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The Association of Goal-Striving Stress with Sleep Duration and Sleep Quality among African Americans in the Jackson Heart Study

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Abstract

Background: African Americans (AAs) report a higher frequency of certain stressors over their lifetime which may impact biological processes that can impair sleep. For this reason, goal-striving stress (GSS), the difference between aspiration and achievement, weighted by disappointment, may contribute to poor sleep quality and suboptimal sleep duration among AAs.

Methods: We completed a cross-sectional analysis using exam 1 data (2000–2004) from the Jackson Heart Study (JHS) (n=4943). GSS was self-reported and categorized in tertiles of low, moderate, and high. Participants self-reported the number of hours they slept per night and rated their sleep quality as (1) very poor to (5) excellent. Sleep duration categories included: short sleep (≤6 hours), normal sleep (7–8 hours) and long sleep (≥ 9 hours). Sleep quality was categorized as high (good/very good/excellent) and low (fair/poor). Relative risk ratios (RRR 95% Confidence Intervals-CI) were estimated for sleep duration and sleep quality categories by GSS using logistic regression.

Results: After full adjustment, there were no significant associations between GSS and sleep duration categories. However, participants who reported high (versus low) GSS had a 20% greater risk (1.20 95% CI 1.01, 1.43) of low (versus high) sleep quality in the fully adjusted model.

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Disclosure Statement
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Conclusion: The stress due to the deficit between goal aspiration and achievement was associated with poor sleep quality. Future investigations should examine the association of changes in GSS with changes in sleep duration and sleep quality.

Keywords

sleep duration; sleep quality; psychosocial stress; goal-striving stress; African Americans; Jackson Heart Study

Introduction

Stress and Sleep

Of the 70 million Americans that suffer from sleep complications, almost 60% of those have a chronic health condition such as chronic kidney disease, obesity, or cardiovascular disease.[1–4] The stress-sleep literature has shown a relationship between various components of stress including financial strain, work stress, and poor family relationships with sleep disturbance as well as poor sleep quality.[5–8] Research has also shown a temporal relationship between chronic stress with sleep disturbance in middle-aged women.[9] The physical and mental health consequences related with sleep deprivation, sleep disorders, and sleepiness, (e.g., pain, emotional distress, mood disorders),[10] contribute approximately $15.9 billion to the national healthcare costs.[1] Therefore, identifying and addressing psychosocial predictors of sleep duration and sleep quality is a fundamental step in preventing and managing chronic disease and associated costs, especially as it relates to the excess burden of unhealthy sleep.

Sleep and Stress in African Americans

There are racial disparities in sleep quality and sleep duration.[11–12] African Americans (AAs) have a lower mean sleep duration, poorer sleep quality, and a higher prevalence of sleep-disordered breathing as compared to Whites.[13–15] Although the determinants of sleep health disparities are understudied, data from the National Sleep Foundation demonstrated that AAs reported shorter sleep duration each night due to anxiety or stress about finances and employment at a higher rate than Whites or Asians.[11] The prior finding suggests that stress may be an important determinant of sleep health for AAs. Studies that have investigated the association between stress and sleep health among AAs have shown an association of global and weekly stress with poor sleep quality and short sleep duration[16–17] as well as associations between neighborhood violence and problems (e.g. neighborhood stressors) with short sleep duration and poor sleep quality.[18] Additionally, AAs report a higher frequency of certain stressors over a lifetime,[19] which may impact biological processes that can impair sleep.[20–22] Thus, investigating experiences of stress may be important for identifying the social determinants of sleep health among AAs.

Goal-striving Stress

One particular stressor that is understudied in social epidemiology is goal-striving stress (GSS). GSS is the psychological stress associated with goal-striving behavior,[23] or in other words the stress due to the deficit between goal aspiration and achievement. Parker and Kleiner (1966) were the first to explore GSS and its relationship to mental illness among

AAs.[23] They noted that the psychological burden of goal-striving is particularly heavy for AAs because they often battle for equality and status in a system that has historically marginalized the AA population.[23] For example, if one's social status translates into upward mobility, this psychological satisfaction may promote social advancement and social inclusion.[23] However, if one's social status does not result in upward mobility, then the absence of psychological satisfaction may adversely affect one's self-esteem and result in frustration, which are components of GSS.[23] This is evident where research shows that even highly educated AAs are less likely to be rewarded for their achievement as manifested by lower income and perceived lower job security (and job authority) when compared to their White counterparts.[24] Research also shows that educational attainment does not confer the same health advantages for AAs as it does for their White counterparts.[25–26] Because AAs often live in a system that is not conducive to upward mobility due to factors such as systematic discrimination, GSS is a particularly important psychosocial stressor to study among AAs.

Goal-striving Stress and Health Outcomes

GSS has been previously associated with mental health outcomes.[27–29] Two studies found that GSS was specifically associated with lower levels of happiness, life satisfaction, self-esteem, higher levels of psychological distress, and decreased psychological well-being among AAs.[27,29] Researchers have also reported an association between GSS and hypertension, physical health problems, prevalent chronic kidney disease, and self-rated health among white Americans, African Americans, and Caribbean blacks.[30–31] It is hypothesized that the hypothalamic-pituitary-adrenal (HPA) axis, the stress response system, helps modulate the sleep cycle.[32] Therefore, GSS may be a stressor that interrupts the HPA causing irregularities in sleep. Therefore, we hypothesized an inverse association between GSS and sleep duration and sleep quality, independent of discrimination and global perceived stress. We conducted exploratory analyses testing interactions by sex, educational attainment, and occupation. We hypothesized that the association between GSS and sleep would vary by sex, age, educational attainment, and occupation due to the nature of GSS[23] and differences in sleep patterns among these groups.[33]

Participants and Methods

Sample Population

There were 5306 AA men and women (ages 21–94 years old) in the baseline examination of the Jackson Heart Study (JHS) (2000–2004), from the greater Jackson, MS metropolitan area (Hinds, Madison, and Rankin counties). The main objective of the JHS is to examine risk factors for the development of cardiovascular disease (CVD) and the etiology of CVD development in AAs. JHS participants were recruited from the Atherosclerosis Risk (ARIC) study (33%), family members of participants (28%), random selection (17%), and community volunteers (25%). There were two additional follow-up exams, visit 2 (2005–2008) and visit 3 (2009–2013). Specific information pertaining to design, data variables, and procedures of the JHS have been published in other studies.[34–35] The JHS approved the current analysis.

For the current paper, we omitted those who had missing values for GSS (n=113), those missing sleep duration or sleep quality data (n=51), and those who had missing covariate data (n=199), leaving a sample size of 4943. Those who were removed from the sample due to missing data (versus those who remained in the sample) were: 66% (versus 63%) female, 48% (versus 62%) college educated, 40% (versus 41%) normal sleep, 66% (versus 66%) high sleep quality, with a mean age of 59 (versus 55) years old, a mean everyday discrimination score of (vs 2.07), and a mean GSS score of 4.42 (3.7). Informed consent was provided by all participants and participating institutions' institutional review boards approved the study: Tougaloo College, Jackson State University, and the University of Mississippi Medical Center.

Goal-Striving Stress

The original GSS-related questions assessed the discrepancies between the respondent's achievements and aspirations in various areas of goal striving, including occupation, income, and overall goal striving using a 10-step ladder to assess aspiration and achievement.[23] In the current study, overall GSS was assessed. GSS was defined as the discrepancy between "where one would like to be next year" and "where one is now" both using 10-point scales. This difference is then weighted by a "disappointment score," using a 4-point scale, if the goal was not achieved by the following year.[27–28,30] Participants were provided a picture of a ladder with 10 possible steps, where the first step represented the worst possible way of life and the tenth step represented the best possible way of life. Then, participants identified the step number where they are now (achievement) and then identified the step they would like to be by the next year (aspirations). The difference between aspiration and attainment was multiplied by probability and importance. Participants also rated how disappointed they would be if they could not reach their goal, with scores ranging from very disappointed to not at all disappointed (1-not at all disappointed, 2-slightly disappointed, 3-fairly disappointed, 4-very disappointed).

The GSS score was derived as follows: (aspiration – achievement) x disappointment. The range of GSS was 0 to 36, where a higher score indicated greater GSS. GSS standard deviation (SD) units were created (GSS/5.01) to model GSS continuously so that results could be interpreted in terms of standard deviation increases. GSS was also categorized into increasing tertiles of low GSS (0–1), moderate GSS (2–4), and high GSS stress (5–36) in order to assess threshold effects. Due to the distribution of responses, the tertiles were not equal. Because GSS is derived from 3 items (aspiration, achievement, and disappointment) and is not derived from a scale that samples the domain of a construct, psychometric properties from a GSS instrument are not available.[36]

Sleep Measures

Participants self-reported sleep duration at baseline as the average number of hours (h) of sleep per day in the last month. Sleep duration was reported in hours (discrete measure) and converted to minutes for statistical analysis. Additionally, the following categories were created for sleep duration: short sleep (≤ 6 h), normal sleep (7 or 8 h), and long sleep (≥ 9 h) sleep for our primary analysis. Both continuous (in minutes) and categorized (short, normal, and long) measures of sleep duration were used in the statistical analyses.[37–38]

Participants also reported sleep quality at baseline, defined as the self-reported rating of overall sleep quality using the following scale: excellent = 1, very good = 2, good = 3, fair = 4 and poor = 5. Sleep quality was categorized as high (excellent, very good, good) and low (fair, poor).

Covariates

Baseline covariates included age (continuous), sex [male/female (referent)], occupation [management/professional (referent), service/sales, farming/construction/production, other], and education status (< high school graduate (referent), high school graduate, attended college). Body mass index (BMI) was calculated as weight (kg) divided by height (m^2). Hypertension was defined as a measured blood pressure of ≥140/90 mm Hg or usage of medication to lower blood pressure.[39] History of cardiovascular disease (CVD) was defined as physician-diagnosed, as reported by the participant [CVD/no CVD (referent)]. Specifically, participants with a history of coronary heart disease (CHD) from ECG and self-reported CHD, self-reported history of carotid angioplasty, or self-reported indication of physician-diagnosed stroke was considered to have a history of CVD. Smoking status was defined as current smoker, former smoker < 1 year, never smoker/quit ≥ 1 (referent). Alcohol use was defined as alcohol use within the last year (yes/no). The American Heart Association's physical activity categorization was used to define physical activity as either poor health (0 minutes of moderate/vigorous activity), intermediate health (< 150 minutes of moderate activity, < 75 minutes of vigorous activity, < 150 minutes of moderate/vigorous activity) or ideal health (≥ 150 minutes of moderate activity, ≥ 75 minutes of vigorous activity, ≥ 150 minutes of moderate/vigorous activity).[40]

We adjusted for everyday discrimination, which is a chronic stressor related to AAs and goal striving.[27] The everyday discrimination score was calculated as the mean of 9 items related to day-to-day experiences of unfair treatment (scored 1–7), and a higher score indicated greater perceived everyday discrimination.[21] Everyday discrimination had good internal consistency ($\alpha = 0.88$).[41] We also adjusted for global perceived stress as a sensitivity analysis. Global perceived stress score consists of eight domains that evaluate chronic stressors, including employment, relationships, medical issues, legal issues, basic needs, racism, and discrimination.[42] Each domain was scored from 0 (not stressful) to 3 (very stressful) and summed, giving a total scale range of 0 to 24. Global perceived stress had good internal consistency ($\alpha = 0.72$).[17] Negative mood (e.g. depression and anxiety symptoms) may be important confounders of the association between GSS and sleep. Thus, a sensitivity analysis was conducted among participants with depressive symptoms scores [n=3,213 (65%)], as symptoms of anxiety were not available. Depressive symptoms were measured using the Centers for Epidemiologic Studies Depression Scale, where participants were asked about their mood over the past week.[43] Scores ranged from 0 to 60, where higher scores indicated higher levels of depression. Depressive symptoms had good internal consistency ($\alpha = 0.82$).[17] Statistical Analysis

Baseline characteristics were examined by tertiles of GSS. Kruskal-Wallis tests were used to examine non-normal continuous variables by GSS tertiles, and chi-square tests were used to examine categorical variables by GSS tertiles. Multivariable linear regression analyses were used to assess the association of GSS with mean differences (standard errors–SE) of continuous sleep duration and sleep quality. Linearity between GSS and sleep measures was assessed using a linear regression fitting curve on a 95% confidence interval. Multivariable logistic regression analyses estimated associations of GSS levels with sleep duration and sleep quality categories where relative risk ratios (RRRs 95% confidence intervals-CI) estimated the relative risk of short sleep (versus normal sleep), long sleep (versus normal sleep), and poor sleep quality (versus high sleep quality) by levels of GSS. RRR is the same as the odds ratio in the case of binary outcomes.

We adjusted for confounders using the following hierarchical adjustments. Model 1 adjusted for age and sex. Model 2 added occupation and education. Model 3 added smoking status, alcohol use, and physical activity. Model 4 added BMI, hypertension, and a history of CVD. Model 5 added everyday discrimination. As a sensitivity analysis, Model 6 added global perceived stress to assess the independence of GSS and sleep outcomes. We hypothesized that the association between GSS and sleep may vary by sex, age, educational attainment, and occupation due to the nature of GSS[23] and differences in sleep patterns among these groups.[33] Therefore, we tested for interactions by these factors. All models are shown to demonstrate the effect of the addition of covariates at each step. Statistical significance was inferred at 2-sided $P<0.05$. Analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

The mean GSS score was 3.67 (SD ±5.01). Forty-one percent had low GSS; 33% had moderate GSS; 26% had high GSS (Table 1). Comparisons of sample characteristics by tertiles of GSS showed the percentage of those in the normal sleep duration, high sleep quality, poor physical activity, and hypertension categories decreased as GSS levels increased (Table 1). The percentage of those in the short sleep duration, low quality sleep, current smoking, intermediate physical activity, and alcohol use categories increased as GSS levels increased. (Table 1). The mean hours of sleep duration and age decreased as GSS levels increased (Table 1). The mean BMI and perceived discrimination score increased as GSS levels increased. (Table 1).

Table 2 shows the associations between continuous GSS with sleep duration and sleep quality measures. In model 5, a 1-SD unit increase in GSS was associated with a 3.55-minute decrease in sleep duration. However, in Model 6 further adjustment for global stress, GSS was not associated sleep duration {$\beta = -1.42(1.40)$; p=0.3130. In model 5, a 1-SD unit increase in GSS was associated with a 0.13 (0.02) lower rating in sleep quality. In Model 6, a 1-SD unit increase in GSS was associated with a 0.08 (0.02) lower rating in sleep quality.

Tables 3 and 4 show the associations between categorical GSS with sleep duration and sleep quality measures. In model 5 of Table 3, high GSS (versus low GSS) was significantly associated with short sleep (versus normal sleep), with a relative risk ratio of 1.25 for short sleep [RRR = 1.25 (1.06, 1.46) p<0.05]. However, when adjusting for global perceived stress (Model 6), high GSS (versus low GSS) was not significantly associated short sleep (versus normal sleep), with a relative risk ratio of 1.13 for short sleep (versus. normal sleep) [RRR =

1.13 (0.95, 1.33) p>0.05]. In model 5 of Table 4, high GSS (versus low GSS) was significantly associated with low sleep quality (versus high sleep quality), with an odds ratio of 1.48 for low sleep quality [OR = 1.48 (1.26, 1.73) p<0.05. When adjusting for global perceived stress (Model 6), the relationship between high GSS (versus low GSS) and low sleep quality (versus high sleep quality) was slightly attenuated but remained significant, with an odds ratio of 1.20 for low sleep quality (versus high sleep quality) [OR = 1.20 (1.01, 1.43) p<0.05].

In the sensitivity analysis adjusting for depressive symptoms in the subsample [n=3,213 (65%)], we found that depressive symptoms attenuated the relationship between GSS and sleep quality. However, the subsample of participants with depressive symptoms may differ from the entire sample. Therefore, these results are not shown. Some characteristics of those missing depression data (versus those who are not missing depression data) include 60% (65%) female, 51% (68%) college educated, 60% (54%) with hypertension, 14% (8.5%) with cardiovascular disease, and mean age of 56 (53). Interactions between GSS with sex, age, educational attainment, and occupation on sleep outcomes were not significant (p-value for interaction > 0.05).

Discussion

This study investigated the association of GSS with sleep duration and sleep quality in a large cohort of AAs. The results showed that higher levels of GSS were not significantly associated with sleep duration but were significantly associated with poor sleep quality, even after the addition of global perceived stress, which suggests that GSS is an important stressor that is related to poor sleep quality among AAs. It also suggests that global perceived stress was a confounding variable in the association between GSS and sleep duration. As a result of the disproportionate burden of poor sleep quality that confronts AAs, it is important to identify the factors that may elucidate why AAs have poorer sleep quality in order to reduce the risk for chronic illness.

The findings of this study are similar to prior studies that reported associations between stress and poor sleep among AAs. Johnson and colleagues reported that higher scores of various stressors (chronic and acute stressors) were significantly associated with poorer sleep quality among JHS participants.[16] They found that those in the highest quartiles of stress (versus lowest quartile) reported poorer sleep quality, after adjusting for age, sex, education, income, physical activity, body mass index, diabetes, and hypertension: global perceived stress [−0.73 (−0.83, −0.63)], major life events stress [−0.38 (−0.49, −0.27)], and weekly stress inventory [−0.52 (−0.65, −0.40)].[16] Slopen et al. also found significant associations between psychosocial stressors and sleep difficulties, adjusted for age, race/ethnicity, sex, education, and income. The significant beta coefficients ranged from 0.04–0.09.[43]

We found similar results with GSS and sleep quality, with a significant beta coefficient of −0.08 (as GSS increases, sleep quality decreases). We also found that those in the highest GSS tertile had a greater risk of poor quality sleep when compared to those with a higher sleep quality rating. In the Johnson et al. study, the authors found that college graduates were most vulnerable to the effects of high stress and short sleep duration.[16] However, in our study, there was no statistically significant interaction between GSS and educational attainment on sleep measures. Although the prior paper identified a population that may have increased risk for the influence of stress on sleep, the authors did not explore stressors, such as GSS,[27] which may not be unique to only those of higher SES. The current study extends prior studies that link stress and sleep health by investigating an understudied domain of stress that considers the discrepancy between aspiration and achievement (i.e., GSS) in a large sample of AAs. Our finding that GSS was associated with sleep quality, but not sleep duration may be due to the notion that GSS may impact mood which may be reflected more in sleep quality—how participants feel about their sleep, (e.g. sleep satisfaction, sleep quality) versus the actual duration of sleep.[44]

GSS has the potential to cause mental and emotional distress, similar to other forms of stress. It is possible that the unrelenting pressure experienced from the aspiration of goals and failure to achieve goals may be associated with poor sleep quality and short sleep. Studies report that the hypothalamic-pituitary-adrenal (HPA) axis, the stress response system, modulates the sleep cycle and circadian rhythm; and the dysfunction of this system following exposure to stressors may cause short sleep.[32] In rodent studies, experiencing stress (intermittent foot shock) resulted in shorter REM sleep and total sleep.[45] Although reports have found that stress can induce short sleep, it is also possible that short sleep can induce dysregulation of the HPA axis.[32]

The results of this research suggest that GSS may contribute to poor sleep health, which has important implications for improving sleep quality among AAs. Interventions which aim to reduce various forms of stress may also improve sleep quality. Future research should explore techniques to overcome stress related to low achievement of desired goals to improve sleep health among AAs. Poor sleep is associated with a host of poor health outcomes such as chronic kidney disease, obesity, or cardiovascular disease,[2–4] which also are highly prevalent among AAs and may contribute to overall health disparities. Exploring GSS as a possible risk factor for poor sleep outcomes may provide better precision for addressing health disparities among AAs. Future research should also explore how GSS may impact sleep across the adult life course to further improve interventions.

This is the very first examination of GSS, a unique stressor relevant to AAs, in association with two important sleep outcomes (sleep duration and quality) in a large sample of AAs. Despite the strengths of this study, there are limitations. The data presented were collected at one-time point, thus causal inference cannot be inferred. This research included self-reported measures of sleep, which are subject to measurement error and may not provide an accurate estimate of the effect. Depression status was also not available for 35% of the sample. Therefore, the effect of depression on these relationships could not be fully assessed in this sample. Also, due to how the occupation variable was collapsed, the results may not be generalizable to those of various occupation types. Additionally, JHS is a single-site study of AAs in the Jackson, MS tri-county area, and is not representative of the wider AA population throughout the US, thus limiting the generalizability of the results.

In conclusion, this study provided important insights regarding the association between GSS and short sleep duration and poor sleep quality among AAs. The results of this study should be further explored to identify potential buffers of GSS on sleep in order to minimize the deleterious effects of stress on sleep. AAs experience worse sleep than any other racial/ ethnic group; therefore, it is important to understand the link between stress and poor sleep in this population and explore prevention efforts that may consider stress associated with goal attainment.

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Table 1 –

The Association of Demographic Variables by Goal-Striving Stress Tertiles

	Entire Sample (n=4943)	Low GSS (0–1) (n=2027, 41.01%)	Moderate GSS (2–4) (n=1644, 33.26%)	High GSS (5–36) (n=1272, 25.73%)	
Sleep Duration (discrete measures)					p < 0.0001
Short: ≤ 6 Hours	2674 (54.10%)	1027 (50.67%)	900 (54.74%)	747 (58.73%)	
Normal: 7 or 8 Hours	2002 (40.50%)	871 (42.97%)	674 (41.00%)	457 (35.93%)	
Long: ≥ 9 Hours	267 (5.40%)	129 (6.36%)	70 (4.26%)	68 (5.35%)	
Hours (Mean ± SD)	6.43 ± 1.51	6.54 ± 1.54	6.41 ± 1.40	6.29 ± 1.59	p < 0.0001
Sleep Quality Categories					p < 0.0001
High	3239 (65.53%)	1420 (70.05%)	1100 (66.91%)	719 (56.53%)	
Low	1704 (34.47%)	607 (29.95%)	544 (33.09%)	553 (43.47%)	
Sex					p = 0.0192
Female	3133 (63.38%)	1290 (63.64%)	1003 (61.01%)	840 (66.04%)	
Male	1810 (36.62%)	737 (36.36%)	641 (38.99%)	432 (33.96%)	
Occupation					
Management/Professional	1790 (36.21%)	732 (36.11%)	669 (40.69%)	389 (30.58%)	p < 0.0001
Service/Sales	2084 (42.16%)	846 (41.74%)	634 (38.56%)	604 (47.48%)	
Farming/Construction/Production	1036 (20.96%)	433 (21.36%)	340 (20.68%)	263 (20.86%)	
Other	33 (0.67%)	16 (0.79%)	1 (0.06%)	16 (1.26%)	
Educational Attainment					p < 0.0001
Less than high school	857 (17.34%)	492 (24.27%)	194 (11.80%)	171 (13.44%)	
High School Graduate	1002 (20.27%)	436 (21.51%)	314 (19.10%)	252 (19.81%)	
Attended College	3084 (62.39%)	1099 (54.22%)	1136 (69.10%)	849 (66.75%)	
Smoking Status					p < 0.0001

	Entire Sample (n=4943)	Low GSS (0–1) (n=2027, 41.01%)	Moderate GSS (2–4) (n=1644, 33.26%)	High GSS (5–36) (n=1272, 25.73%)	
Current Smoker	641 (12.97%)	212 (10.46%)	195 (11.86%)	234 (18.40%)	
Quit Smoking < 1	59 (1.19%)	16 (0.79%)	23 (1.41\0%)	20 (1.57%)	
Never smoked / quit ≥ 1 year	4243 (85.84%)	1799 (88.75%)	1426 (86.74%)	1018 (80.03%)	
Physical Activity Health					p < 0.0001
Poor: 0 minutes of moderate/vigorous activity	2400 (48.55%)	1083 (53.43%)	754 (45.86)	563 (44.26%)	
Intermediate: < 150 minutes of moderate activity, < 75 minutes of vigorous activity, < 150 minutes of moderate/vigorous activity	1582 (32.00%)	578 (28.52%)	547 (33.27%)	457 (35.93%)	
Ideal: ≥ 150 minutes of moderate activity, ≥ 75 minutes of vigorous activity, ≥ 150 minutes of moderate/vigorous activity	961 (19.44%)	366 (18.06%)	343 (20.86%)	252 (19.81%)	
Alcohol Use in Past 12 months					p < 0.0001
No	2670 (54.02%)	1240 (61.17%)	853 (51.89%)	577 (45.36%)	
Yes	2273 (45.98%)	787 (38.68%)	791 (48.11%)	695 (54.64%)	
Hypertension					p < 0.0001
No	2162 (43.74%)	747 (36.85%)	763 (46.41%)	652 (51.26%)	
Yes	2781 (56.26%)	1280 (63.15%)	881 (53.59%)	620 (48.74%)	
History of CVD					p < 0.0001
No	4426 (89.54%)	1766 (87.12%)	1510 (91.85%)	1150 (90.41%)	
Yes	517 (10.46%)	261 (12.88%)	134 (8.15%)	122 (9.59%)	
		Mean ± SD			
Age	55.09 ± 12.76	60.28 ± 11.59	53.16 ± 11.96	49.30 ± 12.37	p < 0.0001
Discrimination Score (Range 1–7)	2.08 ± 1.01	1.88 ± 0.94	2.10 ± 0.95	2.38 ± 1.10	p < 0.0001
BMI (kg/m^2)	31.80 ± 7.25	31.39 ± 6.61	31.78 ± 7.34	32.46 ± 8.04	p = 0.0242

- p-values were calculated using chi-square and Kruskal-Wallis tests as appropriate.
- Because of the high frequencies in some of the discrete responses of the GSS scale, the tertiles were not equal.

Table 2 –

Mean difference (Standard Error) of Goal-Striving Stress SD units and Sleep Duration (in minutes) and Quality at baseline (n=4943)

	Sleep Duration	Sleep Quality
Model 1	*−3.97 (1.35) p = 0.0032	*−0.15 (0.02) p < 0.0001
)Model 2	*−4.23 (1.36) p = 0.0018	*−0.15 (0.02) p < 0.0001
Model 3	*−4.51 (1.36) p = 0.0009	*−0.14 (0.02) p < 0.0001
Model 4	*−4.41 (1.36) p = 0.0012	*−0.14 (0.02) p < 0.0001
Model 5	*−3.55 (1.40) p = 0.0093	*−0.13 (0.02) p < 0.0001
Model 6	−1.42 (1.40) p = 0.3131	*−0.08 (0.02) p < 0.0001

Model 1 –adjusted for sex, age

Model 2 – Model 1 + occupation + education

Model 3 – Model 2 + smoking + physical activity + alcohol use

Model 4 – Model 3 + hypertension + BMI + CVD history

Model 5 – Model 4 + discrimination

Model 6 – Model 5 + global perceived stress

SD - Standard Deviation

*significant p-value

Table 3 –

The cross-sectional association between Goal-Striving Stress tertiles and Sleep Duration at baseline (n=4943)

	Relative Risk Ratios of Short and Long Sleep (vs. Normal Sleep) on a 95% Confidence Interval	
	Sleep Duration Categories	
Model 1	**Short Sleep**	**Long Sleep**
GSS (low)	Reference	Reference
GSS (moderate)	1.09 (0.94, 1.25) p = 0.2491	0.85 (0.62, 1.16) p = 0.3007
GSS (high)	*1.31 (1.12, 1.53) p = 0.0008	1.34 (0.96, 1.87) p = 0.0912
Model 2	**Short Sleep**	**Long Sleep**
GSS (low)	Reference	Reference
GSS (moderate)	1.08 (0.94, 1.24) p = 0.2274	0.88 (0.64, 1.21) p = 0.4168
GSS (high)	*1.30 (1.11, 1.52) p = 0.0011	1.27 (0.90, 1.74) p = 0.1739
Model 3	**Short Sleep**	**Long Sleep**
GSS (low)	Reference	Reference
GSS (moderate)	1.09 (0.94, 1.25) p = 0.2486	0.87 (0.63, 1.20) p = 0.4016
GSS (high)	*1.32 (1.12 1.54) p = 0.0007	1.25 (0.89, 1.76) p = 0.1947
Model 4	**Short Sleep**	**Long Sleep**
GSS (low)	Reference	Reference
GSS (moderate)	1.08 (0.94, 1.25) p = 0.2624	0.87 (0.63, 1.20) p = 0.4091
GSS (high)	1.30 (1.11, 1.53) p = 0.0011	1.23 (0.87, 1.73) p = 0.2413
Model 5	**Short Sleep**	**Long Sleep**
GSS (low)	Reference	Reference
GSS (moderate)	1.07 (0.93, 1.23) p = 0.3588	0.89 (0.64, 1.22) p = 0.4641
GSS (high)	*1.25 (1.06, 1.46) p = 0.0071	1.29 (0.91, 1.81) p = 0.1545
Model 6	**Short Sleep**	**Long Sleep**
GSS (low)	Reference	Reference
GSS (moderate)	1.02 (0.88, 1.17) p = 0.8402	0.91 (0.66, 1.26) p = 0.5666
GSS (high)	1.13 (0.95, 1.33) p = 0.1626	1.28 (0.89, 1.83) p = 0.1817

Model 1 –adjusted for sex, age

Model 2 – Model 1 + occupation + education

Model 3 – Model 2 + smoking + physical activity + alcohol use

Model 4 – Model 3 + hypertension + BMI + CVD history

Model 5 – Model 4 + discrimination

Model 6 – Model 5 + global perceived stress

*significant p-value

Table 4 –

The cross-sectional association between Goal-Striving Stress tertiles and Sleep Quality at baseline

	Odds Ratios of Low Sleep Quality (vs High Sleep Quality) on a 95% Confidence Interval
Model 1	
GSS (low)	Reference
GSS (moderate)	1.10 (0.96, 1.27) p = 0.2068
GSS (high)	*1.64 (1.41, 1.92) p < 0.001
Model 2	
GSS (low)	Reference
GSS (moderate)	1.12 (0.97, 1.30) p = 0.1244
GSS (high)	*1.62 (1.38, 1.89) p < 0.0001
Model 3	
GSS (low)	Reference
GSS (moderate)	1.12 (0.97, 1.30) p = 0.1308
GSS (high)	1.60 (1.36, 1.87) p < 0.0001
Model 4	
GSS (low)	Reference
GSS (moderate)	1.10 (0.96, 1.29) p = 0.1645
GSS (high)	*1.57 (1.34, 1.84) p< 0.0001
Model 5	
GSS (low)	Reference
GSS (moderate)	1.09 (0.94, 1.15) p = 0.2583
GSS (high)	*1.48 (1.26, 1.73) p< 0.0001
Model 6	
GSS (low)	Reference
GSS (moderate)	0.99 (0.85, 1.26) p = 0.9161
GSS (high)	*1.20 (1.01, 1.43) p = 0.0349

Model 1 –adjusted for sex, age

Model 2 – Model 1 + occupation + education

Model 3 – Model 2 + smoking + physical activity + alcohol use

Model 4 – Model 3 + hypertension + BMI + CVD history

Model 5 – Model 4 + discrimination

Model 6 – Model 5 + global perceived stress

*significant p-value

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