQ\_D Xport 'h:\personal\NHANES SES sleep CRP\data\rhq\_d.xpt';

libname RHQ\_e Xport 'h:\personal\NHANES SES sleep CRP\data\rhq\_e.xpt';

libname RHQ\_f Xport 'h:\personal\NHANES SES sleep CRP\data\rhq\_f.xpt';

libname cot\_d Xport 'h:\personal\NHANES SES sleep CRP\data\cot\_d.xpt';

libname cotnal\_e Xport 'h:\personal\NHANES SES sleep CRP\data\cotnal\_e.xpt';

libname cotnal\_f Xport 'h:\personal\NHANES SES sleep CRP\data\cotnal\_f.xpt';

libname paq\_d Xport 'h:\personal\NHANES SES sleep CRP\data\paq\_d.xpt';

libname paq\_e Xport 'h:\personal\NHANES SES sleep CRP\data\paq\_e.xpt';

libname paq\_f Xport 'h:\personal\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** **format** library=dat; \* all formats;

value yesno **2**="No" **1**="Yes";

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 = **2**;

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 = **2**;

format poor\_sleep yesno.;

\*coding as 0/1 for regression;

poor\_sleep\_reg = **2** + (-**1** \* poor\_sleep);

short\_sleep\_reg = **2** + (-**1** \* short\_sleep);

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 = **0**;

if RIAGENDR = **1** then hrt = **0**;

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**;

format obese yesno.;

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

sleep\_med = **2**;

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

format sleep\_med yesno.;

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

birth\_control = **0**;

if RIAGENDR = **1** then birth\_control = **0**;

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 = **2**;

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;

include = **1**;

if crp\_bin = **2** then include=**0**;

**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 include=**0**;

**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 include LBXCRP crp\_bin crp\_log sleep\_dur short\_sleep poor\_sleep

short\_sleep\_reg poor\_sleep\_reg 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 crosstabs=oneway\_dmdeduc2 summary=summary;

**proc** **surveyfreq** data=dat.final; strata strata; cluster cluster; weight weight; tables include\*DMDEDUC2 /row; **run**;

ods output crosstabs=oneway\_pir\_cat;

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

ods output crosstabs=oneway\_short\_sleep;

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

ods output crosstabs=oneway\_poor\_sleep;

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

ods output crosstabs=oneway\_riagendr;

**proc** **surveyfreq** data=dat.final; strata strata; cluster cluster; weight weight; tables include\*riagendr/row; **run**;

ods output crosstabs=oneway\_ridreth1;

**proc** **surveyfreq** data=dat.final; strata strata; cluster cluster; weight weight; tables include\*ridreth1/row; **run**;

ods output crosstabs=oneway\_birth\_control;

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

ods output crosstabs=oneway\_cotinine\_cat;

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

ods output crosstabs=oneway\_hrt;

**proc** **surveyfreq** data=dat.final; strata strata; cluster cluster; weight weight; tables include\*hrt/row; **run**;

ods output crosstabs=oneway\_obese;

**proc** **surveyfreq** data=dat.final; strata strata; cluster cluster; weight weight; tables include\*obese/row; **run**;

ods output crosstabs=oneway\_sleep\_med;

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

ods output crosstabs=oneway\_phys\_act;

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

/\*dmdeduc2 pir\_cat short\_sleep poor\_sleep RIAGENDR RIDRETH1 birth\_control \*/

/\* cotinine\_cat hrt obese sleep\_med \*/

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

value= vvalue(dmdeduc2); percent=rowpercent; where include=**1**; **run**;

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

value= vvalue(pir\_cat); percent=rowpercent; where include=**1**;**run**;

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

value= vvalue(short\_sleep); percent=rowpercent; where include=**1**; **run**;

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

value= vvalue(poor\_sleep); percent=rowpercent; where include=**1**; **run**;

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

value= vvalue(RIAGENDR) ; percent=rowpercent; where include=**1**; **run**;

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

value= vvalue(RIDRETH1) ; percent=rowpercent; where include=**1**; **run**;

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

value= vvalue(birth\_control); percent=rowpercent; where include=**1**; **run**;

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

value= vvalue(cotinine\_cat); percent=rowpercent; where include=**1**; **run**;

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

value= vvalue(hrt); percent=rowpercent; where include=**1**;**run**;

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

value= vvalue(obese) ; percent=rowpercent; where include=**1**;**run**;

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

value= vvalue(sleep\_med); percent=rowpercent; where include=**1**;**run**;

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

value= vvalue(phys\_act); percent=rowpercent; where include=**1**;**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 include \* ", "") );

**run**;

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

/\*dmdeduc2 pir\_cat short\_sleep RIAGENDR RIDRETH1 birth\_control \*/

/\* cotinine\_cat hrt obese sleep\_med \*/

/\* NEED TO FIGURE OUT AGE, CRP mean/SD \*/

ods output crosstabs=ps\_DMDEDUC2 chisq=ps\_DMDEDUC2\_ch;

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

ods output crosstabs=ps\_pir\_cat chisq=ps\_pir\_cat\_ch;

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

ods output crosstabs=ps\_short\_sleep chisq=ps\_short\_sleep\_ch;

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

ods output crosstabs=ps\_riagendr chisq=ps\_riagendr\_ch;

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

ods output crosstabs=ps\_ridreth1 chisq=ps\_ridreth1\_ch;

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

ods output crosstabs=ps\_birth\_control chisq=ps\_birth\_control\_ch;

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

ods output crosstabs=ps\_cotinine\_cat chisq=ps\_cotinine\_cat\_ch;

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

ods output crosstabs=ps\_hrt chisq=ps\_hrt\_ch;

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

ods output crosstabs=ps\_obese chisq=ps\_obese\_ch;

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

ods output crosstabs=ps\_sleep\_med chisq=ps\_sleep\_med\_ch;

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

ods output crosstabs=ps\_phys\_act chisq=ps\_phys\_act\_ch;

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

\*chi-sq p-values;

**data** ps\_dmdeduc2\_ch (keep=table cvalue1); set ps\_dmdeduc2\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="DMDEDUC2"; **run**;

**data** ps\_pir\_cat\_ch (keep=table cvalue1); set ps\_pir\_cat\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="pir\_cat"; **run**;

**data** ps\_short\_sleep\_ch (keep=table cvalue1); set ps\_short\_sleep\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="short\_sleep"; **run**;

**data** ps\_riagendr\_ch (keep=table cvalue1); set ps\_riagendr\_ch ;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="RIAGENDR"; **run**;

**data** ps\_ridreth1\_ch (keep=table cvalue1); set ps\_ridreth1\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="RIDRETH1"; **run**;

**data** ps\_birth\_control\_ch (keep=table cvalue1); set ps\_birth\_control\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="birth\_control"; **run**;

**data** ps\_cotinine\_cat\_ch (keep=table cvalue1); set ps\_cotinine\_cat\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="cotinine\_cat"; **run**;

**data** ps\_hrt\_ch (keep=table cvalue1); set ps\_hrt\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="hrt"; **run**;

**data** ps\_obese\_ch (keep=table cvalue1); set ps\_obese\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="obese"; **run**;

**data** ps\_sleep\_med\_ch (keep=table cvalue1); set ps\_sleep\_med\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="sleep\_med"; **run**;

**data** ps\_phys\_act\_ch (keep=table cvalue1); set ps\_phys\_act\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="phys\_act"; **run**;

\*frequencies;

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

value=vvalue(dmdeduc2); percent=rowpercent; table="DMDEDUC2"; where poor\_sleep=**1** and include=**1**; **run**;

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

value= vvalue(pir\_cat); percent=rowpercent;table="pir\_cat"; where poor\_sleep = **1** and include=**1**; **run**;

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

value=vvalue(short\_sleep);percent=rowpercent;table="short\_sleep"; where poor\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(riagendr ); percent=rowpercent;table="RIAGENDR"; where poor\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(ridreth1); percent=rowpercent;table="RIDRETH1"; where poor\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(birth\_control);percent=rowpercent; table="birth\_control"; where poor\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(cotinine\_cat); percent=rowpercent;table="cotinine\_cat"; where poor\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(hrt);percent=rowpercent; table="hrt"; where poor\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(obese);percent=rowpercent; table="obese"; where poor\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(sleep\_med); percent=rowpercent;table="sleep\_med"; where poor\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(phys\_act); percent=rowpercent; table="phys\_act"; where poor\_sleep=**1** and include=**1**; **run**;

\*merge p-values with frequences;

**data** ps\_dmdeduc2; merge ps\_dmdeduc2 ps\_dmdeduc2\_ch; by table; **run**;

**data** ps\_pir\_cat; merge ps\_pir\_cat ps\_pir\_cat\_ch; by table; **run**;

**data** ps\_short\_sleep; merge ps\_short\_sleep ps\_short\_sleep\_ch; by table; **run**;

**data** ps\_riagendr ; merge ps\_riagendr ps\_riagendr\_ch; by table; **run**;

**data** ps\_ridreth1; merge ps\_ridreth1 ps\_ridreth1\_ch; by table; **run**;

**data** ps\_birth\_control; merge ps\_birth\_control ps\_birth\_control\_ch; by table; **run**;

**data** ps\_cotinine\_cat; merge ps\_cotinine\_cat ps\_cotinine\_cat\_ch; by table; **run**;

**data** ps\_hrt; merge ps\_hrt ps\_hrt\_ch; by table; **run**;

**data** ps\_obese; merge ps\_obese ps\_obese\_ch; by table; **run**;

**data** ps\_sleep\_med; merge ps\_sleep\_med ps\_sleep\_med\_ch; by table; **run**;

**data** ps\_phys\_act; merge ps\_phys\_act ps\_phys\_act\_ch; by table; **run**;

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

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 = percent \* **0.01**;

ps\_p = cvalue1;

**run**;

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

/\*dmdeduc2 pir\_cat poor\_sleep RIAGENDR RIDRETH1 birth\_control \*/

/\* cotinine\_cat hrt obese sleep\_med \*/

ods output crosstabs=ss\_DMDEDUC2 chisq=ss\_DMDEDUC2\_ch;

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

ods output crosstabs=ss\_pir\_cat chisq=ss\_pir\_cat\_ch;

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

ods output crosstabs=ss\_poor\_sleep chisq=ss\_poor\_sleep\_ch;

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

ods output crosstabs=ss\_riagendr chisq=ss\_riagendr\_ch;

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

ods output crosstabs=ss\_ridreth1 chisq=ss\_ridreth1\_ch;

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

ods output crosstabs=ss\_birth\_control chisq=ss\_birth\_control\_ch;

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

ods output crosstabs=ss\_cotinine\_cat chisq=ss\_cotinine\_cat\_ch;

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

ods output crosstabs=ss\_hrt chisq=ss\_hrt\_ch;

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

ods output crosstabs=ss\_obese chisq=ss\_obese\_ch;

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

ods output crosstabs=ss\_sleep\_med chisq=ss\_sleep\_med\_ch;

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

ods output crosstabs=ss\_phys\_act chisq=ss\_phys\_act\_ch;

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

\*chi sq p-values;

**data** ss\_dmdeduc2\_ch (keep=table cvalue1); set ss\_dmdeduc2\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="DMDEDUC2"; **run**;

**data** ss\_pir\_cat\_ch (keep=table cvalue1); set ss\_pir\_cat\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="pir\_cat"; **run**;

**data** ss\_poor\_sleep\_ch (keep=table cvalue1); set ss\_poor\_sleep\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="poor\_sleep"; **run**;

**data** ss\_riagendr\_ch (keep=table cvalue1); set ss\_riagendr\_ch ;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="RIAGENDR"; **run**;

**data** ss\_ridreth1\_ch (keep=table cvalue1); set ss\_ridreth1\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="RIDRETH1"; **run**;

**data** ss\_birth\_control\_ch (keep=table cvalue1); set ss\_birth\_control\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="birth\_control"; **run**;

**data** ss\_cotinine\_cat\_ch (keep=table cvalue1); set ss\_cotinine\_cat\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="cotinine\_cat"; **run**;

**data** ss\_hrt\_ch (keep=table cvalue1); set ss\_hrt\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="hrt"; **run**;

**data** ss\_obese\_ch (keep=table cvalue1); set ss\_obese\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="obese"; **run**;

**data** ss\_sleep\_med\_ch (keep=table cvalue1); set ss\_sleep\_med\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="sleep\_med"; **run**;

**data** ss\_phys\_act\_ch (keep=table cvalue1); set ss\_phys\_act\_ch;

where substr(table, **1**, **7**) = "Table 2" AND label1="Pr > ChiSq"; table="phys\_act"; **run**;

\*frequencies;

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

value=vvalue(dmdeduc2); percent=rowpercent; table="DMDEDUC2"; where short\_sleep=**1** and include=**1**; **run**;

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

value= vvalue(pir\_cat);percent=rowpercent; table="pir\_cat"; where short\_sleep = **1** and include=**1**; **run**;

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

value=vvalue(poor\_sleep); percent=rowpercent; table="poor\_sleep"; where short\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(riagendr );percent=rowpercent; table="RIAGENDR"; where short\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(ridreth1); percent=rowpercent; table="RIDRETH1"; where short\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(birth\_control); percent=rowpercent; table="birth\_control"; where short\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(cotinine\_cat); percent=rowpercent; table="cotinine\_cat"; where short\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(hrt); percent=rowpercent; table="hrt"; where short\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(obese); percent=rowpercent; table="obese"; where short\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(sleep\_med); percent=rowpercent; table="sleep\_med"; where short\_sleep=**1** and include=**1**; **run**;

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

value=vvalue(phys\_act); percent=rowpercent; table="phys\_act"; where short\_sleep=**1** and include=**1**; **run**;

\*merge chi-sq with frequencies;

**data** ss\_dmdeduc2; merge ss\_dmdeduc2 ss\_dmdeduc2\_ch; by table; **run**;

**data** ss\_pir\_cat; merge ss\_pir\_cat ss\_pir\_cat\_ch; by table; **run**;

**data** ss\_poor\_sleep; merge ss\_poor\_sleep ss\_poor\_sleep\_ch; by table; **run**;

**data** ss\_riagendr ; merge ss\_riagendr ss\_riagendr\_ch; by table; **run**;

**data** ss\_ridreth1; merge ss\_ridreth1 ss\_ridreth1\_ch; by table; **run**;

**data** ss\_birth\_control; merge ss\_birth\_control ss\_birth\_control\_ch; by table; **run**;

**data** ss\_cotinine\_cat; merge ss\_cotinine\_cat ss\_cotinine\_cat\_ch; by table; **run**;

**data** ss\_hrt; merge ss\_hrt ss\_hrt\_ch; by table; **run**;

**data** ss\_obese; merge ss\_obese ss\_obese\_ch; by table; **run**;

**data** ss\_sleep\_med; merge ss\_sleep\_med ss\_sleep\_med\_ch; by table; **run**;

**data** ss\_phys\_act; merge ss\_phys\_act ss\_phys\_act\_ch; by table; **run**;

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

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 = percent \* **0.01**;

ss\_p = cvalue1;

**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\documents\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;

domain include;

**run**;

**data** p; set p; effect='DMDEDUC2'; where include=**1**; **run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** edu (keep=effect parameter estimate probF); length effect $**15**; 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;

domain include;

**run**;

**data** p; set p; effect='pir\_cat'; where include=**1**; **run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** pir (keep=effect parameter estimate probF); length effect $**15**; 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;

domain include;

**run**;

**data** p; set p; effect='phys\_act'; where include=**1**;**run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** phys (keep=effect parameter estimate probF); length effect $**15**; 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;

domain include;

**run**;

**data** p; set p; effect='RIAGENDR';where include=**1**; **run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** gender (keep=effect parameter estimate probF); length effect $**15**; 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;

domain include;

**run**;

**data** p; set p; effect='RIDRETH1';where include=**1**; **run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** race(keep=effect parameter estimate probF);length effect $**15**; 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;

domain include;

**run**;

**data** p; set p; effect='agecat'; where include=**1**;**run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** age (keep=effect parameter estimate probF); length effect $**15**; 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;

domain include;

**run**;

**data** p; set p; effect='birth\_control'; where include=**1**;**run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** birth (keep=effect parameter estimate probF);length effect $**15**; 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;

domain include;

**run**;

**data** p; set p; effect='cotinine\_cat';where include=**1**; **run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** cotinine (keep=effect parameter estimate probF);length effect $**15**; 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;

domain include;

**run**;

**data** p; set p; effect='hrt'; where include=**1**; **run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** hrt (keep=effect parameter estimate probF); length effect $**15**; 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;

domain include;

**run**;

**data** p; set p; effect='obese'; where include=**1**; **run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** obese (keep=effect parameter estimate probF); length effect $**15**; 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;

domain include;

**run**;

**data** p; set p; effect='poor\_sleep';where include=**1**; **run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** poor (keep=effect parameter estimate probF);length effect $**15**; 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;

domain include;

**run**;

**data** p; set p; effect='short\_sleep';where include=**1**; **run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** short (keep=effect parameter estimate probF); length effect $**15**; 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;

domain include;

**run**;

**data** p; set p; effect='sleep\_med'; where include=**1**; **run**; **data** e; set e; where not(effect='Model') and include=**1**; **run**;

**data** sleep\_med (keep=effect parameter estimate probF); length effect $**15**; 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, STRIP(effect), "") );

exp\_estimate = exp(estimate);

**run**;

\*get total geometric mean crp;

ods trace off;

ods output domain=mean\_crp\_log;

**proc** **surveymeans** data=dat.final;

strata strata; cluster cluster; weight weight;

var crp\_log;

domain include;

**run**;

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

geom\_mean = exp(mean);

where include=**1**;

**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**;

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

/\* 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;

domain include;

**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;

domain include;

**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;

where include=**1**;

**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;

domain include;

**run**;

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

set p;

where substr(parameter, **1**, **3**) = "pir" AND include=**1**;

**run**;

/\*outcome (E+M) 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;

domain include;

**run**;

/\* outcome (M) regression\*/

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

strata strata; cluster cluster; weight weight;

class poor\_sleep sleep\_med

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;

ods select none;

ods output ParameterEstimates = outcome\_mediator\_model;

domain include;

**run**;

**data** poorsleep2 (keep = replicate poorsleep); set outcome\_model;

where parameter = 'poor\_sleep Yes' AND include=**1**;

poorsleep = estimate;

**run**;

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

where parameter = 'poor\_sleep\*pir\_cat Yes 0-100%' AND include=**1**;

poorsleep\_pir0100 = estimate;

**run**;

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

where parameter = 'poor\_sleep\*pir\_cat Yes 100-199%' AND include=**1**;

poorsleep\_pir199 = estimate;

**run**;

/\*mediator (E) 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\_reg = pir\_cat RIAGENDR RIDRETH1 RIDAGEYR birth\_control

cotinine\_cat hrt obese sleep\_med /solution;

ods select all;

ods output ParameterEstimates = mediator\_model;

domain include;

**run**;

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

where parameter = 'pir\_cat 0-100%' AND include=**1**;

pir0100 = estimate;

**run**;

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

where parameter = 'pir\_cat 100-199%' AND include=**1**;

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;

domain include;

**run**;

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

where parameter = 'short\_sleep Yes' AND include=**1**;

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;

domain include;

**run**;

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

where parameter = 'pir\_cat 0-100%' AND include=**1**;

pir0100 = estimate;

**run**;

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

where parameter = 'pir\_cat 100-199%' AND include=**1**;

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;

domain include;

**run**;

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

set total\_effect\_pir p;

where (substr(parameter, **1**, **3**) = "DMD" OR substr(parameter, **1**, **3**) = "pir") AND include=**1**;

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;

domain include;

**run**;

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

where parameter = 'short\_sleep Yes' AND include=**1**;

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;

domain include;

**run**;

**data** LessThan9th (keep = replicate LessThan9th); set mediator\_model; where parameter = 'DMDEDUC2 Less Than 9th Grade' AND include=**1**;

LessThan9th = estimate; **run**;

**data** From9to11 (keep = replicate From9to11); set mediator\_model; where parameter = 'DMDEDUC2 9-11th Grade (Includes 12th grade with no diploma)' AND include=**1**;

From9to11 = estimate; **run**;

**data** HighSchool (keep = replicate HighSchool); set mediator\_model; where parameter = 'DMDEDUC2 High School Grad/GED or Equivalent' AND include=**1**;

HighSchool = estimate; **run**;

**data** SomeCollege (keep = replicate SomeCollege); set mediator\_model; where parameter = 'DMDEDUC2 Some College or AA degree' AND include=**1**;

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**;

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

/\* ADDITIONAL RESULTS NOT IN TABLES \*/

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

/\* POOR SLEEP ~ INCOME \*/

\*crude;

**proc** **surveyreg** data=dat.final;

strata strata; cluster cluster; weight weight;

class pir\_cat;

model poor\_sleep\_reg = pir\_cat /solution CLPARM;

domain include;

**run**;

\*adjusted;

**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 poor\_sleep\_reg = pir\_cat RIAGENDR RIDRETH1 RIDAGEYR birth\_control

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

domain include;

**run**;

/\* SHORT SLEEP ~ INCOME \*/

\*crude;

**proc** **surveyreg** data=dat.final;

strata strata; cluster cluster; weight weight;

class pir\_cat;

model short\_sleep\_reg = pir\_cat /solution CLPARM;

domain include;

**run**;

\*adjusted;

**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 short\_sleep\_reg = pir\_cat RIAGENDR RIDRETH1 RIDAGEYR birth\_control

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

domain include;

**run**;

/\* POOR SLEEP ~ EDUCATION \*/

\*crude;

**proc** **surveyreg** data=dat.final;

strata strata; cluster cluster; weight weight;

class DMDEDUC2;

model poor\_sleep\_reg = DMDEDUC2 /solution CLPARM;

domain include;

**run**;

\*adjusted;

**proc** **surveyreg** data=dat.final;

strata strata; cluster cluster; weight weight;

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

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

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

domain include;

**run**;

/\* SHORT SLEEP ~ EDUCATION \*/

\*crude;

**proc** **surveyreg** data=dat.final;

strata strata; cluster cluster; weight weight;

class DMDEDUC2;

model short\_sleep\_reg = DMDEDUC2 /solution CLPARM;

domain include;

**run**;

\*adjusted;

**proc** **surveyreg** data=dat.final;

strata strata; cluster cluster; weight weight;

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

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

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

domain include;

**run**;

/\* CRP ~ poor sleep \*/

\*crude;

**proc** **surveyreg** data=dat.final;

strata strata; cluster cluster; weight weight;

class poor\_sleep;

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

domain include;

**run**;

\*adjusted;

**proc** **surveyreg** data=dat.final;

strata strata; cluster cluster; weight weight;

class poor\_sleep sleep\_med 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;

domain include;

**run**;

/\* CRP ~ short sleep \*/

\*crude;

**proc** **surveyreg** data=dat.final;

strata strata; cluster cluster; weight weight;

class short\_sleep;

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

domain include;

**run**;

\*adjusted;

**proc** **surveyreg** data=dat.final;

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;

domain include;

**run**;