Having Sleep Conditions Can Give You Higher Levels of Stress

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Abstract: This is an observational study assessing patients with sleep disorders enrolled in a sleep management training program intended to improves their levels of stress, specifically with respect to anxiety, depression, and distress. By analyzing this population and applying various statistical models, we found that people with sleep disorders, on average, have higher initial levels of stress than people without sleep disorders.

Abbreviations: Sleep Management Training (SMT), Sleep Assessment Questionnaire (SAQ), Obstructive Sleep Apnea (OSA), Nonrestorative Sleep (NRS), Excessive Daytime Sleepiness (EDS), Delayed Sleep Phase Disorder (DSPD), Restless Legs Syndrome (RLS)

Introduction

This study examines how levels of stress, including anxiety, distress, and depression change in people with sleep disorders that complete the Stress Management Training (SMT) program. The sleep assessment questionnaire (SAQ) is a measurement for the number and severity of sleep disorders and is comprised of several components: insomnia, obstructive sleep apnea (OSA), nonrestorative sleep (NRS), excessive daytime sleepiness (EDS), delayed sleep phase disorder (DSPD), and restless legs syndrome (RLS). The SMT program consists of seven weeks of classes that teaches methods to reduce stress, such as relaxation techniques and breathing exercises. Each patient was required to fill out a questionnaire at entry and completion of the program which measured their levels of stress.

The primary research question is whether or not patients with sleep conditions benefit less from SMT program. If in fact, patients benefit less, we want to identify which specific sleep conditions are preventing patients from improving their levels of stress. The results of this analysis may provide insight into who the SMT program should be recommended to. The secondary research question is whether or not patients with sleep conditions have higher levels of stress than people without sleep conditions. We can compare the results of this analysis to the improvement of all patients. If the improvement due to the program is smaller than the difference between people with and without sleep disorder then it would not be effective to enrol patients with sleep disorders in the program. Conversely, if the improvement is larger than the difference between people with and without sleep disorders then the program is still effectively improving their levels of distress, anxiety, and depression irrespective of having sleep disorders.

The subsequent sections will describe in detail a summary of the data, statistical methods used to analyze the data and the results, interpretation of the results, and limitations of this study. Linear mixed models were used to answer the primary research question, logistic regression models were used to assess the correlation between covariates and drop-out / participation and two-sample t-tests were used to assess differences in means of our covariates for the secondary research question. Finally, several limitations will be discussed that may have hindered the results of our analysis.

Data summary and manipulation

Table 1 shows a general overview of the population in terms of how many patients had SAQ data available and statistics on the stress levels. SAQ is given to us as both continuous and binary variables, however for the binary variable, the cutoff for high SAQ is relatively low while the range of SAQ in this population is very large leading to a very disproportionate grouping in sample size. In order to have more equal categories, we split up the largest category in while maintaining the cutoff which is standard for the SAQ measurement.

Table 1.

	Time 1		Time 2	
	Female (n=66)	Male (n=83)	Female (n=66)	Male (n=83)
SAQ present				
Yes	50 (75.8%)	65 (78.3%)	50 (75.8%)	65 (78.3%)
No	16 (24.2%)	18 (21.7%)	16 (24.2%)	18 (21.7%)
Anxiety				
Mean (SD)	17.6 (9.31)	13.0 (10.3)	14.3 (10.3)	11.9 (8.22)
Median [Min, Max]	15.0 [1.00, 37.0]	11.0 [0.00, 62.0]	11.0 [3.00, 48.0]	10.0 [0.00, 43.0]
Missing	0 (0%)	1 (1.2%)	30 (45.5%)	50 (60.2%)
Depression				
Mean (SD)	16.4 (12.1)	14.6 (11.4)	11.8 (10.1)	11.4 (8.58)
Median [Min, Max]	15.0 [0.00, 49.0]	12.0 [0.00, 51.0]	9.00 [0.00, 47.0]	9.00 [1.00, 35.0]
Missing	0 (0%)	0 (0%)	30 (45.5%)	51 (61.4%)
Distress				
Mean (SD)	8.23 (4.87)	7.02 (4.96)	5.91 (3.80)	5.42 (3.28)
Median [Min, Max]	7.00 [0.00, 22.0]	6.00 [0.00, 22.0]	5.00 [1.00, 20.0]	5.00 [1.00, 13.0]
Missing	1 (1.5%)	0 (0%)	29 (43.9%)	50 (60.2%)

Figure 1.

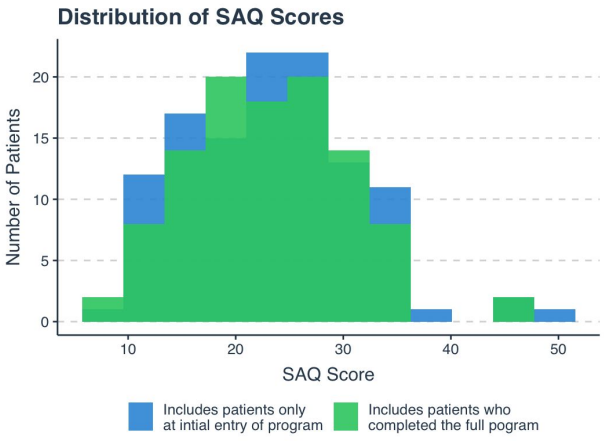


Figure 2.

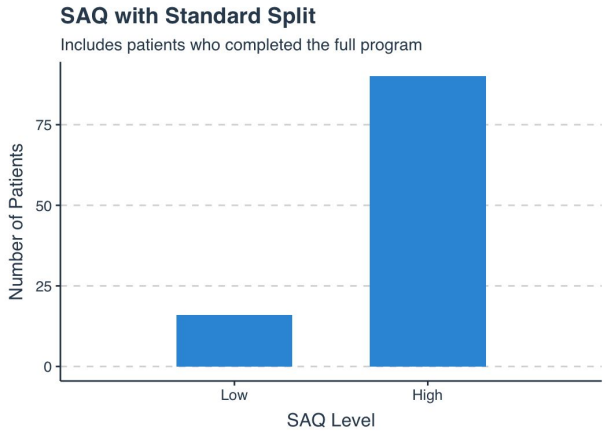
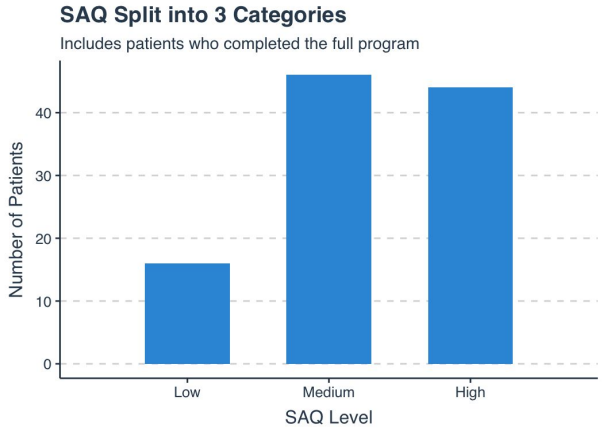


Figure 3.



Methods

In order the answer the question of whether or not patients with sleep disorders benefit less from the SMT program, we measured the interaction effect between time and SAQ or sleep disorders. In other words, we examined the change in stress separately in each category of SAQ and sleep disorder.

Linear mixed model

To model this interaction effect, we can use a linear mixed model because patients are independent of each other and we can treat patients' idiosyncrasies as random effects in our models. We fit multiple linear mixed models for each response variable (anxiety, depression, distress): models with SAQ split by three categories, the individual disorders, the total number of disorders as covariates. Time as a covariate and a subject level random effects were included in all models. All these models include various methods of treating sleep disorders as a variable in order to have different interpretations of the results, however they all essentially capture the same information. Potential confounding variables include external sources of stress (work, home, and financial), and PTSD. To account for confounding effects, we also included these variables in our models.

Logistic regression model

We fit a logistic regression model to determine if patient drop-out and participation is correlated with the sleep conditions. We can obtain the likelihood that a patient will complete the program given that they have sleep disorders. This could potentially invalidate our analysis of our primary research question because it would mean that the data is not missing at random. This could be important because if patients with sleep disorders are likely to drop-out then it would not be ideal to enrol these patients to begin with. Furthermore, if the patients with the highest stress levels drop out, it will lead to skewed results.

Two-sample t-test

By using a two-sample t-test, we can determine if having a specific disorder will result in initially higher levels of stress in order to address our secondary research question. We will conduct a two-sample t-test on each disorder for anxiety, depression, and distress.

Results

Figure 4 and 5 are indicative of the presence of an interaction effect between SAQ/sleep disorder and time. We expect to see that patients with high SAQ scores will not benefit as much as people with low SAQ scores because the SMT program is not targeting their sleep disorders. This is illustrated by a shallower slope in high SAQ and a steeper slope in low SAQ. For stress levels split by sleep disorders, OSA and insomnia seem to hinder patients' abilities to improve their stress levels compared to other disorders. A similar story can be illustrated with depression and distress (see figures 8-11 in the appendix).

Figure 4.

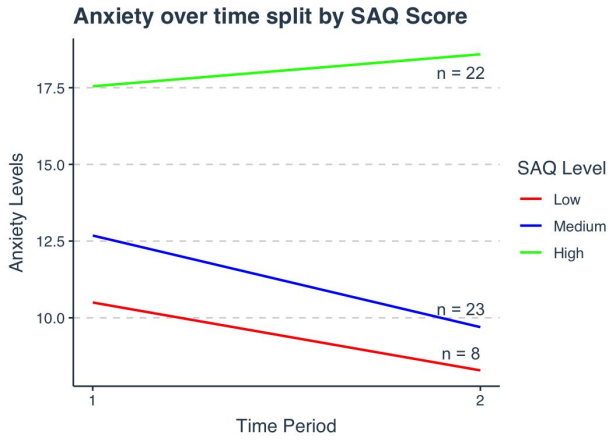
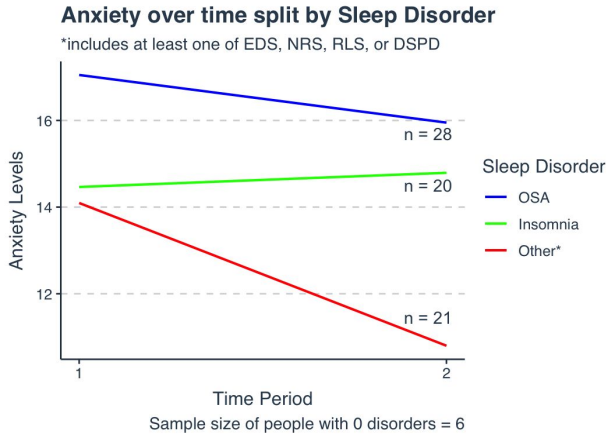


Figure 5.



After running the linear mixed models to determine whether or not there was a true interaction effect, only 2 of the results were significant: distress over time split by three categories SAQ score (t-value = +2.27, p-value = 0.03, n = 53) and depression over time split by the number of sleep disorders a patient had (t-value = -2.33, p-value = 0.02, n = 67). However, this method was considerably limited by the sample size which leads to poor statistical power and high variability so these results are not very reliable.

The logistic regression model to determine patient drop-out and participation shows that in general, sleep disorders and levels of stress do not correlate with drop-out and participation. Only DSPD resulted in a significant finding (z-value = 2.18, p-value = 0.03) indicating that patients with DSPD are more likely to drop out of the program.

Since our analysis was not very conclusive, it may be a good idea to answers our secondary research question: Whether or not people entering the program with sleep disorders have initially higher levels of stress and if this difference is larger than the improvement of an average patient due to the program. Figure 6 shows side-by-side boxplots of the stress levels of each sleep disorder and illustrate differences between having and not having a condition. After testing the significance with two-sample t-tests, we can note that the majority of the results for each sleep disorders are statistically significant (table 2) indicating that there is sufficient evidence that there exists a true difference in stress between having and not having the condition.

Table 2: Mean differences in stress levels per disorder

Condition	# Cases	# Non-cases	Anxiety	Depression	Distress
DSPD	41	93	**4.0** (0.07)	**6.0** (0.01)	**2.6** (0.007)
EDS	60	85	3.0 (0.06)	**5.0** (0.01)	**2.4** (0.008)
Insomnia	50	87	**5.0** (0.01)	**6.0** (0.02)	2.1 (0.3)
NRS	99	40	**8.4** ($\ll 0.01$)	**8.4** ($\ll 0.01$)	**3.0** (< 0.01)
OSA	60	82	1.0 (0.5)	2.0 (0.2)	1.0 (0.3)
RLS	85	62	**4.0** (0.01)	**5.0** (0.008)	1.0 (0.2)

Note format: coefficient (p-value)

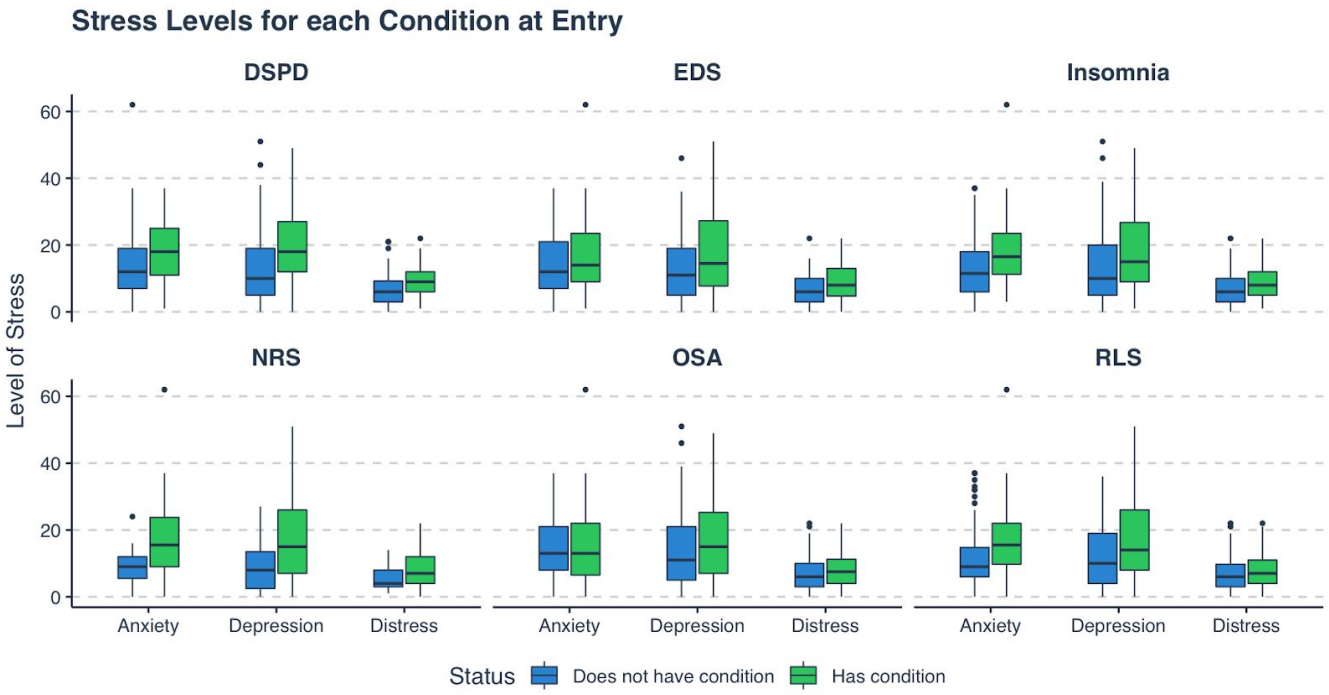
The findings of the two-sample t-tests can be compared to the linear mixed models of using just time as a covariate. The linear mixed models indicate that on average individual who complete the SMT program improve their levels of stress (table 3).

Table 3: Improvement of stress levels in all patients

Anxiety	Depression	Distress
1.8 (0.05)	2.6 (< 0.01)	1.5 ($\ll 0.01$)

For example, patients with EDS enter the program 2.4 points higher in their levels of distress compared to patients without EDS and improve only 1.50 points from the program. Even though their stress levels decreased, they started the program at much higher levels so it would be much better if they addressed their sleep conditions prior to entering the program. This is conditional on if treating their sleep disorders can bring their levels of stress down to the levels of the people without sleep disorders. This gives us a good indication of the initial stress levels attributable to the six sleep conditions.

Figure 6.



Discussion

The aim of this study was to determine whether or not patients with sleep conditions benefit less in the SMT program and although visualization of the data was suggestive of significant findings, we were limited in statistical power by a very small sample size and were unable to detect significant differences that in theory, should have been apparent. All the results except for DSPD for drop-out and participation were not significant meaning that none of the variables influenced drop-out or participation. This is a good sign in our case because it tells us that our original analysis is correct and is not invalidated by evidence that data is missing not at random. We did not find evidence of data missing not at random but we did not prove that the data is missing at random.

Although we could not definitively answer our primary research question, we did find that in general, people with sleep disorders have, on average, initially higher levels of stress. If we examine the distribution of sleep disorders within the population, it remains fairly constant after completion of the program which indicates the program is not improving a specific sleep condition (see figure 7 in appendix). We found that people with sleep disorders typically have higher levels of anxiety, and depression, and distress entering the program and that difference is larger than the improvement of the average patient, thus they will not be better off than any other individual in the SMT program.

Between the two measurement times, unfortunately there was a large proportion of patients who dropped out of the program so we could really only use around 30-40% of the total population for the analysis of our primary research question. This is one of the largest limitations to this analysis and the sample sizes get even smaller when we make more categories. We addressed this issue while still answering an important question by comparing the improvement of all patients with the initial levels of distress, anxiety, and depression of patients with sleep disorders.

A limitation to this study that can be improved is missing data not due to drop-out. We cannot control the patients who drop-out of the program but we can make all questions in the questionnaire mandatory so there are no missing answers.

Another limitation includes the fact that we did not have a significant control group for sleep disorders. We only had 6 patients without any sleep disorders which is simply not enough data to make any conclusions on the levels of stress of a patient with multiple sleep disorders in comparison to someone without any sleep disorders.

The findings for the primary research question were inconclusive overall but were suggestive of being consistent with the underlying theory. However, our secondary research question provided context to how sleep disorders affect stress levels. This pilot study provides a solid foundation for future research as it identifies sleep conditions that are related to elevated levels of stress. Future researchers may benefit from conducting a power analysis in order to determine a sufficient sample size for more robust results and having access to a more comprehensive questionnaire to have higher quality data.

Appendix

Figure 7.

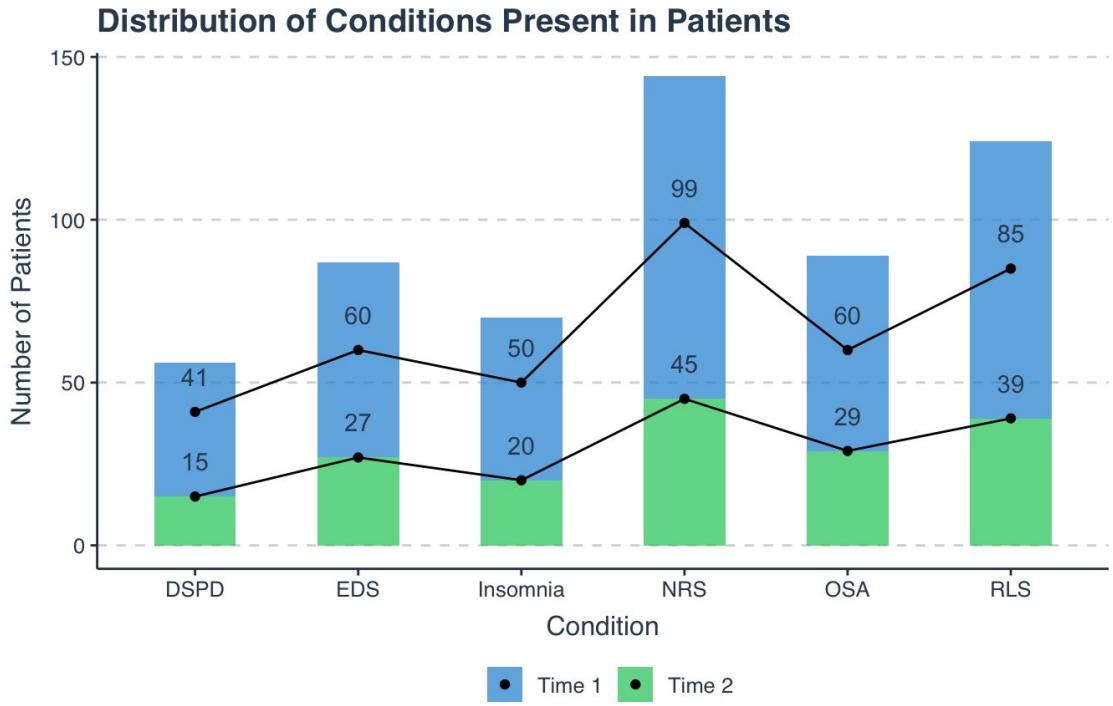


Figure 8.

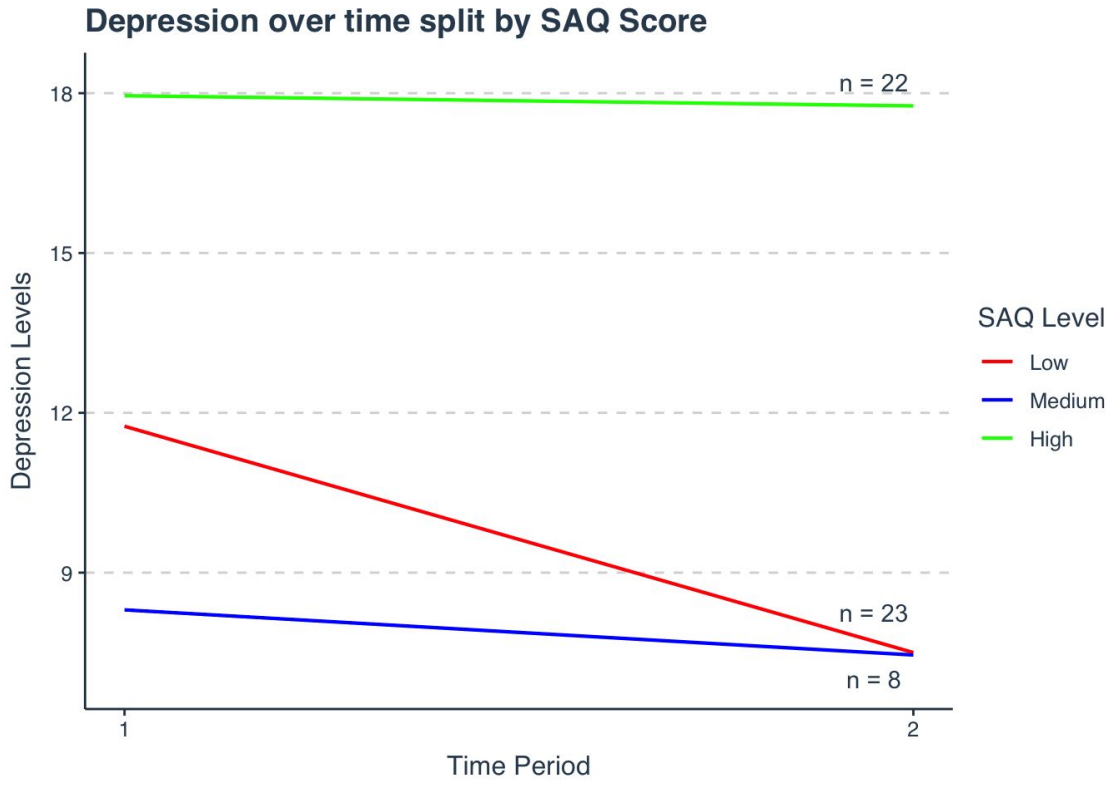


Figure 9.

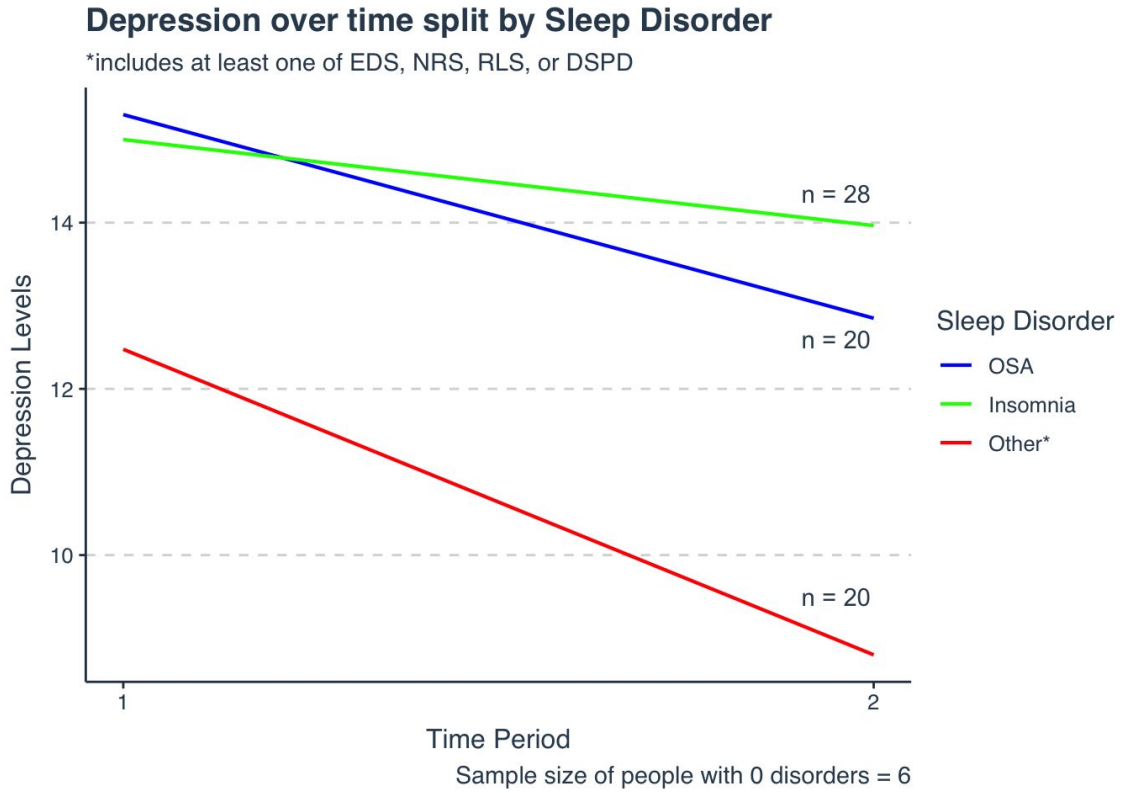


Figure 10.

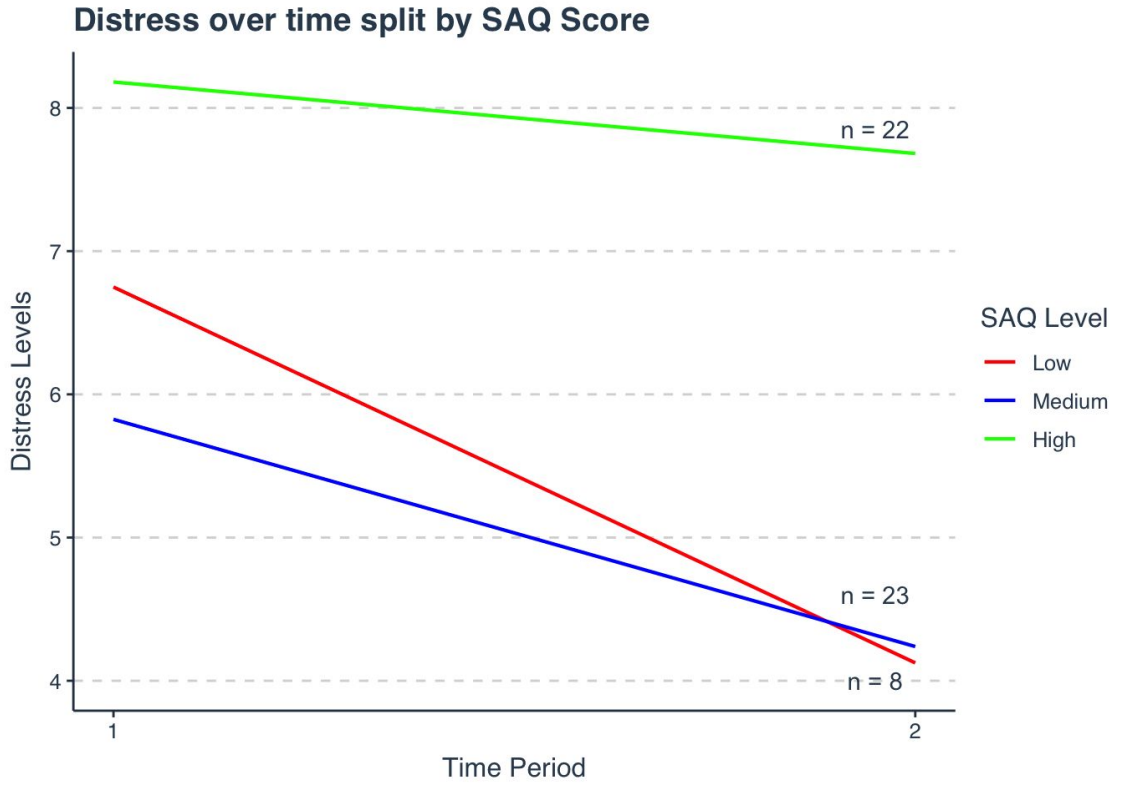
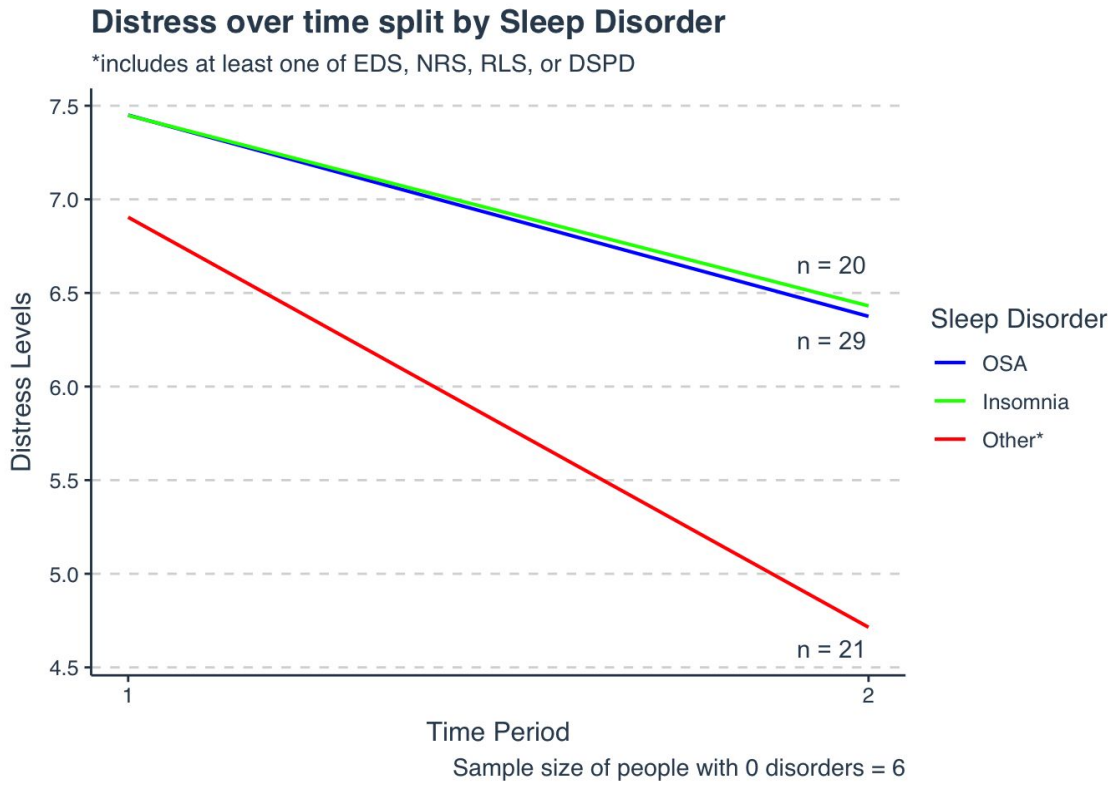


Figure 11.


Distress over time split by Sleep Disorder
*includes at least one of EDS, NRS, RLS, or DSPD
Distress Levels
7.5
7.0
6.5
6.0
5.5
5.0
4.5
1
2
Time Period
n = 20
n = 29
n = 21
Sleep Disorder
OSA
Insomnia
Other*
Sample size of people with 0 disorders = 6