

# **Persistent and Changing Material Hardship and Sleep: Results from the Michigan Recession and Recovery Study**

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## **ABSTRACT**

Past research has found that lower socioeconomic status is associated with worse sleep outcomes. An emerging literature suggests material hardship is a key mechanism underlying this sleep disparity. This study is the first of our knowledge to examine how material hardship, measured over time, is associated with sleep in the U.S. population context. Using two waves of panel data collected in southeast Michigan ( $n = 691$ ) and implementing diagonal reference models, we investigate associations between three hardship measures (financial problems, food insecurity, and the total number of material hardships) and three sleep outcomes (sleep time, sleep problems, and nonrestorative sleep). We find persistent financial hardship, very low food security, and overall high hardship load to be associated with shorter sleep duration. Increase in the amount of financial hardship is associated with both sleep problems and non-restorative sleep.

## **INTRODUCTION**

Past studies have identified clear socioeconomic patterns across a range of sleep outcomes, with those of lower socioeconomic status (SES) more likely to report poor quality sleep and suboptimal sleep duration (Grandner et al. 2010, 2013; Krueger and

Friedman 2009). To better understand the pathways that mediate this relationship, scholars have begun to investigate the material conditions that often accompany low SES. An emerging literature suggests that material hardship is a key mechanism underlying socioeconomic inequalities in sleep. Researchers have often found a relationship between poor sleep and inadequate access to food, housing, and other basic material necessities (Ding et al. 2015; Liu et al. 2014; Perales and Plage 2017; Whinnery et al. 2014).

Prior study of material hardship and sleep, however, has generally been cross-sectional. Most researchers have not been able to investigate how changes in material hardship may be associated with changes in sleep outcomes, or how chronic and acute hardship may differ in their implications for sleep. One exception is a study by Lallukka and colleagues (2012), who examined two waves of panel data on British and Finnish civil servants. The authors categorized respondents as experiencing no hardship, occasional hardship, or frequent hardship at both baseline and follow-up, then cross-classified these to create a nine-category material hardship measure. Using logistic regression, they found that increasing hardship across waves—none to frequent, and occasional to frequent—as well as persistent, frequent hardship were all associated with sleep problems. This analytic strategy, however, cannot decompose what part of the measured association was attributable to a between-wave change in material hardship and what was explained by hardship level at baseline or follow-up, or persistent hardship (van der Waal, Daenekindt, and de Koster 2017). The regression models used in the study could not, for example, determine whether the association between poor sleep and a change from no hardship to frequent hardship was due to an increase in hardship or simply the fact that respondents were experiencing frequent hardship at follow-up.

Our study is the first to evaluate the associations between chronic and acute material hardship and sleep outcomes over time in the U.S. context. We build on prior, cross-sectional work on material hardship and sleep and apply diagonal reference models (DRM), a methodological approach that enables us to decompose the associations between material hardship levels measured at one point in time and change in material hardship over time. We analyze data from the Michigan Recession and Recovery Study (MRRS), a panel survey collected between 2009 and 2013. Using its rich set of material hardship and sleep measures, we are uniquely positioned to examine how persistent hardship and changes in hardship are associated with sleep outcomes.

We ask two research questions: First, how is persistent hardship at various levels of severity associated with sleep, net of sociodemographic, socioeconomic, and health controls? Second, how is the change in hardship level over time associated with sleep, net of sociodemographic, socioeconomic, and health controls? We investigate these associations with respect to three key indicators of material hardship (financial problems, food hardship, and number of material hardships) and three commonly studied sleep outcomes (sleep time, sleep problems, and nonrestorative sleep).

## DATA AND METHODS

### Data

The Michigan Recession and Recovery Study is a population-representative panel survey of working-age adults living in Southeast Michigan. The survey was conducted in three waves following the Great Recession: the first set of interviews took place from October 2009 to April 2010 ( $n = 914$ ), the second set from April to August of 2011 ( $n = 847$ ), and the final set from June to October of 2013 ( $n = 751$ ). We use data collected from the second and third waves of MRRS, referred to in our analysis as baseline and follow-up, respectively. All sleep outcomes and control variables are measured at follow-up, except gender and race which were collected at Wave 1. Material hardships were measured at both baseline and follow-up. In our analyses, we excluded respondents who were missing data on any of the study variables other than income, which was multiply imputed. Our final analytic sample was comprised of 691 respondents, that is, 92% of total respondents at follow-up.

### Measures

#### *Sleep Outcomes*

We constructed three sleep measures at follow-up: sleep time in minutes, sleep problems, and nonrestorative sleep. Sleep time is a continuous measure assessed by the question “How much sleep do you get in a 24-hour period?” (mean time of 6 hours and 50 minutes). We created a dichotomous measure of sleep problems from the question “Over the last two weeks, how often have you been bothered by trouble falling asleep or sleeping too much?” Possible responses were “None at all,” “Several days,” “More than half the days,” or “Nearly every day.” Those who answered more than half or nearly every day were categorized as having sleep problems (17%). Nonrestorative sleep was measured by “How often do you feel unrested during the day, no matter how many hours of sleep you had?” Respondents could select “Never,” “Rarely (once a month),” “Sometimes (2-4 times per month),” “Often (2-3 times per week),” or “Almost always (4 or more times per week).” Those who answered often or almost always were categorized as having nonrestorative sleep (38%).

#### *Material Hardship*

For the purposes of this abstract we present results from three material hardship measures: financial problems, food hardship, and total number of material hardships reported. Each hardship measure was constructed at baseline and follow-up. Financial problems include having a credit card canceled, being behind on utility payments, receiving a loan or cash advance from a payday lender or check casher, or filing for bankruptcy. We summed across these indicators and categorized respondents as having no financial problems (68% at baseline, 72% at follow-up), one financial problem (26% at baseline, 22% at follow-up), or two or more financial problems (6% at baseline, 6% at follow-up). Food hardship was measured with the six-item short form of the USDA Food Security Survey Module (Economic Research Service 2012). We categorized respondents as having high/marginal food security (79% at baseline, 77% at follow-up), low food security (15% at baseline, 12% at follow-up), and very low food security (6% at

baseline, 11% at follow-up) according to scoring guidelines provided by the USDA (Bickel et al. 2000).

Our third material hardship measure counts the total number of material hardships respondents reported. This measure is comprised of five distinct dimensions of material hardship: financial problems, food insecurity, employment instability, housing instability, and forgone medical care. Financial problems are defined as reporting at least one financial problem, and food insecurity as reporting low or very low food security. We define employment instability as being unemployed or laid off in the past year, or having work hours shortened, wages reduced, or furlough time since the last interview. Housing instability includes being behind on rent or mortgage, moving for cost reasons, moving in with others to share expenses, current or recent foreclosure, eviction, or homelessness. Forgone medical care is defined as being unable to afford to see a doctor or dentist, or cutting or reducing doses of prescription medication to save money. We categorized the variable as reporting no material hardship (38% at baseline, 46% at follow-up), one material hardship (30% at baseline, 23% at follow-up), two or three material hardships (25% at baseline, 24% at follow-up), and four or five material hardships (7% at baseline, 7% at follow-up).

#### *Other Covariates*

There are other sociodemographic, socioeconomic, and health variables which may explain the relationship between material hardship and sleep. We controlled for age, gender, race (Black or non-Black), partnership status (married/cohabiting or not), number of children in the household, education (less than high school, high school or some college, or a Bachelor's degree or more), employment status, log-transformed household income, poor or fair self-rated health, obesity (a BMI of 30 or more), harmful or hazardous alcohol use measured by the AUDIT (Reinert and Allen 2007), anxiety measured by the GAD-7 (Spitzer et al. 2006), and depression measure by the PHQ-9 (Kroenke, Spitzer, and Williams 2001). We used a score of 10 as the cutoff for both the GAD-7 and PHQ-9 (Kroenke et al. 2010), and when scoring the PHQ-9, we excluded the third item which asked about sleep problems.

#### **Statistical Analysis**

We use diagonal reference models to estimate the association between material hardship and sleep. DRMs were originally developed to study social mobility. Mobility researchers were interested in how social and health outcomes could be explained by socioeconomic status at origin, status at destination, and the act of mobility itself (Sobel 1985). It is not feasible, however, to estimate all three associations in a classical linear model as origin position, destination position, and mobility are highly multicollinear. Sobel (1981, 1985) introduced a class of models—the DRM—to address this issue. Formally, a linear DRM can be written as:

$$y_{ijk} = p * \mu_{ii} + q * \mu_{jj} + \beta_1 x_{ijk1} + \beta_2 x_{ijk2} + \dots + \beta_n x_{ijkn} + e_{ijk}$$

where  $y_{ijk}$  is the value of the dependent variable for an individual  $k$  of origin position  $i$  and destination position  $j$ . In this model,  $\mu_{ii}$  and  $\mu_{jj}$  are the average outcome for

individuals who remained at positions  $i$  and  $j$ , respectively, at both time points. The constants  $p$  and  $q$  represent the relative weight of origin and destination status on the outcome, where both are constrained to the interval  $[0, 1]$  and  $p + q = 1$ . If, for example,  $p$  is larger than  $q$ , then the origin position has a greater effect on the outcome than the destination position. Intuitively,  $p * \mu_{ii} + q * \mu_{jj}$  can be interpreted as the effect of origin position, weighted by its relative importance, plus the effect of destination, similarly weighted. Modeling origin and destination effects in this manner allows mobility—and other covariates—to be included as regular regression coefficients. In the above equation,  $x_{ijk1}$  could be a dummy variable indicating upward mobility, and  $x_{ijk2}$  a dummy variable indicating downward mobility. For a more detailed explanation of DRMs and their advantages over more conventional approaches, see van der Waal et al. (2017).

While originally designed to study social mobility, DRMs can be easily adapted to our own study of material hardship and sleep. We use linear DRMs to model the relationship between sleep time and our three material hardship measures, and linear diagonal reference probability models (analogous to linear probability models) for sleep problems and nonrestorative sleep. As we use hardship level at baseline and follow-up instead of origin and destination status,  $\mu_{ll}$  identifies the average sleep outcome for individuals who experience hardship level  $l$  at both baseline and follow-up—for example, the association between sleep time and persistent, very low food security. In each model we also include two dummy variables to indicate whether respondents experienced an increase or decrease in hardship from baseline to follow-up—analogue to indicators of mobility. All models were performed on Stata 15.1 using the command `-drm-` (Kaiser 2018). We applied survey weights to make our results representative of adults aged 19-64 from Southeast Michigan.

## RESULTS

### Sleep Time

Table 3 reports results from the models of sleep time in minutes. Those who did not experience financial problems at baseline and follow-up reported on average 15 more minutes of sleep, net of other individual characteristics. In contrast, those with the persistent presence of one financial problem had 23 fewer minutes of sleep on average. Neither increase nor decrease in financial hardship were independently associated with sleep time. In this model, as in all other models in this series, hardships at baseline and follow-up were about equally important in estimating sleep time, with weights for baseline and follow-up hardship experience at about 0.5. Holding other variables constant, people with persistent low food security reported 19 more minutes of sleep on average, while people with persistent very low food security reported 19 fewer minutes of sleep. An increase in food insecurity from baseline to follow-up was associated with 32 fewer minutes of sleep. A decrease in food insecurity was not associated with a change in sleep time. We found that those in the persistent no hardship group reported 23 more minutes of sleep than average, net of their other individual characteristics. People who had two or three hardships at both waves reported on average 19 minutes

more sleep, holding other variables constant. Those with the highest level of persistent hardship reported 51 fewer minutes of sleep than average, net of their other characteristics. Neither increase nor decrease in the number of material hardships was associated with statistically significant changes in sleep time. Across the three models, being unemployed was associated with between 73 and 74 more minutes of sleep, while poor self-rated and mental health were associated with shorter sleep duration.

### **Sleep Problems**

Table 4 shows results from models of material hardship and sleep problems. Net of other individual characteristics, those experiencing no financial problems, one problem, or multiple problems at both waves did not on average report a statistically significantly increased probability of sleep problems. An increase in the number of financial problems was associated with a 17 percentage point greater probability of sleep problems. With a weight of 0.91, follow-up hardship was more important for determining sleep problems at follow-up than baseline hardship. Independent of the other variables in our model, those who reported high/marginal, low, or very low food security at both waves did not on average report a statistically significant difference in the probability of sleep problems. Increase or decrease of food insecurity was not associated with changes in the probability of sleep problems. As the weight for follow-up hardship is 1, baseline food insecurity has no effect on the probability of sleep problems. People with no hardships at both waves had a 9 percentage point lower probability of sleep problems than average, net of their other characteristics. An increase in the number of hardships was a marginally statistically significant predictor of sleep problems, associated with a 10 percentage point greater probability of sleep problems. In contrast to the other models, the weight for baseline hardship is 1, suggesting that the number of material hardships at follow-up is not responsible for determining the probability of sleep problems at follow-up. Across the models, worse self-rated and mental health were again associated with a greater probability of poor sleep outcomes.

### **Nonrestorative Sleep**

Table 5 shows results from models predicting the probability of nonrestorative sleep. As with sleep problems, we find no difference in the probability of nonrestorative sleep between people who experienced no financial problems at either baseline or follow-up, or experienced them chronically at both time points. However, an increase in financial problems was marginally statistically significant and associated with a 12 percentage point greater probability of nonrestorative sleep. For food insecurity, those reporting persistent low food security reported on average a 9 percentage point greater probability of nonrestorative sleep, while changes in food hardship alone were not independent statistically significant predictors of nonrestorative sleep, net of other individual characteristics. Baseline food insecurity was not relevant for estimating the probability of nonrestorative sleep at follow-up. Those with no material hardship at baseline and follow-up reported a 15 percentage point lower probability of nonrestorative sleep than average, net of other individual characteristics. Neither an increase nor decrease in the number of material hardships was statistically significantly associated with nonrestorative sleep. As with food insecurity, the weight for baseline hardship was zero, and thus it was not important in determining nonrestorative sleep at

follow-up. Across the three models, being Black was associated with a lower probability of nonrestorative sleep while being a woman and reporting anxiety were positively associated with the probability of nonrestorative sleep.

## **PREMILIMINARY CONCLUSIONS**

This study investigates associations between three sleep outcomes (sleep time, sleep problems, and nonrestorative sleep) and persistent and acute material hardship. We use DRMs to simultaneously estimate these associations. Our results reveal a complex relationship between persistent material hardship and sleep. We found that those experiencing chronic material hardship often report poor sleep outcomes. Those with one financial problem, very low food security, and four or five hardships at both baseline and follow-up reported shorter sleep duration on average. However, on average people with persistent low food security and two or three material hardships both reported 19 more minutes of sleep, net of other individual characteristics. A similar trend in food insecurity was found by Whinnery and colleagues (2014) in a large, cross-sectional sample of U.S. adults. They report that, while those with marginal and very low food security were more likely to report short sleep than those with high food security, no significant association was found for low food security. In unadjusted analyses, the authors note that those with low food security had a slightly higher likelihood of long sleep. It may be, therefore, that those at these mid-level ranges of material hardship are more likely to experience long sleep, and the nature of the relationship is non-linear.

To our knowledge, this study is first in the U.S. context to look at longitudinal relationships between material hardship and sleep, and the only one of our knowledge which appropriately disentangles the effects of baseline and follow-up hardship from changes in hardship. Using a diverse set of sleep outcomes and material hardship variables, we found a complex relationship between persistent hardship and sleep duration, and associations between increasing hardship and poor sleep, across a range of material hardship and sleep dimensions.

## **NEXT STEPS**

Before PAA 2019, we will further refine and expand our current analysis. First, we are investigating the possibility of pooling together data from Wave 1 to 2 and Wave 2 to 3 to address possible power issues due to the small size of our sample. Second, we will examine how economic and social support may moderate the associations between material hardship and sleep. Beyond questions on program participation, such as food assistance and housing vouchers, MRRS asked an extensive set of informal economic support questions, including those on the use of friend and family networks for small loans and gifts to pay for living expenses. Respondents were also asked about their levels of social support, such as having someone to take them to the doctor or talk to about their problems. We will investigate to what extent these types of support may buffer against the harmful effects of material hardship on sleep.

## REFERENCES

- Bergmans, R. S., L. M. Berger, M. Palta, S. A. Robert, D. B. Ehrenthal, and K. Malecki. 2018. "Participation in the Supplemental Nutrition Assistance Program and Maternal Depressive Symptoms: Moderation by Program Perception." *Social Science and Medicine* 197:1–8.
- Bickel, Gary, Mark Nord, Cristofer Price, William Hamilton, and John Cook. 2000. "Guide to Measuring Household Food Security, Revised 2000."
- Ding, M., M. K. Keiley, K. B. Garza, P. A. Duffy, and C. A. Zizza. 2015. "Food Insecurity Is Associated with Poor Sleep Outcomes among US Adults." *Journal of Nutrition* 145(3):615–21.
- Economic Research Service. 2012. *U.S. Household Food Security Survey Module: Six-Item Short Form*. U.S. Department of Agriculture, Economic Research Service.
- Grandner, M. A., N. P. Patel, P. R. Gehrman, D. Xie, D. Sha, T. Weaver, and N. Gooneratne. 2010. "Who Gets the Best Sleep? Ethnic and Socioeconomic Factors Related to Sleep Complaints." *Sleep Medicine* 11(5):470–78.
- Grandner, M. A., M. E. Rutter Petrov, P. Rattanaumpawan, N. Jackson, A. Platt, and N. P. Patel. 2013. "Sleep Symptoms, Race/Ethnicity, and Socioeconomic Position." *Journal of Clinical Sleep Medicine* 9(9):897–905.
- Heflin, Colleen M. and James P. Ziliak. 2008. "Food Insufficiency, Food Stamp Participation, and Mental Health\*." *Social Science Quarterly* 89(3):706–27.
- Heflin, Colleen, John Sandberg, and Patrick Rafail. 2009. "The Structure of Material Hardship in U.S. Households: An Examination of the Coherence behind Common Measures of Well-Being." *Social Problems* 56(4):746–64.
- Kaiser, Caspar. 2018. *DRM Diagonal Reference Model Stata*.
- Kent de Grey, Robert G., Bert N. Uchino, Ryan Trettevik, Sierra Cronan, and Jasara N. Hogan. 2018. "Social Support and Sleep: A Meta-Analysis." *Health Psychology* 37(8):787–98.
- Kroenke, K., R. L. Spitzer, and J. B. W. Williams. 2001. "The PHQ-9: Validity of a Brief Depression Severity Measure." *Journal of General Internal Medicine* 16(9):606–13.
- Kroenke, K., R. L. Spitzer, J. B. W. Williams, and B. Löwe. 2010. "The Patient Health Questionnaire Somatic, Anxiety, and Depressive Symptom Scales: A Systematic Review." *General Hospital Psychiatry* 32(4):345–59.



- Krueger, P. M. and E. M. Friedman. 2009. "Sleep Duration in the United States: A Cross-Sectional Population-Based Study." *American Journal of Epidemiology* 169(9):1052–63.
- Lallukka, T., J. E. Ferrie, M. Kivimäki, M. J. Shipley, O. Rahkonen, and E. Lahelma. 2012. "Economic Difficulties and Subsequent Sleep Problems: Evidence from British and Finnish Occupational Cohorts." *Sleep Medicine* 13(6):680–85.
- Liu, Y., R. S. Njai, K. J. Greenlund, D. P. Chapman, and J. B. Croft. 2014. "Relationships between Housing and Food Insecurity, Frequent Mental Distress, and Insufficient Sleep among Adults in 12 US States, 2009." *Preventing Chronic Disease* 11(3).
- Munger, Ashley L., Sandra L. Hofferth, and Stephanie K. Grutzmacher. 2016. "The Role of the Supplemental Nutrition Assistance Program in the Relationship between Food Insecurity and Probability of Maternal Depression." *Journal of Hunger & Environmental Nutrition* 11(2):147–61.
- Oddo, Vanessa M. and James Mabli. 2015. "Association of Participation in the Supplemental Nutrition Assistance Program and Psychological Distress." *American Journal of Public Health* 105(6):e30–35.
- Perales, F. and S. Plage. 2017. "Losing Ground, Losing Sleep: Local Economic Conditions, Economic Vulnerability, and Sleep." *Social Science Research* 62:189–203.
- Reinert, D. F. and J. P. Allen. 2007. "The Alcohol Use Disorders Identification Test: An Update of Research Findings." *Alcoholism: Clinical and Experimental Research* 31(2):185–99.
- Sobel, Michael E. 1981. "Diagonal Mobility Models: A Substantively Motivated Class of Designs for the Analysis of Mobility Effects." *American Sociological Review* 46(6):893–906.
- Sobel, Michael E. 1985. "Social Mobility and Fertility Revisited: Some New Models for the Analysis of the Mobility Effects Hypothesis." *American Sociological Review* 50(5):699–712.
- Spitzer, R. L., K. Kroenke, J. B. W. Williams, and B. Löwe. 2006. "A Brief Measure for Assessing Generalized Anxiety Disorder: The GAD-7." *Archives of Internal Medicine* 166(10):1092–97.
- van der Waal, Jeroen, Stijn Daenekindt, and Willem de Koster. 2017. "Statistical Challenges in Modelling the Health Consequences of Social Mobility: The Need for Diagonal Reference Models." *International Journal of Public Health* 62(9):1029–37.

Whinnery, J., N. Jackson, P. Rattanaumpawan, and M. A. Grandner. 2014. "Short and Long Sleep Duration Associated with Race/Ethnicity, Sociodemographics, and Socioeconomic Position." *Sleep* 37(3):601–11.

Table 1. Population-weighted sample characteristics of the Michigan Recession and Recovery Study (n = 691)

Measure	Mean	SD
Sleep time in minutes	409.90	84.85
Sleep problems	.17	
Nonrestorative sleep	.38	
Baseline material hardship		
Number of financial problems (0-4)	.40	.64
Food security score (0-6)	.83	1.60
Number of material hardships (0-5)	1.23	1.34
Follow-up material hardship		
Number of financial problems (0-4)	.35	.63
Food security score (0-6)	.99	1.84
Number of material hardships (0-5)	1.10	1.32
Age	45.38	12.73
Woman	.51	
Black	.26	
Married or cohabiting	.65	
Number of children	.86	1.18
Education		
Less than high school	.06	
HS or some college	.64	
Bachelor's or more	.31	
Employment status		
Employed	.61	
Unemployed	.06	
Not in the labor force	.32	
Household income	\$77,791	\$72,355
Poor or fair self-rated health	.18	
Obese (BMI $\geq$ 30)	.33	
Hazardous alcohol use	.10	
Depression	.11	
Anxiety	.11	

Note: all sample characteristics are from follow-up, unless otherwise specified

Table 2. Population-weighted material hardship experiences at baseline and follow-up (n = 691)

		<b>Follow-up (2013)</b>				
		<b>Financial Problems (%)</b>				
		None	One problem	>One problem		
<b>Baseline (2011)</b>	None	59	8	1		
	One problem	11	12	3		
	>One problem	2	3	1		
			<b>Food Security (%)</b>			
			High/marginal	Low	Very low	
	High/marginal	70	6	3		
	Low	6	4	4		
	Very low	1	1	3		
			<b>Number of Material Hardships (%)</b>			
			None	One hardship	2-3 hardships	4-5 hardships
None	29	6	3	1		
One hardship	13	11	6	0		
2-3 hardships	5	6	10	4		
4-5 hardships	0	1	4	3		

Table 3. Linear diagonal reference models of sleep time in minutes (n = 691)

	Sleep Time in Minutes					
	Model 1		Model 2		Model 3	
	$\beta$	95% CI	$\beta$	95% CI	$\beta$	95% CI
<b>No Change in Hardship</b>						
Financial problems						
None	15.2†	[-1.1, 31.5]				
One problem	-22.9*	[-40.5, -5.2]				
More than one problem	7.7	[-15.8, 31.2]				
Food security						
High/marginal food security			0.2	[-17.5, 17.9]		
Low food security			18.7†	[-2.8, 40.3]		
Very low food security			-19.0†	[-40.5, 2.5]		
Material hardship count						
None					23.0**	[5.9, 40.1]
One hardship					9.2	[-12.5, 30.8]
Two or three hardships					18.8*	[0.3, 37.2]
Four or five hardships					-50.9**	[-83.3, -18.6]
<b>Change in Hardship</b>						
Increase in hardship	2.2	[-23.8, 28.1]	-31.5*	[-59.7, -3.3]	-5.2	[-27.0, 16.7]
Decrease in hardship	11.2	[-11.9, 34.3]	3.4	[-24.3, 31.2]	3.6	[-16.0, 23.2]
<b>Weights</b>						
Weight of baseline hardship	0.51	-	0.48	-	0.51	-
Weight of follow-up hardship	0.49	-	0.52	-	0.49	-
<b>Other Covariates</b>						
Age	0.4	[-0.4, 1.1]	0.4	[-0.3, 1.2]	0.3	[-0.4, 1.0]
Woman	12.6	[-2.9, 28.2]	10.8	[-4.7, 26.3]	10.3	[-4.9, 25.5]
Black	16.2†	[-3.0, 35.3]	9.2	[-9.0, 27.4]	14.8	[-3.9, 33.4]
Married or cohabiting	4.7	[-10.5, 20.0]	4.6	[-11.1, 20.4]	4.5	[-11.0, 20.1]
Number of children	-1.0	[-7.3, 5.4]	-2.4	[-9.0, 4.2]	-2.0	[-8.3, 4.3]
Education (ref: Bachelor's or more)						
Less than high school	21.0	[-17.9, 59.8]	21.8	[-15.7, 59.4]	23.1	[-15.7, 61.8]
HS or some college	1.0	[-15.1, 17.0]	-1.0	[-16.6, 14.7]	0.7	[-15.2, 16.6]
Log household income	-1.7	[-7.9, 4.5]	-1.4	[-7.6, 4.8]	-1.9	[-7.9, 4.1]
Employment status (ref: Employed)						
Unemployed	72.7***	[32.8, 112.6]	72.8***	[32.8, 112.8]	77.2***	[36.3, 118.1]
Not in the labor force	13.4	[-4.9, 31.8]	15.0	[-3.3, 33.2]	11.3	[-6.8, 29.5]
Poor or fair self-rated health	-29.1*	[-56.6, -1.7]	-28.4*	[-56.0, -0.8]	-23.8†	[-51.7, 4.1]
Obese (BMI $\geq$ 30)	-1.9	[-17.2, 13.4]	-1.0	[-16.0, 14.1]	-1.3	[-16.0, 13.5]
Hazardous alcohol use	-0.9	[-28.7, 26.9]	-1.3	[-28.4, 25.8]	-1.2	[-28.4, 26.0]
Depression	-37.7*	[-70.7, -4.6]	-37.0*	[-68.1, -6.0]	-32.0†	[-65.9, 1.9]
Anxiety	-32.7†	[-68.1, 2.7]	-28.7†	[-60.3, 2.8]	-31.5†	[-66.3, 3.4]
<b>Constant</b>	<b>393.1***</b>	<b>[293.1, 493.0]</b>	<b>402.5***</b>	<b>[307.1, 497.9]</b>	<b>394.7***</b>	<b>[299.6, 489.8]</b>

† p&lt;0.1, \* p&lt;.05, \*\* p&lt;.01, \*\*\* p&lt;.001

Table 4. Linear diagonal reference probability models of sleep problems (n = 691)

	Sleep Problems					
	Model 4		Model 5		Model 6	
	$\beta$	95% CI	$\beta$	95% CI	$\beta$	95% CI
<b>No Change in Hardship</b>						
Financial problems						
None	0.031	[-0.049, 0.112]				
One problem	0.031	[-0.030, 0.092]				
More than one problem	-0.063	[-0.178, 0.052]				
Food security						
High/marginal food security			-0.001	[-0.093, 0.092]		
Low food security			0.045	[-0.050, 0.140]		
Very low food security			-0.044	[-0.149, 0.060]		
Material hardship count						
None					-0.093*	[-0.169, -0.016]
One hardship					0.022	[-0.042, 0.085]
Two or three hardships					-0.018	[-0.079, 0.042]
Four or five hardships					0.089	[-0.029, 0.208]
<b>Change in Hardship</b>						
Increase in hardship	0.174*	[0.023, 0.326]	0.105	[-0.069, 0.279]	0.104†	[-0.008, 0.216]
Decrease in hardship	0.015	[-0.088, 0.118]	0.017	[-0.114, 0.147]	-0.051	[-0.134, 0.033]
<b>Weights<sup>a</sup></b>						
Weight of Wave 2 hardship	0.09	-	0	-	1	-
Weight of Wave 3 hardship	0.91	-	1	-	0	-
<b>Other Covariates</b>						
Age	-0.001	[-0.004, 0.002]	-0.001	[-0.004, 0.002]	-0.001	[-0.003, 0.002]
Woman	0.035	[-0.026, 0.096]	0.034	[-0.027, 0.095]	0.027	[-0.035, 0.089]
Black	-0.009	[-0.082, 0.063]	-0.005	[-0.078, 0.067]	-0.023	[-0.098, 0.051]
Married or cohabiting	0.031	[-0.036, 0.098]	0.037	[-0.035, 0.110]	0.030	[-0.040, 0.100]
Number of children	-0.010	[-0.037, 0.016]	-0.011	[-0.039, 0.016]	-0.010	[-0.037, 0.017]
Education (ref: Bachelor's or more)						
Less than high school	0.073	[-0.075, 0.221]	0.052	[-0.104, 0.209]	0.059	[-0.098, 0.216]
HS or some college	-0.030	[-0.094, 0.034]	-0.037	[-0.098, 0.024]	-0.038	[-0.099, 0.024]
Log household income	-0.012†	[-0.024, 0.000]	-0.013†	[-0.027, 0.001]	-0.010†	[-0.023, 0.002]
Employment status (ref: Employed)						
Unemployed	-0.111†	[-0.231, 0.009]	-0.091	[-0.218, 0.036]	-0.130*	[-0.249, -0.011]
Not in the labor force	-0.024	[-0.096, 0.047]	-0.028	[-0.098, 0.041]	-0.019	[-0.093, 0.056]
Poor or fair self-rated health	0.179**	[0.054, 0.304]	0.168*	[0.036, 0.300]	0.151*	[0.024, 0.278]
Obese (BMI $\geq$ 30)	0.028	[-0.037, 0.094]	0.028	[-0.035, 0.091]	0.017	[-0.049, 0.083]
Hazardous alcohol use	0.062	[-0.058, 0.183]	0.086	[-0.038, 0.210]	0.064	[-0.065, 0.193]
Depression	0.447***	[0.279, 0.614]	0.481***	[0.311, 0.652]	0.456***	[0.289, 0.623]
Anxiety	0.052	[-0.115, 0.219]	0.042	[-0.136, 0.220]	0.034	[-0.138, 0.205]
<b>Constant</b>	0.193†	[-0.020, 0.406]	0.245*	[0.015, 0.475]	0.256*	[0.059, 0.453]

† p<0.1, \* p<.05, \*\* p<.01, \*\*\* p<.001

<sup>a</sup> In Models 5 and 6, weights were constrained to 0 and 1

Table 5. Linear diagonal reference probability models of nonrestorative sleep (n = 691)

	Nonrestorative Sleep					
	Model 7		Model 8		Model 9	
	$\beta$	95% CI	$\beta$	95% CI	$\beta$	95% CI
<b>No Change in Hardship</b>						
Financial problems						
None	0.009	[-0.087, 0.104]				
One problem	-0.029	[-0.103, 0.045]				
More than one problem	0.020	[-0.096, 0.136]				
Food security						
High/marginal food security			-0.080	[-0.177, 0.017]		
Low food security			0.089†	[-0.013, 0.190]		
Very low food security			-0.009	[-0.126, 0.108]		
Material hardship count						
None					-0.145**	[-0.247, -0.043]
One hardship					0.051	[-0.048, 0.150]
Two or three hardships					0.058	[-0.024, 0.139]
Four or five hardships					0.037	[-0.111, 0.184]
<b>Change in Hardship</b>						
Increase in hardship	0.122†	[-0.011, 0.255]	0.041	[-0.135, 0.216]	0.034	[-0.100, 0.168]
Decrease in hardship	0.095	[-0.072, 0.262]	0.007	[-0.129, 0.143]	0.060	[-0.048, 0.168]
<b>Weights<sup>a</sup></b>						
Weight of Wave 2 hardship	1	-	0	-	0	-
Weight of Wave 3 hardship	0	-	1	-	1	-
<b>Other Covariates</b>						
Age	-0.004†	[-0.009, 0.001]	-0.004†	[-0.009, 0.000]	-0.003	[-0.008, 0.001]
Woman	0.103*	[0.007, 0.200]	0.104*	[0.008, 0.200]	0.099*	[0.005, 0.192]
Black	-0.168***	[-0.264, -0.073]	-0.170***	[-0.263, -0.076]	-0.201***	[-0.299, -0.102]
Married or cohabiting	-0.076	[-0.182, 0.030]	-0.065	[-0.176, 0.047]	-0.055	[-0.158, 0.049]
Number of children	-0.001	[-0.046, 0.043]	-0.005	[-0.051, 0.040]	-0.010	[-0.053, 0.032]
Education (ref: Bachelor's or more)						
Less than high school	0.027	[-0.130, 0.184]	-0.009	[-0.178, 0.160]	-0.012	[-0.185, 0.161]
HS or some college	0.037	[-0.070, 0.145]	0.025	[-0.084, 0.133]	0.009	[-0.095, 0.113]
Log household income	-0.008	[-0.024, 0.008]	-0.008	[-0.027, 0.011]	-0.006	[-0.022, 0.011]
Employment status (ref: Employed)						
Unemployed	-0.093	[-0.287, 0.101]	-0.094	[-0.282, 0.093]	-0.118	[-0.314, 0.077]
Not in the labor force	-0.064	[-0.174, 0.045]	-0.073	[-0.178, 0.032]	-0.051	[-0.159, 0.057]
Poor or fair self-rated health	0.129†	[-0.012, 0.270]	0.105	[-0.043, 0.253]	0.115	[-0.025, 0.254]
Obese (BMI $\geq$ 30)	0.019	[-0.081, 0.120]	0.023	[-0.075, 0.121]	0.019	[-0.079, 0.116]
Hazardous alcohol use	0.101	[-0.054, 0.256]	0.116	[-0.044, 0.275]	0.096	[-0.071, 0.263]
Depression	0.130	[-0.044, 0.305]	0.143†	[-0.027, 0.314]	0.136†	[-0.023, 0.295]
Anxiety	0.238**	[0.071, 0.405]	0.221*	[0.049, 0.392]	0.203*	[0.044, 0.362]
<b>Constant</b>	<b>0.586***</b>	<b>[0.278, 0.894]</b>	<b>0.679***</b>	<b>[0.359, 0.998]</b>	<b>0.608***</b>	<b>[0.313, 0.904]</b>

† p<0.1, \* p<.05, \*\* p<.01, \*\*\* p<.001

<sup>a</sup> In all models, weights were constrained to 0 and 1