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PII: S1389-9457(22)01129-7
DOI: https://doi.org/10.1016/j.sleep.2022.09.001
Reference: SLEEP 5371

To appear in: Sleep Medicine

Received Date: 10 February 2022
Revised Date: 18 July 2022
Accepted Date: 2 September 2022

Please cite this article as: McKinley B, Daines B, Allen M, Pulsipher K, Zapata I, Wilde B, Mental health and sleep habits during preclinical years of medical school., Sleep Medicine (2022), doi: https://doi.org/10.1016/j.sleep.2022.09.001.

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AUTHORS CONTRIBUTIONS

Blake McKinley, Bryan Daines, Mitchell Allen, Kayd Pulsipher: Conceptualization, Methodology, Investigation, Writing - Original Draft. Isain Zapata: Methodology, Formal Analysis, Data Curation, Supervision, Visualization, Writing – Original Draft, Review & Editing. Benjamin Wilde: Conceptualization, Methodology, Project Administration
Mental health and sleep habits during preclinical years of medical school.

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No special funding was received for the realization of this study.

The authors have no financial or personal conflicts of interest to declare that are associated with the presented study.
Blake McKinley, Bryan Daines, Mitchell Allen, Kayd Pulsipher: Conceptualization, Methodology, Investigation, Writing - Original Draft. Isain Zapata: Methodology, Formal Analysis, Data Curation, Supervision, Visualization, Writing – Original Draft, Review & Editing. Benjamin Wilde: Conceptualization, Methodology, Project Administration

HIGHLIGHTS

- Going through medical school is a big challenge for students.
- Medical school has a cyclical negative impact on mental health and sleep habits.
- Inherent rigors of medical school overshadow any effect that the pandemic may have.
- Students tend to wrongly attribute their declining state to the pandemic.
ABSTRACT

OBJECTIVES: The purpose of this non interventional study was to define changes in anxiety, depression, and sleep quality of medical students in their first two years of medical school while considering potential risk factors of self-reported chronic disease, sleep quantity, year of medical school and exercise habits. Since this study was ongoing during the COVID-19 pandemic, its effect was also evaluated.

PARTICIPANTS/METHODS: A cohort of 197 medical students was evaluated longitudinally using survey methods to quantify changes from pre-medical school and summer break to each semester in medical school throughout years one and two. This study was performed from July 2019 through June 2021. Data was analyzed using Generalized Linear Mixed Models (GLMMs) on the numeric responses of General Anxiety Disorder-7 (GAD-7), Patient Health Questionnaire-9 (PHQ-9), Sleep Quality (SQ-3) and Pittsburg Sleep Quality Index (PSQI). Additional assessments evaluated exercise habits, chronic disease, and impact of COVID-19 Pandemic. The COVID-19 Pandemic was evaluated directly in the model (pre- and post-COVID-19 period variable), and through additional questions on their perceived effect.

RESULTS: Depression, anxiety, and sleep habits displayed a cyclical change that was associated with the academic/seasonal cycle. The COVID-19 pandemic was never found significant. Medical students who had a chronic disease diagnosis and fewer hours of sleep had increased severity. Exercise did not play a role.

CONCLUSION: Based on our sample, the main driver for depression, anxiety, and poor sleep quality appears to be the academic/seasonal cycle, while the COVID-19 pandemic did not have an impact on mental health.

KEYWORDS: Medical school, GAD-7, PHQ-9, PSQI, exercise, chronic disease, sleep quality, COVID-19
1. INTRODUCTION

During the first two years of medical school, students are expected to reprioritize their lives to meet the long hours of lecture material, laboratory sessions, and study for both school and national exams. To be competitive for residency, students also devote considerable time to extracurricular activities such as volunteer, work, and research experiences. The schedule of students prior to medical school is often less demanding than that of a medical student. Increased demands may account for the higher rates of burnout and mental illness reported in enrolled medical students compared to the general population. Multiple studies have discovered a correlation between medical school enrollment and changes in mental health, including increased levels of depression, anxiety, stress, and burnout. These feelings of burnout and depression persist in medical residents and physicians. The ability to identify risk factors that contribute to mental health deterioration in medical students can have implications for residents and physicians.

Risk factors which impact mental health include sleep quality and quantity, exercise, and chronic disease. Arguably, poor sleep quality has the most significant association with poor mental health in medical students. It is associated with increased stress, anxiety, and depression among medical students. College students that present with depressive symptoms have greater comorbid anxiety when they experience sleep disturbances. Students with depressive symptoms rate sleep quality as poor and experience increased somnolence in class. Poor sleep quality, decreased quantity, and increased depression levels are independent predictors of burnout and have a strong association with decreased mental health. Additionally, reduced incidence rates of depression and some anxiety disorders have been observed in exercising individuals; exercise has even been shown to be an effective treatment of depression, and to a lesser extent anxiety. Likewise, chronic disease has been shown to lead to depression and anxiety. Additionally, depression, anxiety, and sleep disorders have been linked to the COVID-19 pandemic among the general public. Studies have noted that college
students are anxious regarding cancellation of examinations and academic events. These disruptions are likely to contribute negatively to students’ mental health.

Anxiety and depression were chosen as metrics to evaluate mental health along with sleep quality due to its strong association with them. The purpose of this non interventional study was to define changes in anxiety, depression, and sleep quality of medical students in their first two years of medical school while identifying associated risk factors. The following risk factors were considered: chronic disease, sleep quantity, year of medical school, class year, exercise habits, and COVID-19 pandemic. The novelty of this study is that it allows medical schools to better understand the dynamics of mental health and sleep patterns on their students, enabling them to develop strategies to help students minimize mental distress. Additionally, by determining the effectiveness of assessment tools and their association to risk factors, it will be possible to have reliable methods to monitor and detect students at risk. It is important to improve the well-being of medical students, as they will become future physicians providing an important service to our society.

2. MATERIALS AND METHODS

2.1 Participants and study approach

An invitation to participate in this non-interventional study was delivered to all enrolled students in the class of 2023 and the class of 2024 in a medical school (in the United Stated, accredited by the HLC and COCA) with two separate campuses, the inclusion criteria was being a medical student currently enrolled at the specific level (first or second year). Follow-up survey invitations were emailed to those students that signed the informed consent to participate in this study and completed the first survey. Exclusion criteria was students that did not complete a consent form or did not meet the requirements for enrollment for the semester. An outline of the study is presented in Figure 1.
No compensation was provided for participation, which was voluntary. All participants consented prior to participating. The project was reviewed by the Rocky Vista University Institutional Review Board with the corresponding IRB# 2019-0070. The project was deemed exempt from a full IRB review. No specific funding was received to conduct this study.

2.2 Surveys

Surveys assessed underlying chronic disease, sleep quantity and quality, exercise habits, and depression and anxiety. A chronic disease was specified as one diagnosed by a physician, this was done to reduce the risk of including self-diagnosed conditions. Sleep quantity was assessed as average hours of sleep per night over the last month. Sleep quality was assessed the first year of the study with three questions that incorporated graded responses to quantify sleep quality changes (SQ-3). Although the sleep quality questions were common questions used in other studies to quantify sleep quality, they have never been used in this format. These specific questions are (rated on a likert scale): “On average, how many times throughout the week do you feel the inclination to fall asleep during the day?” “On average, how often do you feel tired or fatigued after you sleep?” “During your waking time, do you feel tired, fatigued, or not up to par?”. The Pittsburgh Sleep Quality Index (PSQI)\(^27\) was added in the survey for the Summer ‘20 to supplement the evaluation of sleep quality. Exercise was assessed as days per week and minutes per session with total weekly minutes being calculated. To assess mental health, validated questionnaires were used to analyze levels of anxiety and depression, Generalized Anxiety Disorder-7 (GAD-7) and Patient Health Questionnaire-9 (PHQ-9), respectively\(^28,29\). Therefore, all subjective measurements were assessed with previously validated questionnaires. Three additional questions were added to evaluate for self-reported effects of COVID-19 in the summer survey of 2020 (Likert scale (strongly disagree, disagree, neither agree or disagree agree, and strongly agree). These questions were: “COVID-19 has caused me to experience higher levels of depression over the two weeks before orientation.” “COVID-19 has caused me to experience higher levels of anxiety over the two
weeks before orientation.” “COVID-19 has caused a decrease in my quality of sleep during the past month.” All data provided by the participants was self-reported. The survey used is available as a supplementary file.

2.3 Statistical Analysis

Data was analyzed using Generalized Linear Mixed Models (GLMMs) on the numeric responses of SQ-3, GAD-7, PHQ-9 and PSQI. These models included fixed effects of class year (class of 2023/class of 2024), COVID-19 period (Pre-/ Post-), specific time points (Summer ’19 through Spring ’21), chronic disease diagnosis (Yes/No), average number of sleep hours (hours), and total exercise per week (minutes). Repeated measurements by participants were included in the models as a random effect. All models assumed errors to be normally distributed with mean zero and variance of $\sigma^2$. All modeling and descriptive statistical evaluations were performed with SAS v.9.4 (SAS Institute, Cary, NC). Statistical significance was declared at a confidence level of 95%.

The analysis was performed on three separate cohorts defined by the time points and class years. The first modeling analysis was performed on the full dataset which included both classes of 2023 and 2024, this cohort did not analyze COVID-19 specific questions. The second modeling analysis did include the COVID-19 specific questions. The third, and last modeling analysis, was performed only on the class of 2023 cohort, this was done to separate the effect of participants from the class of 2024 that had only been in medical school during the pandemic. This separate cohort approach was devised to reduce any possible bias introduced by environmental confounders derived from the COVID-19 pandemic. This study was ongoing while the pandemic developed and thus decisions were made based on available data.

3. RESULTS
The total number of participants in the study was 197. 85 out of 130 students participated from the class of 2023 and 112 out of 145 students participated from the class of 2024. Participant frequencies are summarized in Table 1 by COVID period, time point, and chronic disease diagnosis. A summary of the data is presented in Table 2. The full correlation analysis of variables used in the analysis is presented in a Supplementary File. Here we observed that SQ-3, which is a variable not previously validated, displayed a significant correlation ($P<0.0001$) to GAD-7, PHQ-9 and PSQI ($r=0.43, 0.60$ and $0.50$ respectively). Validated assessment metrics GAD-7 displayed a significant correlation ($P<0.0001$) to PHQ-9 and PSQI ($r=0.77$ and $0.45$ respectively) and last, PHQ-9 displayed a significant correlation to PSQI ($r=0.55$). Internal consistency assessment through standardized Cronbach’s alpha was 0.6909 when all variables analyzed are evaluated together and 0.8576 when only the psychological items are evaluated (SQ-3, GAD-7, PHQ-9, PSQI and the three COVID specific questions). It is important to recognize that only one of the 7 components in the calculation of the PSQI is hours of sleep, favoring the correlation with the PSQI. Thus, the addition of the SQ-3, with a continuous effect consideration of hours of sleep is important when evaluating the effect of sleep quality.

The GLMM modeling analysis used in this study allows for simultaneous evaluation of effects such as class year, COVID-19 period, differences across time points, chronic disease, average sleep hours, and total exercise. Therefore, estimation for individual effects on SQ-3, GAD-7, PHQ-9, and PSQI is already adjusted for other effects in the model. Figure 2 presents the differences across time points for the study’s full dataset. Significant variations were observed across time points with similar trends in the individual analysis of SQ3, GAD-7, PHQ-9, and PSQI. Pre-medical school for class of 2023 (Summer ‘19), 2024 (Summer ‘20) and summer break for class of 2023 between year 1 and 2 of medical school (Summer ‘20), reported significant lower scores for all time points. When analyzing the differences across time points, a lower number of sleep hours and having a diagnosis of chronic diseases significantly increased SQ-3, PHQ-9, and PSQI. The differences across time points and having a diagnosis
of chronic diseases significantly increased GAD-7. P-values for these associations are presented in Table 3. A separate evaluation of time points (pre-medical school, fall semester, and spring semester of year one) for individual class year cohorts (class of 2023 and class of 2024) displayed the same pattern (data not shown).

The full data was then evaluated again but included the three additional variables of self-reported change of anxiety, depression, and sleep quality due to COVID-19; labeled as “COVID-19 Anxiety,” “COVID-19 Depression,” and “COVID-19 Quality of sleep” and measured in a five-point Likert scale. The self-reported COVID-19 variables displayed significant associations to SQ-3, GAD-7, PHQ-9 and PSQI scores; differences across time points had a significant effect on GAD-7 and PSQI; having a chronic disease diagnosis had a significant effect on SQ3, PHQ-9, and PSQI; average sleep hours had a significant effect on SQ-3 and PSQI; COVID-19 Depression had a significant effect on SQ-3, GAD-7, PHQ-9, and PSQI; COVID-19 Anxiety had a significant effect on GAD-7; and COVID-19 Quality of sleep had a significant effect on SQ-3 and PSQI. No other variables had a significant effect. These associations are presented in Table 3.

The data was analyzed again but only for the class of 2023, excluding all data from the class of 2024, with variables of COVID-19 period, differences across time points, chronic disease, average sleep hours, and total exercise accounted for when assessing for the individual effect on SQ3, GAD-7, PHQ-9, and PSQI. Time point change had a significant effect on SQ-3, GAD-7, PHQ-9; having a chronic disease diagnosis and average sleep hours had a significant effect on SQ-3, GAD-7, PHQ-9, and PSQI. No other variables had a significant effect. These associations are presented in Table 3.

In summary, the evaluations of differences across time points, along with the consideration of the effect of the COVID-19 pandemic, that was never significant, suggests that the stress of being a medical student, having a chronic disease diagnosis, and getting fewer hours of sleep lead to increased levels of anxiety and depression that promotes a cyclical pattern of decreased sleep quality.
4. DISCUSSION

4.1 Mental health and sleep habits

Medical school has a significant effect on sleep quality, depression, and anxiety. The majority of analyses are cross sectional studies that are an assessment of one time point, relying on other studies to provide context for their findings. However, the longitudinal analysis of students in this study uniquely allowed the quantification of the change from pre-medical school and summer break to each semester in medical school throughout years one and two, allowing students to act as their own controls and reducing confounding factors. The results across time points displayed a cyclic change in mental health and sleep quality of medical students that was associated directly with the academic/seasonal calendars.

There is great variability in the literature in sleep quality, depression, and/or anxiety of medical students. The reported percentages of students that suffer from poor sleep quality range from 55.8-76%, anxiety from 41-73%, and depression from 10.4-65%. This variation is due in part to the lack of standardized assessment tools to assess anxiety, depression, and sleep quality in medical students, leading to a variety of assessments being used. Additionally, it is difficult to account for the different structures and expectations within medical schools around the world. As such, this study does not compare the percentages of total anxiety, depression, and sleep quality to other analyses, but assesses the longitudinal change.

The medical school assessed in this study is structured similarly to the general model of medical schools throughout the United States: 4-year curriculum divided into two years of basic science coursework followed by two years of clinical clerkships. This study evaluated students in their first two years of basic science coursework noting no significant difference in anxiety, depression, and/or sleep quality.
quality between year one and year two. However, differing levels of anxiety, depression, and sleep quality have been observed in other studies when all years of training are considered.\textsuperscript{32,38}

The analysis revealed that class year (class of 2023 versus class of 2024) and exercise habits had no effect on mental health or sleep quality. Although exercise has shown to cause reduced incidence of anxiety and depression in the general population\textsuperscript{16}, this study suggests that there is no significant effect in medical students.

The presence of chronic disease, diagnosed by a physician (self-reported), corresponded with higher anxiety and depression levels with decreased sleep quality. A systematic review of 20 studies outlined that chronic disease may be interrelated to anxiety/depression, one causing the other or both potentially exacerbating each other\textsuperscript{17}. A potential explanation for this finding could be that people have a limited ability to compensate for stress. Thus, when students are living with a chronic illness, their level of stress is already higher than average; when the pressures of medical school are added, they are limited in their reserve to compensate healthily and are more susceptible to developing mental illness.

Fewer hours of sleep were shown to have a negative effect on sleep quality and mental health. Number of hours of sleep was shown to affect depression levels more than anxiety levels. Evidence suggests that sleeping less than six hours leads to the development of chronic disease\textsuperscript{39}, a risk factor for increased anxiety, depression, and poor sleep quality. One study found that medical students often sacrifice sleep to meet the demands of school\textsuperscript{13}. Helping students prioritize sufficient hours of sleep each night could have long term benefits.

This analysis provides insight into areas that medical schools may focus, including sleep patterns and mental health. “Good” sleep improves academic performance\textsuperscript{40} and medical students who are sleep deprived have significantly lower GPAs\textsuperscript{41}. Anxiety, depression, and stress lead to poor academic performance in medical students\textsuperscript{42,43}. Students often recognize these problems and perceive their effect on their academic performance\textsuperscript{22}, but do not always know how to receive help. At a United States
medical school where confidential mental health services were available, only 26.5% of the identified depressed students reported treatment. Notably, 20.4% of the depressed students reported experiencing suicidal ideation. Medical student mental health is a serious and prevalent issue that requires more attention.

Medical schools should focus on student health promotion emphasizing the importance of sleep and mental health. One suggestion to help prevent depression is to educate students on appropriate sleep hygiene and encourage students to pursue professional guidance to treat sleep disturbances. Another suggestion is for medical schools to institute stress coping mechanisms and improvement of interpersonal relationships. A well-being curriculum or targeted interventions that have shown some promising results at the college level could also be considered. Curriculum additions and interventions can be challenging to implement because of the rigid and saturated curricula that is often followed for medical education in the United States. However, this study offers understanding of the patterns at which advertisement and outreach of current services can be more appreciated.

4.2 Assessment of the impact of COVID-19

The COVID-19 pandemic arose about halfway through the data collection period of this study causing the incorporation of a virtual learning environment to encourage social distancing. The pandemic has had a negative impact on depression, anxiety, and sleep disorders. However, other studies report increases in sleep among college students.

In this study, the effect of COVID-19 was evaluated in two ways: first, by evaluating directly its effect in the model (pre- and post-COVID-19 period variable) and second, by comparing the first three time points (Summer ‘19 - Spring ‘20), to the corresponding seasons of the following year: time points 4-6 (Summer ‘20 - Spring ‘21). On the full dataset, there were no differences across time points for the same season of the year regardless of pre- or post-COVID-19 period variable, suggesting that COVID-19 did not significantly contribute to anxiety, depression, or sleep quality. To further account for
confounding effects of putting together two classes (2023 and 2024), the analysis was also run with only
the class of 2023. Findings revealed that the COVID-19 period had no significant effect on any scores.
Similarly, a recent report showed the effect of the COVID-19 pandemic on stress and sleep was not
necessarily negative and suggested that college students are largely resilient. After the COVID-19
pandemic started, 3 questions were added to the surveys to measure the self-reported effect of COVID-
19 on sleep quality, anxiety, and depression. The results indicated worse outcomes in all three
categories. However, change in anxiety, depression, and sleep quality as assessed by GAD-7, PHQ-9, and
SQ-3, respectively, were not significant. These findings suggest that students are unable to recognize the
cause of their decline in mental health but are more likely to blame the pandemic than medical school.

4.3 Limitations and future directions

This study comes with important caveats. First, it is important to note that the cyclical
fluctuation that we attributed to the academic year has some confounding with the seasonal calendar.
In the northern hemisphere, it is traditional to start the academic year during the fall and end in the
summer. It would be interesting to have the opportunity to evaluate these effects in alternate locations
where the seasonal calendar has different characteristics. This would allow for a more precise
estimation of these effects. Second, the patterns we present are representative of a very specific
subpopulation of students. Medical school in the United States comes after the completion of a
bachelor’s degree. These students are unlikely to be comparable to college students as they are older,
more mature and go through a heavy pre-selection process for medical school admission. Third, the
strategy and the setup of the COVID-19 assessment was opportunistic. The study was ongoing on the
first class when the pandemic occurred. Strategies to accommodate for the changing conditions were
introduced with the second class. Unfortunately, under these changing conditions, a true randomized
experimental approach was never feasible. Last, a limitation of this study is its representativeness across
institutions since data was collected from a single medical school consisting of two campuses. Also, the
sleep quality analysis added a standardized assessment, PSQI, that was not utilized in the first year.

Future research should expand the population surveyed across multiple universities and to include comparisons to other professions that require a terminal degree (graduate school, dentistry school, law school, among others) to better generalize results. This would expand the inference of our findings to students in similar maturity and age range. Furthermore, studies should incorporate third- and fourth-year medical students to provide data that spans the entire medical school training.

4.4 Conclusion

Based on our sample and considering the inherent limitations of our non-interventional study, we conclude that the first two years of medical school display changes in the levels of depression, anxiety, and poor sleep quality; we attribute this effect mostly to the academic and seasonal cycle. Self-reported chronic medical conditions and decreased total number of sleep hours were identified as risk factors for poor mental health and poor sleep quality among medical students. The COVID-19 pandemic did not have an effect we could isolate on medical student mental health or sleep patterns. Medical schools and students themselves should take an active role in addressing sleep patterns and mental health to achieve better well-being, improved academic performance, and ultimately become better physicians.

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FIGURE LEGENDS

Figure 1. Study timeline.

Figure 2. Time point effect estimates A) SQ-3. B) GAD-7. C) PHQ-9. D) PSQI. In all panels, brackets indicate pairwise differences at a P≤0.05 level. Error bars correspond to the Standard Error of Mean (SEM).
Table 1. Participants included in the study on the full dataset and by class year cohorts.

| Variable                          | Full Dataset N=197 | Class 2023 alone N=85 | Class of 2024 alone N=112 |
|-----------------------------------|--------------------|------------------------|----------------------------|
| **COVID-19 period**               |                    |                        |                            |
| Post (Summer ’20 – Spring ’21)   | 149                | 62                     | 112                        |
| Pre (Summer ’19 – Spring ’20)    | 83                 | 83                     | 0                          |
| **Time point**                    |                    |                        |                            |
| Summer ’19 (Oct 29 to Nov 13 Retrospective) | 83                 | 83                     | 0                          |
| Autumn ’19 (Oct 29 to Nov 13)    | 76                 | 76                     | 0                          |
| Spring ’20 (Apr 14 to May 11)    | 57                 | 57                     | 0                          |
| Summer ’20 (Jul 19 to Aug 05)    | 149                | 37                     | 112                        |
| Autumn ’20 (Oct 30 to Nov 24)    | 109                | 47                     | 62                         |
| Spring ’21 (Mar 23 to Apr 8)     | 124                | 48                     | 76                         |
| **Chronic disease (self-reported)** |                   |                        |                            |
| Yes                               | 53                 | 22                     | 31                         |
Table 2. Mean and Standard Deviations in the dataset.

| Variable                      | Full dataset | Class year | COVID-19 Period | Chronic disease |
|-------------------------------|--------------|------------|-----------------|-----------------|
|                               | Mean | Std | Mean | Std | Mean | Std | Mean | Std | Mean | Std | Mean | Std |
| Average Sleep Hours (Hours)   | 7.474 | 1.129 | 7.799 | 1.059 | 7.024 | 1.068 | 7.799 | 1.065 | 7.043 | 1.067 | 7.425 | 1.213 | 7.496 | 1.089 |
| SQ-3                          | 5.830 | 3.003 | 5.776 | 3.060 | 5.908 | 2.923 | 5.769 | 3.083 | 5.914 | 2.893 | 6.758 | 2.707 | 5.539 | 2.962 |
| Total exercise per week (Minutes) | 201.17  | 177.33 | 190.91  | 162.47 | 215.52 | 195.69 | 190.91  | 163.59 | 214.92 | 193.72 | 198.15 | 203.65 | 202.57 | 163.98 |
| GAD-7                         | 6.035 | 5.057 | 5.701 | 5.036 | 6.508 | 5.060 | 5.719 | 5.024 | 6.465 | 5.081 | 7.651 | 5.609 | 5.408 | 4.608 |
| PHQ-9                         | 5.127 | 5.055 | 5.065 | 5.084 | 5.216 | 5.022 | 5.029 | 5.013 | 5.262 | 5.119 | 7.016 | 5.878 | 4.362 | 4.399 |
| COVID-19 Depression            | -0.128 | 1.291 | -0.150 | 1.264 | -0.116 | 1.307 | -0.157 | 1.263 | -0.113 | 1.307 | 0.252 | 1.272 | -0.316 | 1.261 |
| COVID-19 Anxiety               | 0.232 | 1.366 | 0.128 | 1.305 | 0.288 | 1.396 | 0.157 | 1.318 | 0.270 | 1.390 | 0.583 | 1.288 | 0.059 | 1.372 |
| COVID-19 Quality of sleep      | -0.668 | 1.124 | -0.702 | 1.155 | -0.648 | 1.109 | -0.672 | 1.162 | -0.665 | 1.106 | -0.447 | 1.095 | -0.780 | 1.124 |
| PSQI                          | 5.864 | 3.190 | N/A | N/A | 5.940 | 3.195 | N/A | N/A | 5.902 | 3.181 | 7.291 | 3.185 | 5.150 | 2.949 |


**Table 3. Significance testing for each model’s included effects.** Significant associations are declared at $P \leq 0.05$ and are indicated in the table with an asterisk *. Columns correspond to the assessment tool evaluated while rows correspond to the $p$-value of such association. Outcomes for the three models are presented: full dataset, dataset including COVID-19 specific questions and class of 2023 alone.

| Effect                                           | SQ-3  | GAD-7  | PHQ-9  | PSQI  |
|--------------------------------------------------|-------|--------|--------|-------|
| **Full Dataset (N=197)**                         |       |        |        |       |
| Class year (2023/2024)                           | 0.7791| 0.3217 | 0.3614 | 0.4334|
| COVID-19 period (Pre-/Post-)                     | 0.7517| 0.4112 | 0.3310 | 0.4287|
| Time point (Summer ’19 - Spring ’21)            | 0.0002*| 0.0002*| 2.7E-08*| 0.0010*|
| Chronic disease (Yes/No)                         | 0.0001*| 0.0002*| 4.7E-06*| 3.0E-06*|
| Average sleep hours (Hours)                      | 0.0011*| 0.1048 | 0.0194*| 1.1E-22*|
| Total exercise per week (Minutes)                | 0.3193| 0.7204 | 0.6881 | 0.4997|
| **Including COVID-19 specific questions (N=149)**|       |        |        |       |
| Class year (2023/2024)                           | 0.7514| 0.5694 | 0.2957 | 0.6333|
| COVID-19 period (Pre-/Post-)                     | 0.6225| 0.5331 | 0.3392 | 0.5631|
| Time point (Summer ’19 - Spring ’21)            | 0.0740| 0.0246*| 0.0015*| 0.3576|
| Chronic disease (Yes/No)                         | 0.0064*| 0.1365 | 0.0106*| 2.9E-05*|
| Average sleep hours (Hours)                      | 0.0392*| 0.4755 | 0.2546 | 2.3E-23*|
| Total exercise per week (Minutes)                | 0.2364| 0.7981 | 0.0603 | 0.6362|
| COVID-19 Depression (Strongly disagree - Strongly agree) | 0.0002*| 0.0015*| 3.4E-07*| 0.0001*|
| COVID-19 Anxiety (Strongly disagree - Strongly agree) | 0.1507| 0.0080*| 0.9965 | 0.6306|
| COVID-19 Quality of sleep (Strongly disagree - Strongly agree) | 0.0145*| 0.4223 | 0.3493 | 1.2E-05*|
| **Class of 2023 alone (N=83)**                   |       |        |        |       |
| COVID-19 period (Pre-/Post-)                     | 0.7217| 0.4155 | 0.3399 | 0.4477|
| Time point (Summer ’19 - Spring ’21)            | 0.0183*| 0.0005*| 4.6E-05*| 0.1916|
| Chronic disease (Yes/No)                         | 1.8E-05*| 4.0E-06*| 3.6E-09*| 0.0001*|
| Average sleep hours (Hours)                      | 0.0004*| 0.0452*| 0.0151*| 1.2E-08*|
| Total exercise per week (Minutes)                | 0.2783| 0.1943 | 0.3876 | 0.0859|
HIGHLIGHTS

- Going through medical school is a big challenge for students.
- Medical school has a cyclical negative impact on mental health and sleep habits.
- Inherent rigors of medical school overshadow any effect that the pandemic may have.
- Students tend to wrongly attribute their declining state to the pandemic.