



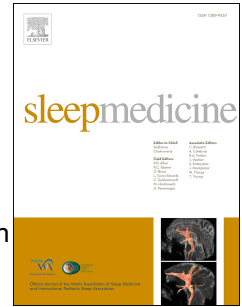
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Journal Pre-proof

Mental health and sleep habits during preclinical years of medical school.

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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

Journal Pre-proof

1 **TITLE**

2 Mental health and sleep habits during preclinical years of medical school.

3

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20 The authors have no financial or personal conflicts of interest to declare that are associated with the
21 presented study.

22

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24 **Blake McKinley, Bryan Daines, Mitchell Allen, Kayd Pulsipher:** Conceptualization, Methodology,
25 Investigation, Writing -Original Draft. **Isain Zapata:** Methodology, Formal Analysis, Data Curation,
26 Supervision, Visualization, Writing – Original Draft, Review & Editing. **Benjamin Wilde:**
27 Conceptualization, Methodology, Project Administration

28

29 **HIGHLIGHTS**

- 30
- Going through medical school is a big challenge for students.
- 31
- Medical school has a cyclical negative impact on mental health and sleep habits.
- 32
- Inherent rigors of medical school overshadow any effect that the pandemic may have.
- 33
- Students tend to wrongly attribute their declining state to the pandemic.

34

35 ABSTRACT

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

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

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

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

56

57 KEYWORDS:

58 Medical school, GAD-7, PHQ-9, PSQI, exercise, chronic disease, sleep quality, COVID-19

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60 1. INTRODUCTION

61 During the first two years of medical school, students are expected to reprioritize their lives to
62 meet the long hours of lecture material, laboratory sessions, and study for both school and national
63 exams¹. To be competitive for residency, students also devote considerable time to extracurricular
64 activities such as volunteer, work, and research experiences^{2,3}. The schedule of students prior to
65 medical school is often less demanding than that of a medical student^{4,5}. Increased demands may
66 account for the higher rates of burnout and mental illness reported in enrolled medical students
67 compared to the general population⁶⁻⁸. Multiple studies have discovered a correlation between medical
68 school enrollment and changes in mental health, including increased levels of depression⁹⁻¹², anxiety
69^{6,9,12}, stress¹¹⁻¹³, and burnout¹⁴. These feelings of burnout and depression persist in medical residents
70 and physicians^{10,15}. The ability to identify risk factors that contribute to mental health deterioration in
71 medical students can have implications for residents and physicians.

72 Risk factors which impact mental health include sleep quality and quantity, exercise, and chronic
73 disease¹⁶⁻¹⁸. Arguably, poor sleep quality has the most significant association with poor mental health
74 in medical students. It is associated with increased stress, anxiety, and depression among medical
75 students^{12,13,19}. College students that present with depressive symptoms have greater comorbid anxiety
76 when they experience sleep disturbances^{12,19-21}. Students with depressive symptoms rate sleep quality
77 as poor and experience increased somnolence in class²². Poor sleep quality, decreased quantity, and
78 increased depression levels are independent predictors of burnout¹⁴ and have a strong association with
79 decreased mental health. Additionally, reduced incidence rates of depression and some anxiety
80 disorders have been observed in exercising individuals²³; exercise has even been shown to be an
81 effective treatment of depression, and to a lesser extent anxiety^{23,24}. Likewise, chronic disease has been
82 shown to lead to depression and anxiety¹⁷. Additionally, depression, anxiety, and sleep disorders have
83 been linked to the COVID-19 pandemic among the general public²⁵. Studies have noted that college

84 students are anxious regarding cancellation of examinations and academic events ²⁶. These disruptions
85 are likely to contribute negatively to students' mental health.

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

97

98 **2. MATERIALS AND METHODS**

99 *2.1 Participants and study approach*

100 An invitation to participate in this non-interventional study was delivered to all enrolled
101 students in the class of 2023 and the class of 2024 in a medical school (in the United States, accredited
102 by the HLC and COCA) with two separate campuses, the inclusion criteria was being a medical student
103 currently enrolled at the specific level (first or second year). Follow-up survey invitations were emailed
104 to those students that signed the informed consent to participate in this study and completed the first
105 survey. Exclusion criteria was students that did not complete a consent form or did not meet the
106 requirements for enrollment for the semester. An outline of the study is presented in Figure 1.

107 No compensation was provided for participation, which was voluntary. All participants
108 consented prior to participating. The project was reviewed by the Rocky Vista University Institutional
109 Review Board with the corresponding IRB# 2019-0070. The project was deemed exempt from a full IRB
110 review. No specific funding was received to conduct this study.

111 2.2 Surveys

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

131 weeks before orientation.” “COVID-19 has caused a decrease in my quality of sleep during the past
132 month.” All data provided by the participants was self-reported. The survey used is available as a
133 supplementary file.

134 *2.3 Statistical Analysis*

135 Data was analyzed using Generalized Linear Mixed Models (GLMMs) on the numeric responses
136 of SQ-3, GAD-7, PHQ-9 and PSQI. These models included fixed effects of class year (class of 2023/class of
137 2024), COVID-19 period (Pre-/ Post-), specific time points (Summer '19 through Spring '21), chronic
138 disease diagnosis (Yes/No), average number of sleep hours (hours), and total exercise per week
139 (minutes). Repeated measurements by participants were included in the models as a random effect. All
140 models assumed errors to be normally distributed with mean zero and variance of σ^2 . All modeling and
141 descriptive statistical evaluations were performed with SAS v.9.4 (SAS Institute, Cary, NC). Statistical
142 significance was declared at a confidence level of 95%.

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

152

153 **3. RESULTS**

154 The total number of participants in the study was 197. 85 out of 130 students participated from
155 the class of 2023 and 112 out of 145 students participated from the class of 2024. Participant
156 frequencies are summarized in Table 1 by COVID period, time point, and chronic disease diagnosis. A
157 summary of the data is presented in Table 2. The full correlation analysis of variables used in the analysis
158 is presented in a Supplementary File. Here we observed that SQ-3, which is a variable not previously
159 validated, displayed a significant correlation ($P<0.0001$) to GAD-7, PHQ-9 and PSQI ($r=0.43, 0.60$ and
160 0.50 respectively). Validated assessment metrics GAD-7 displayed a significant correlation ($P<0.0001$) to
161 PHQ-9 and PSQI ($r=0.77$ and 0.45 respectively) and last, PHQ-9 displayed a significant correlation to PSQI
162 ($r=0.55$). Internal consistency assessment through standardized Cronbach's alpha was 0.6909 when all
163 variables analyzed are evaluated together and 0.8576 when only the psychological items are evaluated
164 (SQ-3, GAD-7, PHQ-9, PSQI and the three COVID specific questions). It is important to recognize that only
165 one of the 7 components in the calculation of the PSQI is hours of sleep, favoring the correlation with
166 the PSQI. Thus, the addition of the SQ-3, with a continuous effect consideration of hours of sleep is
167 important when evaluating the effect of sleep quality.

168 The GLMM modeling analysis used in this study allows for simultaneous evaluation of effects
169 such as class year, COVID-19 period, differences across time points, chronic disease, average sleep
170 hours, and total exercise. Therefore, estimation for individual effects on SQ-3, GAD-7, PHQ-9, and PSQI is
171 already adjusted for other effects in the model. Figure 2 presents the differences across time points for
172 the study's full dataset. Significant variations were observed across time points with similar trends in the
173 individual analysis of SQ3, GAD-7, PHQ-9, and PSQI. Pre-medical school for class of 2023 (Summer '19),
174 2024 (Summer '20) and summer break for class of 2023 between year 1 and 2 of medical school
175 (Summer '20), reported significant lower scores for all time points. When analyzing the differences
176 across time points, a lower number of sleep hours and having a diagnosis of chronic diseases
177 significantly increased SQ-3, PHQ-9, and PSQI. The differences across time points and having a diagnosis

178 of chronic diseases significantly increased GAD-7. P-values for these associations are presented in Table
179 3. A separate evaluation of time points (pre-medical school, fall semester, and spring semester of year
180 one) for individual class year cohorts (class of 2023 and class of 2024) displayed the same pattern (data
181 not shown).

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

192 The data was analyzed again but only for the class of 2023, excluding all data from the class of
193 2024, with variables of COVID-19 period, differences across time points, chronic disease, average sleep
194 hours, and total exercise accounted for when assessing for the individual effect on SQ3, GAD-7, PHQ-9,
195 and PSQI. Time point change had a significant effect on SQ-3, GAD-7, PHQ-9; having a chronic disease
196 diagnosis and average sleep hours had a significant effect on SQ-3, GAD-7, PHQ-9, and PSQI. No other
197 variables had a significant effect. These associations are presented in Table 3.

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

202

203 **4. DISCUSSION**204 *4.1 Mental health and sleep habits*

205 Medical school has a significant effect on sleep quality, depression, and anxiety^{9-14,19,21,30-35}. The
206 majority of analyses are cross sectional studies that are an assessment of one time point, relying on
207 other studies to provide context for their findings^{6,30,35 5,12,30,31,36}. However, the longitudinal analysis of
208 students in this study uniquely allowed the quantification of the change from pre-medical school and
209 summer break to each semester in medical school throughout years one and two, allowing students to
210 act as their own controls and reducing confounding factors. The results across time points displayed a
211 cyclic change in mental health and sleep quality of medical students that was associated directly with
212 the academic/seasonal calendars.

213 There is great variability in the literature in sleep quality, depression, and/or anxiety of medical
214 students. The reported percentages of students that suffer from poor sleep quality range from 55.8-
215 76%, anxiety from 41-73%, and depression from 10.4-65%^{11-13,19,21,30-33,36}. This variation is due in part to
216 the lack of standardized assessment tools to assess anxiety, depression, and sleep quality in medical
217 students, leading to a variety of assessments being used. Additionally, it is difficult to account for the
218 different structures and expectations within medical schools around the world. As such, this study does
219 not compare the percentages of total anxiety, depression, and sleep quality to other analyses, but
220 assesses the longitudinal change.

221 The medical school assessed in this study is structured similarly to the general model of medical
222 schools throughout the United States: 4-year curriculum divided into two years of basic science
223 coursework followed by two years of clinical clerkships³⁷. This study evaluated students in their first two
224 years of basic science coursework noting no significant difference in anxiety, depression, and/or sleep

225 quality between year one and year two. However, differing levels of anxiety, depression, and sleep
226 quality have been observed in other studies when all years of training are considered ^{32,38}.

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

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

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

244 This analysis provides insight into areas that medical schools may focus, including sleep patterns
245 and mental health. "Good" sleep improves academic performance ⁴⁰ and medical students who are
246 sleep deprived have significantly lower GPAs ⁴¹. Anxiety, depression, and stress lead to poor academic
247 performance in medical students ^{42,43}. Students often recognize these problems and perceive their effect
248 on their academic performance ²², but do not always know how to receive help. At a United States

249 medical school where confidential mental health services were available, only 26.5% of the identified
250 depressed students reported treatment. Notably, 20.4% of the depressed students reported
251 experiencing suicidal ideation³³. Medical student mental health is a serious and prevalent issue that
252 requires more attention.

253 Medical schools should focus on student health promotion emphasizing the importance of sleep
254 and mental health²¹. One suggestion to help prevent depression is to educate students on appropriate
255 sleep hygiene and encourage students to pursue professional guidance to treat sleep disturbances²².
256 Another suggestion is for medical schools to institute stress coping mechanisms and improvement of
257 interpersonal relationships¹¹. A well-being curriculum⁴⁴ or targeted interventions that have shown
258 some promising results at the college level^{45,46} could also be considered. Curriculum additions and
259 interventions can be challenging to implement because of the rigid and saturated curricula that is often
260 followed for medical education in the United States. However, this study offers understanding of the
261 patterns at which advertisement and outreach of current services can be more appreciated.

262 *4.2 Assessment of the impact of COVID-19*

263 The COVID-19 pandemic arose about halfway through the data collection period of this study
264 causing the incorporation of a virtual learning environment to encourage social distancing^{47,48}. The
265 pandemic has had a negative impact on depression, anxiety, and sleep disorders^{25,26}. However, other
266 studies report increases in sleep among college students⁴⁹.

267 In this study, the effect of COVID-19 was evaluated in two ways: first, by evaluating directly its
268 effect in the model (pre- and post-COVID-19 period variable) and second, by comparing the first three
269 time points (Summer '19 - Spring '20), to the corresponding seasons of the following year: time points 4-
270 6 (Summer '20 - Spring '21). On the full dataset, there were no differences across time points for the
271 same season of the year regardless of pre- or post-COVID-19 period variable, suggesting that COVID-19
272 did not significantly contribute to anxiety, depression, or sleep quality. To further account for

273 confounding effects of putting together two classes (2023 and 2024), the analysis was also run with only
274 the class of 2023. Findings revealed that the COVID-19 period had no significant effect on any scores.
275 Similarly, a recent report showed the effect of the COVID-19 pandemic on stress and sleep was not
276 necessarily negative and suggested that college students are largely resilient⁵⁰. After the COVID-19
277 pandemic started, 3 questions were added to the surveys to measure the self-reported effect of COVID-
278 19 on sleep quality, anxiety, and depression. The results indicated worse outcomes in all three
279 categories. However, change in anxiety, depression, and sleep quality as assessed by GAD-7, PHQ-9, and
280 SQ-3, respectively, were not significant. These findings suggest that students are unable to recognize the
281 cause of their decline in mental health but are more likely to blame the pandemic than medical school.

282 *4.3 Limitations and future directions*

283 This study comes with important caveats. First, it is important to note that the cyclical
284 fluctuation that we attributed to the academic year has some confounding with the seasonal calendar.
285 In the northern hemisphere, it is traditional to start the academic year during the fall and end in the
286 summer. It would be interesting to have the opportunity to evaluate these effects in alternate locations
287 where the seasonal calendar has different characteristics. This would allow for a more precise
288 estimation of these effects. Second, the patterns we present are representative of a very specific
289 subpopulation of students. Medical school in the United States comes after the completion of a
290 bachelor's degree. These students are unlikely to be comparable to college students as they are older,
291 more mature and go through a heavy pre-selection process for medical school admission. Third, the
292 strategy and the setup of the COVID-19 assessment was opportunistic. The study was ongoing on the
293 first class when the pandemic occurred. Strategies to accommodate for the changing conditions were
294 introduced with the second class. Unfortunately, under these changing conditions, a true randomized
295 experimental approach was never feasible. Last, a limitation of this study is its representativeness across
296 institutions since data was collected from a single medical school consisting of two campuses. Also, the

297 sleep quality analysis added a standardized assessment, PSQI, that was not utilized in the first year.
298 Future research should expand the population surveyed across multiple universities and to include
299 comparisons to other professions that require a terminal degree (graduate school, dentistry school, law
300 school, among others) to better generalize results. This would expand the inference of our findings to
301 students in similar maturity and age range. Furthermore, studies should incorporate third- and fourth-
302 year medical students to provide data that spans the entire medical school training.

303 *4.4 Conclusion*

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

313

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445 **FIGURE LEGENDS**446 **Figure 1. Study timeline.**

447

448 **Figure 2. Time point effect estimates** A) SQ-3. B) GAD-7. C) PHQ-9. D) PSQI. In all panels, brackets449 indicate pairwise differences at a $P \leq 0.05$ level. Error bars correspond to the Standard Error of Mean

450 (SEM).

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453 TABLES

454 Table 1. Participants included in the study on the full dataset and by class year cohorts.

Variable	Full Dataset	Class 2023 alone	Class of 2024 alone
	N=197	N=85	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

455

456

457 **Table 2. Mean and Standard Deviations in the dataset.**

458

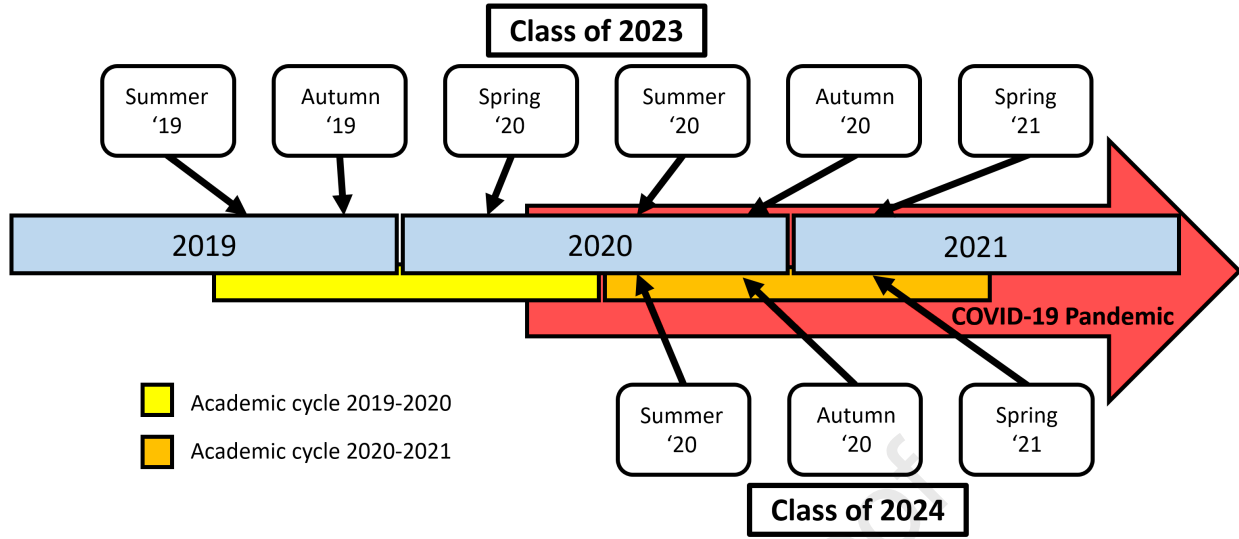
Variable	Full dataset		Class year				COVID-19 Period				Chronic disease			
			2023		2024		Pre		Post		Yes		No	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Average Sleep Hours (Hours)	7.474	1.129	7.799	1.059	7.024	1.068	7.799	1.065	7.043	1.067	7.425	1.213	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

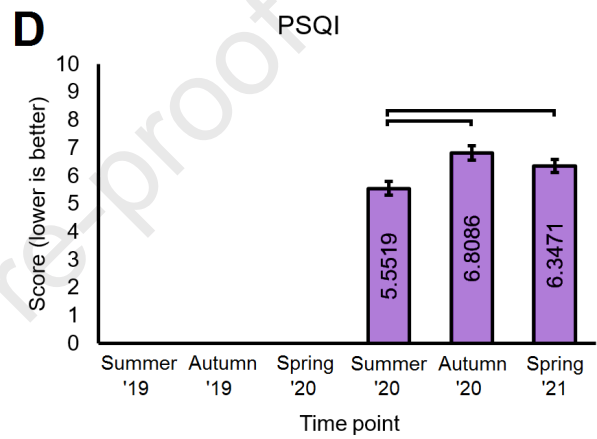
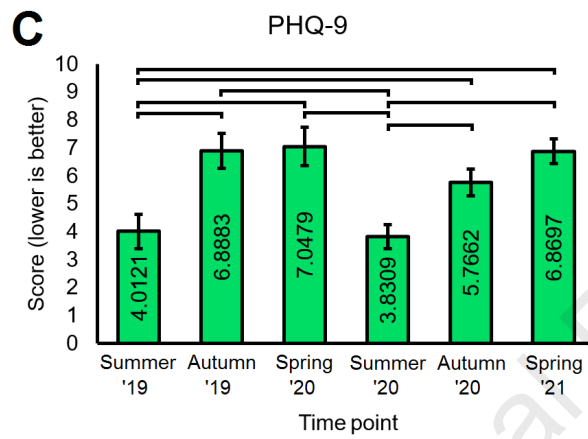
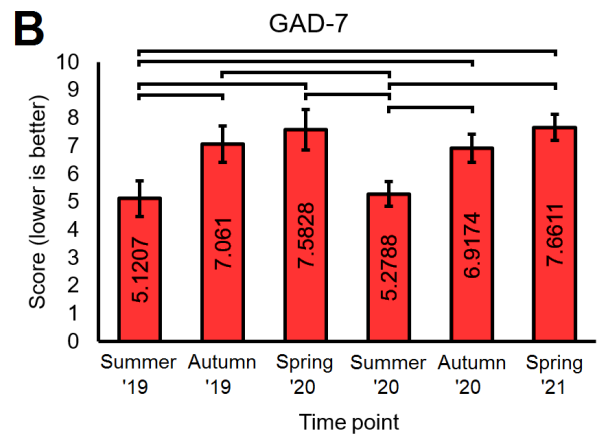
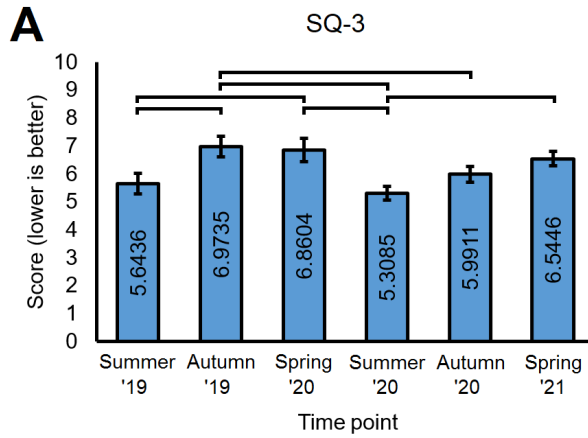
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460 **Table 3. Significance testing for each model's included effects.** Significant associations are declared at
 461 $P \leq 0.05$ and are indicated in the table with an asterisk *. Columns correspond to the assessment tool
 462 evaluated while rows correspond to the p-value of such association. Outcomes for the three models are
 463 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-)	0.8225	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

464





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.

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