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Julia N. Soulakova

Lisa Crockett

Mary Schmidt-Owens

Eric W. Schrimshaw

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1 **Correlates of COVID-19 Vaccine Uptake Among U.S. College Students**

2 Julia N. Soulakova,¹ PhD, Lisa J. Crockett,² PhD, Mary Schmidt-Owens,³ PhD, and
3 Eric W. Schrimshaw,¹ PhD

4 ¹Department of Population Health Sciences, College of Medicine, University of Central Florida,
5 6900 Lake Nona Blvd., Orlando, FL 32827, USA

6 ²Department of Psychology, University of Nebraska-Lincoln, 315 Burnett Hall, Lincoln, NE,
7 68588-0308, USA

8 ³Student Health Services, University of Central Florida, 4098 Libra Drive, Orlando, FL, 32816,
9 USA

10

11 **Corresponding author:** Julia N. Soulakova, Associate Professor of Medicine, Department of
12 Population Health Sciences, College of Medicine, University of Central Florida, 6900 Lake
13 Nona Blvd., Orlando, FL 32827, USA, 1 (407)266-7072, Julia.Soulakova@ucf.edu

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31 **Abstract**

32 Hesitance toward COVID-19 vaccination has greatly decreased over the course of the pandemic
33 in the U.S. However, some populations have lower vaccination rates than the general population.
34 This study was conducted to identify correlates of being fully vaccinated (i.e., having received
35 all doses required to be fully vaccinated) among college students using students' responses to the
36 2022 Spring American College Health Association—National College Health Assessment. The
37 surveys were administered in March of 2022. The sample (n=617) included 18-to-30-year-old
38 students. Firth logistic regression models were performed that controlled for age, sex assigned at
39 birth, and food security (at a 5% significance level). The model-assisted results indicated that
40 being a member of sexual and gender minority communities, being a graduate student, and being
41 concerned about someone close getting COVID-19 were positively associated with being fully
42 vaccinated, while current use of any tobacco product and current use of e-cigarettes were
43 negatively associated with being fully vaccinated (all p-values<0.05). In addition, the percentage
44 of fully vaccinated students was higher among transgender/gender non-binary students (95%)
45 than among cisgender men and women (85-87%), and among sexual minority groups (93-97%)
46 than among heterosexual/straight students (82%). Among the racial/ethnic groups considered, the
47 percentage of fully vaccinated students was lowest among non-Hispanic Black/African American
48 students (77%), but the racial/ethnic differences were not statistically significant (at 5% level).
49 The study points to a critical need for development and implementation of tailored vaccination
50 campaigns to help students from diverse communities, including tobacco users, make informed
51 decisions and become fully vaccinated.

52 **Key words:** COVID-19, vaccination, health disparities, sexual and gender minority young
53 adults

54 **Highlights**

- 55 • Sexual and gender minorities (SGMs) more commonly reported being fully vaccinated
- 56 (BFV) than did non-SGMs
- 57 • Being a graduate (vs. undergraduate) student was positively associated with BFV
- 58 • Concerns about health of close others were positively associated with BFV
- 59 • Current tobacco use and e-cigarette use were negatively associated with BFV

60

61 **Abstract**

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81 decisions and become fully vaccinated.

82 **Key words:** COVID-19, vaccination, health disparities, sexual and gender minority young adults

83 1. Introduction

84 Attitudes toward COVID-19 vaccination have changed greatly over the course of the pandemic
85 among U.S. adults. Vaccine hesitance was most widespread in 2020, before the COVID-19
86 vaccine became available, mainly due to concerns about the safety and effectiveness of the
87 vaccines being developed (Callaghan et al., 2020; Lin et al., 2020). While estimates differed
88 across studies, the overall conclusion was that a large proportion of the U.S. population did not
89 intend to get vaccinated when a vaccine became available, e.g., 31% of adults reported hesitancy
90 toward getting vaccinated in May-June of 2020 (Callaghan et al., 2020). Shortly after COVID-19
91 vaccines became available in early 2021 vaccine hesitance decreased. In April 2021 about 30% of
92 the population was fully vaccinated (i.e., had received all doses required to be fully vaccinated)
93 and only about 20% of adults reported that they were unwilling to get vaccinated (“Centers for
94 Disease Control and Prevention COVID Data Tracker: Vaccinations in the U.S.,” n.d.; El-
95 Mohandes et al., 2021). As of July 20, 2022 the percentage of fully COVID-19 vaccinated adults
96 was relatively high, 90% (“Centers for Disease Control and Prevention COVID Data Tracker:
97 Vaccinations in the U.S.,” n.d.).

98 Despite the overall high rate of fully vaccinated adults in the U.S. currently, there are disparities
99 in vaccination rates by age: the percentage of fully vaccinated adults is lowest among 18-24
100 year-old adults followed by 25-39 year-old adults (64% and 68%, respectively, as of August 2,
101 2022), suggesting additional barriers to vaccine uptake in the younger cohort (“COVID-19
102 Vaccination and Case Trends by Age Group, United States, Centers for Disease Control and
103 Prevention,” n.d.). However, the nature of the barriers to COVID-19 vaccination have not been
104 examined among young adults.

105 Prior studies that have examined COVID-19 vaccination hesitance or uptake of human
106 papillomavirus vaccine have pointed to possible disparities in vaccination rates associated with
107 educational attainment (Boakye et al., 2018; Malik et al., 2020), low income (El-Mohandes et al.,
108 2021) and substance use including tobacco use (Barocas, 2021; Krebs et al., 2021; Kumar et al.,
109 2022; Mellis et al., 2021). Moreover, it has been suggested that sexual and gender minority
110 (SGM) populations could be more skeptical towards COVID-19 vaccination than non-SGM
111 populations because stigma, perceived discrimination and medical mistrust may create barriers to
112 COVID-19 vaccine acceptance and uptake among SGM communities (Teixeira Da Silva et al.,
113 2021). In addition, interest in future COVID-19 vaccination was higher among transgender
114 relative to cisgender adults and bisexual/pansexual relative to gay/lesbian adults (Phillips et al.,
115 2021).

116 While we could not identify any studies that directly examined associations between pandemic-
117 related events and attitudes (e.g., between ever having COVID-19 and COVID-19 vaccination
118 acceptance), stress due to the pandemic was shown to be positively associated with substance use
119 during the pandemic lockdown among college students (Soulakova et al., 2021). Moreover,
120 among college students, the negative impact of the pandemic in terms of stress level and
121 pandemic-specific concerns was significantly higher among SGM groups and communities of
122 color (Soulakova et al., n.d.). For example, cisgender women and transgender/gender non-binary
123 students were more likely than cisgender men to report experiencing pandemic-related stress,
124 and non-Hispanic (NH) Asian/Asian American students were more likely than NH White

125 students to report being extremely or very concerned that they would get COVID, that someone
 126 close would get COVID, and that someone close would die from COVID-19 (Soulakova et al.,
 127 n.d.). We anticipated that these disparities across SGM and racial/ethnic groups in pandemic-
 128 related stress and concerns could translate into disparities in COVID-19 vaccine uptake among
 129 college students, and that those groups that are more concerned about the pandemic would be
 130 more likely to get vaccinated.

131 This study was conducted to examine disparities in COVID-19 vaccine uptake among college
 132 students and identify correlates of being fully vaccinated. Integrating the prior knowledge
 133 described above we hypothesized that gender identity, sexual orientation and SGM status,
 134 race/ethnicity, pandemic-related events (e.g., ever having COVID-19), stress and concerns about
 135 COVID-19, and tobacco use would be significantly associated with being fully vaccinated
 136 among college students. In addition, we aimed to determine which of these factors are facilitators
 137 of, and which are barriers to, vaccine uptake among college students and to identify whether
 138 structural (e.g., time and transportation access) or attitudinal (e.g., misconceptions and mistrust)
 139 factors (Fisk, 2021) are more influential in the context of vaccine uptake.

140 2. Materials and Methods

141 2.1. Data Source

142 We used de-identified data from the 2022 Spring American College Health Association
 143 (ACHA)—National College Health Assessment (NCHA). The Assessment was administered
 144 online to a random sample of students at a large southeastern university (the total enrollment
 145 exceeds 25,000 students) in March of 2022. The survey was open for three weeks (per ACHA
 146 recommendations) and was completed anonymously. Three email reminders were sent to non-
 147 respondents within the three-week period. All respondents were given the opportunity to
 148 participate in a drawing, and 15 respondents were awarded a \$100 gift card. The response rate
 149 computed by ACHA was about 10%. The study was determined to be exempt by the Institutional
 150 Review Board. The study sample included 617 students. Table 1 presents the sample
 151 characteristics.

152 2.2. Study Measures

153 The **dependent measure** was vaccination status (fully vaccinated, not fully vaccinated). The
 154 **primary independent measures** included: (1) gender identity, sexual orientation, and SGM
 155 status; (2) race/ethnicity; (3) pandemic-related measures; and (4) two tobacco-use measures.
 156 **SGM status** was determined by gender identity and sexual orientation, and differentiated
 157 between SGM students (transgender/gender non-binary, any sexual minority) and non-SGM
 158 students (see Table 1). The **pandemic-related measures** included ever having COVID-19 (yes,
 159 no, not sure), two binary pandemic-specific stress measures (i.e., financial stress and overall
 160 stress due to a substantial impact of the COVID-19 pandemic), and pandemic-specific concerns
 161 over the past 30 days (e.g., concern with getting COVID-19; see Table 2). The **tobacco use**
 162 **measures** included questions about current use (in the past three months) of tobacco (i.e., any
 163 tobacco product; yes, no) and current use of e-cigarettes (yes, no). **Secondary independent**
 164 **measures** included sociodemographic and college-related characteristics (see Table 1) along
 165 with the overall level of stress students reported experiencing in the past 30 days. The food

166 security measure (*U.S. Household Food Security Survey Module: Six-Item Short Form Economic*
 167 *Research Service, USDA, 2012*) was included as a proxy measure for financial well-being (see
 168 Table 1), because income was not included in the survey. Appendix A provides additional
 169 information about the study measures and corresponding survey items.

170 **2.3. Statistical Analysis**

171 First, we conducted exploratory analyses to examine the sample sizes for cross-groups created by
 172 intersecting vaccination status with each independent variable. We tested for significant
 173 associations between vaccination status and each independent variable using a chi-square (CS)
 174 test at a 5% significance level. Moreover, we assessed possible associations among the measures
 175 of pandemic-specific concerns. Only primary and secondary independent variables that were
 176 significantly associated with vaccination status at a 10% significance level were included in the
 177 primary analysis, with three exceptions. The exceptions were age, sex assigned at birth, and food
 178 security, which were included as control variables. Appendix B presents additional information
 179 on how results from the exploratory analysis informed the primary analyses.

180 The primary analysis incorporated Firth multiple logistic regression models suitable for
 181 modeling data with small cross-group sizes (Firth, 1993). The Firth method helps reduce bias and
 182 results in finite and consistent estimates (Firth, 1993; Heinze and Schemper, 2002; Wang, 2014).
 183 We examined two models for vaccination status. Each model included a common set of
 184 covariates: age, sex assigned at birth, SGM status, race/ethnicity, program type, overall stress
 185 level, indicator of ever having COVID-19, and concerns that someone close will get COVID-19.
 186 In addition, the first model (Likelihood Ratio CS=69.30, df=17, $p<0.0001$) included current use
 187 of tobacco ($p=0.0431$) and the second model (Likelihood Ratio CS=70.44, df=17, $p<0.0001$)
 188 included current use of e-cigarettes ($p=0.0212$). The results of both models were consistent in
 189 terms of significance of independent variables; thus, we only report detailed results based on the
 190 first model (see Table 3). We used a 5% significance level and Bonferroni adjustments for
 191 multiplicity. Statistical computing was performed using SAS®9.4 (*SAS/STAT® 14.2 User's*
 192 *Guide, 2016*).

193 **3. Results**

194 **3.1. Gender Identity, Sexual Orientation, SGM Status, and Vaccination Status**

195 About 85.9% of students reported being fully vaccinated (see Table 2). The percentage of fully
 196 vaccinated students was higher among transgender/gender non-binary students (relative to
 197 cisgender men and cisgender women), sexual minority students relative to heterosexual/straight
 198 students, and SGM students relative to non-SGM students. SGM status was also significantly
 199 associated with vaccination status after adjusting for the other factors in the primary analysis: the
 200 odds of being fully vaccinated were considerably higher among SGM relative to non-SGM
 201 students (see Table 3).

202 **3.2. Race/Ethnicity and Vaccination Status**

203 Race/ethnicity was significantly associated with vaccination status (at the 5% significance level
 204 in the exploratory analysis and the 10% significance level in the primary analysis). Among the

205 racial/ethnic groups considered, the percentage of fully vaccinated students was highest among
206 NH Asian/Asian American students; indeed, almost all NH Asian/Asian American students
207 reported being fully vaccinated (see Table 2). In addition, the odds of being fully vaccinated was
208 higher among Hispanic students and lower among NH Black/African American students relative
209 to NH White students. However, after adjusting for other factors, race/ethnicity was significantly
210 associated with vaccination status only at the 10% level; thus, the relative differences (versus NH
211 White students) were not further assessed (see Table 3).

212 **3.3. Pandemic-Specific Measures and Vaccination Status**

213 Most students (52.5%) reported that they had never had COVID-19; another 38.4% of students
214 reported that they had had COVID-19, and 9.1% reported that they were not sure whether they
215 had had COVID-19 or not. The indicator of ever having COVID-19 was significantly associated
216 with vaccination status at the 10% level: the highest percentage of fully vaccinated students was
217 observed among students who reported that they had never had COVID-19. However, the
218 association was not significant in the primary analysis after adjusting for the other factors.

219 About 27.4% of students reported that the COVID-19 pandemic made their current financial
220 situation a lot more stressful and about 36.6% of students reported that their current overall level
221 of stress significantly increased as a result of the COVID-19 pandemic. However, neither
222 financial stress nor the overall level of stress was significantly associated with vaccination status.

223 Figure 1 depicts the relative frequencies for the measures of pandemic-specific concerns. All
224 measures of pandemic-specific concerns except for “concerns with getting COVID-19” were
225 significantly associated with vaccination status (see Table 2); for all concerns measures, the
226 percentage of fully vaccinated students was highest among students who reported being
227 extremely or very concerned. Moreover, the primary analysis indicated that the odds of being
228 fully vaccinated was significantly higher among students who reported being extremely or very
229 concerned that someone close to them would get COVID-19 compared to those who reported
230 being slightly concerned or not at all concerned that someone close would get COVID-19 (even
231 after adjustment for multiplicity, see Table 3).

232 **3.4. Current Tobacco Use and Vaccination Status**

233 About 16.5% of students reported current use of tobacco. Among current tobacco users (n=102),
234 e-cigarettes was the major tobacco product reported (83.3%), followed by regular cigarettes
235 (24.5%), hookah tobacco (13.4%), cigars (10.1%), and chewing tobacco (4.2%). Overall, about
236 13.8% of students reported current use of e-cigarettes. Both, current use of any tobacco product
237 and current use of e-cigarettes were significantly associated with vaccination status. The
238 percentage of fully vaccinated students was higher among non-users than among users for each
239 measure (see Table 2). Moreover, these disparities remained significant after adjusting for the
240 other factors: the odds of being fully vaccinated were lower for (current) users of tobacco
241 relative to non-users of tobacco (see Table 3) as well as for (current) users of e-cigarettes relative
242 to non-users of e-cigarettes (OR=0.47, 95%CI=0.25:0.89).

243 **3.5. Secondary Measures and Vaccination Status**

244 The percentage of fully vaccinated students was higher among graduate students (95.8%) relative
245 to undergraduate students (84.6%). Likewise, the odds of being fully vaccinated were
246 significantly higher among graduate than undergraduate students in the primary analysis (see
247 Table 3). The overall level of stress was significantly associated with vaccination status at the
248 10% level ($CS=3.29$, $df=1$, $p=0.0699$). A similar result was observed in the primary analysis (at
249 the 10% level, see Table 3). The other secondary measures—sociodemographic and college-
250 related characteristics (such as age, sex assigned at birth, food security, relationship status,
251 enrollment type and GPA)—were not significantly associated with vaccination status.

252 4. Discussion

253 4.1. Primary Findings

254 The study indicated a relatively high percentage of fully vaccinated students (85.9%), suggesting
255 that the vaccination programs (including the ones implemented on campus) were highly
256 successful overall.

257 Transgender/gender non-binary, sexual minority and SGM students reported higher rates of
258 being fully vaccinated relative to cisgender, heterosexual/straight and non-SGM students,
259 respectively. While prior studies have suggested that SGM populations are more likely to
260 experience stigma and medical mistrust that could impact their COVID-19 vaccine acceptance
261 and uptake (Teixeira Da Silva et al., 2021), we observed that being a member of an SGM
262 community serves as a facilitator for vaccine uptake, which is consistent with results based on
263 the National Immunization Survey Adult COVID Module (McNaghten et al., 2022). Among
264 some SGM populations, this effect could be explained by longstanding recommendations that
265 sexually-active gay and bisexual men, as well as transgender women who have sex with men,
266 receive regular HIV testing, sexually transmitted infections testing, and vaccination for other
267 illnesses for which they are at increased risk, including hepatitis A and B, meningitis, and human
268 papillomavirus (“Centers for Disease Control and Prevention Assists with Meningococcal
269 Disease Outbreak Investigation in Florida | Centers for Disease Control and Prevention Online
270 Newsroom,” n.d., “Recommendations for Gay and Bisexual Men’s Health | Centers for Disease
271 Control and Prevention,” n.d.). To the extent that many SGM individuals follow these
272 recommendations, they may be more likely than non-SGM individuals to be in regular contact
273 with healthcare providers, and to have past experiences with receiving vaccinations as an adult,
274 and therefore have more favorable views of vaccination. Further, existing outreach efforts
275 targeting members of the SGM population for testing and vaccination may have been repurposed
276 for COVID-19 testing and vaccination during the pandemic, resulting in greater COVID-19
277 vaccination prevalence within SGM populations.

278 In addition, being a graduate student was positively associated with being fully vaccinated. This
279 finding is consistent with prior literature suggesting that among 55+ year-old adults surveyed,
280 the COVID-19 vaccination acceptance was positively associated with educational attainment
281 (Malik et al., 2020) and among 18-26 year-old adults, vaccination against human papillomavirus
282 was positively associated with having a college degree (Boakye et al., 2018).

283 Moreover, being concerned that someone close will get COVID-19 was positively associated
284 with being fully vaccinated. While this measure of pandemic-specific concern was the only one

285 explored in detail, four of the five measures of pandemic-specific concerns were significantly
286 (and positively) associated with being fully vaccinated. The results were consistent across the
287 four measures: the highest vaccination rate was observed among students who reported being
288 extremely or very concerned with how long the COVID-19 pandemic will last, that someone
289 close will get COVID-19, that someone close will die from COVID-19 and with uncertainty
290 about the future. Moreover, among the four “concerns” measures, being concerned with how
291 long the COVID-19 pandemic will last and being concerned that someone close will get COVID-
292 19 were the strongest correlates of being fully vaccinated. (The fifth concerns measure, concerns
293 about getting COVID-19, was not significantly association with vaccination status but as with
294 the other concerns measures, the percentage of vaccinated students was highest among students
295 who reported being extremely or very concerned about getting COVID-19, followed by students
296 who reported being moderately concerned; and the percentage was the lowest among students
297 who reported being slightly or not at all concerned.)

298 Interestingly, the four pandemic-specific concerns were more strongly associated with being
299 fully vaccinated than were the level of overall stress and the two pandemic-specific stress
300 measures, pointing to a possibly unique impact of each pandemic-specific concern on COVID-19
301 vaccination uptake. The findings that vaccine uptake was positively associated with concerns
302 that someone close will get COVID-19 and that someone close will die from COVID-19 are
303 consistent with prior research demonstrating a link between empathy/altruism and intentions for
304 COVID-19 vaccine uptake (Pfattheicher et al., 2022; Teixeira Da Silva et al., 2021).

305 An additional finding was that among diverse racial/ethnic groups, the highest vaccination rate
306 was observed among NH Asian/Asian American students. In addition, the vaccination rate was
307 higher among Hispanic and lower among NH Black/African American students relative to NH
308 White students. However, racial/ethnic differences were not statistically significant after
309 adjusting for the other factors (probably because of insufficient sample sizes for the communities
310 of color). The observed racial/ethnic differences are consistent with findings about vaccine
311 acceptance in a sample of 55+ year -old adults surveyed in May 2020 (Malik et al., 2020).

312 Current use of any tobacco product and current use of e-cigarettes were negatively associated
313 with being fully vaccinated. These findings are especially concerning in light of recent studies
314 demonstrating more severe health impacts of COVID-19 among tobacco users. For example, a
315 meta-analysis of 47 studies showed that former and current smokers not only have an increased
316 risk of severe COVID-19 but also an increased risk for in-hospital mortality and need for
317 mechanical ventilation (Reddy et al., 2021).

318 **4.2. Study Limitations**

319 The study has several limitations. First, a number of important confounders (e.g., having children
320 and living with elderly) could have influenced the observed associations between the
321 characteristics considered and vaccination status. Second, there may be significant interactions
322 among some primary independent measures associated with COVID-19 vaccination (e.g.,
323 between SGM status and current tobacco use). However, we did not include interactions in the
324 models due to the small sample sizes for cross-groups. Third, while we used the Firth approach
325 (Firth, 1993), which allowed us to obtain narrower confidence intervals and simultaneous bands

326 for comparisons involving small groups, there is a potential lack of power when group sizes are
327 small. Finally, the study was limited to 18-30 year-old students, and the findings may not be
328 generalizable to other age cohorts and/or to student populations.

329 **4.3. Conclusion**

330 The study identified several correlates of COVID-19 vaccination uptake among college students.
331 Because the measures of financial well-being (i.e., food security and the financial stress due to a
332 substantial impact of the COVID-19) were not significantly associated with vaccine uptake and
333 because vaccination sites offered free vaccination services to students on campus, we believe that
334 attitudinal barriers to vaccination, e.g., mistrust towards vaccines as well as towards “regulatory
335 agencies that monitor vaccine development and distribution” (Fisk, 2021) were more prevalent
336 than structural barriers (e.g., lack of transportation) among these students. Thus, the findings
337 have several implications. First, our findings that vaccination uptake is less common among
338 undergraduate students and current users of tobacco (including e-cigarettes) could inform
339 healthcare professionals and facilitators of campus health programs about misconceptions and
340 mistrust prevalent in some populations. Applied to this study, Fisk’s (2021) recommendations
341 are to build partnerships between healthcare providers and student communities, identify the key
342 concerns and fears faced by these communities, and provide tailored education to motivate
343 students to become fully vaccinated. Second, the positive association observed between being
344 concerned with someone close getting COVID-19 (and someone close dying from COVID-19)
345 and being fully vaccinated highlights the importance of promoting empathy and altruism during
346 vaccination campaigns. That is, students might be inspired to get fully vaccinated because it is “a
347 prosocial act that helps to protect vulnerable others” (Pfattheicher et al., 2022).

348 Given that the U.S. has invested more than \$19 billion in fast-track COVID-19 vaccine
349 development and was highly successful in delivering the vaccine to the general public (Frank et
350 al., 2021; Wood and Schulman, 2021), it is critical to make sure that all student communities can
351 make informed decisions about COVID-19 vaccine uptake and get fully vaccinated to prevent
352 another COVID-19 pandemic outbreak.

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354 Author BLINDED proposed the study aims, supervised all aspects of the study and statistical
355 analyses, and prepared the first draft of the manuscript. Author BLINDED provided expertise in
356 behavioral psychology, health-risk behaviors specifically, and helped prepare the manuscript.
357 Author BLINDED helped acquire the data, provided expertise in health behaviors among college
358 students and helped improve the manuscript. Author BLINDED provided expertise in health of
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368

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- 459

461 Table 1. Description of Study Sample of College Students (n=617); Data Source: 2022 Spring
 462 ACHA-NCHA

Characteristic	Group	Group Sample Size	%
Age	18-20 years old	279	45.2
	21-24 years old	250	40.5
	25-30 years old	88	14.3
Sex assigned at birth ^a	Female	450	72.9
	Male	167	27.1
Gender identity	Cisgender woman	413	66.9
	Cisgender man	161	26.1
	Transgender/gender non-binary (TGNB)	43	7.0
Sexual orientation	Gay/lesbian	24	3.9
	Bisexual	87	14.1
	Other sexual minority ^b	69	11.2
	Heterosexual/straight	437	70.8
Sexual and Gender Minority (SGM) Status			
Race/ethnicity ^c			

Food security	Very low food security	146	23.7
	Low food security	158	25.6
	High or marginal food security	313	50.7
Relationship status	Not in a relationship	343	55.6
	In a relationship (married/partnered or in relationship not married/partnered)	274	44.4
Program type	Undergraduate	545	88.3
	Graduate	72	11.7
Enrollment type	Full time	530	85.9
	Part time	87	14.1
Overall GPA	A	394	64.1
	B	187	30.4
	C or below	34	5.5

463 ^aSex assigned at birth included “intersex” as an additional response category but there were no
 464 students who self-reported being intersex.

465 ^bThe “Other sexual minority” group includes 13 asexual, 17 pansexual, 15 queer, 21 questioning,
 466 and 3 students with other sexual orientation.

467

468 Table 2. Disparities in COVID-19 Vaccination Uptake Among College Students; Data Source:
 469 2022 Spring ACHA-NCHA

Characteristic	Group	Percent (%) of fully vaccinated students
Gender identity (NP) ^{a,b}	Cisgender man	87.0
	Transgender/gender non-binary	95.4
Sexual orientation (NP) ^c	Gay/lesbian	95.8
	Bisexual	93.1
	Other sexual minority	97.1
	Heterosexual/straight	82.2
SGM Status (CS=18.11, df=1, p<0.0001)		
Race/ethnicity (NP) ^d		
Indicator of ever having COVID-19 (CS=5.96, df=2, p=0.0508)		
Financial stress due to a substantial impact of COVID-19		
Overall stress due to a substantial impact of COVID-19		
Over the past 30 days being concerned ...		

With how long the COVID-19 pandemic will last (CS=14.36, df=2, p=0.0008)	Moderately concerned	86.3
	Slightly or not at all concerned	79.3
With getting COVID-19 (NS)	Extremely or very concerned	90.1
	Moderately concerned	85.7
	Slightly or not at all concerned	83.8
That someone close will get COVID-19 (CS=13.71, df=2, p=0.0011)		
That someone close will die from COVID-19 (CS=8.27, df=2, p=0.0160)	Extremely or very concerned	91.2
	Moderately concerned	81.4
With uncertainty of the future (CS=8.32, df=2, p=0.0156)		
Current tobacco use (CS=4.25, df=1, p=0.0397)		
Current use of e-cigarettes (CS=5.54, df=1, p=0.0189)		
Overall		85.9

470 ^aNP stands for “Chi-Square test was not performed due to insufficient size for at least one cross
471 group”

472 ^bAmong transgender/gender non-binary students only two reported not being fully vaccinated

473 ^cAmong gay/lesbian and “other sexual minority” students only one and two, respectively,
474 reported not being fully vaccinated

475 ^dAmong NH Asian/Asian American students only one reported not being fully vaccinated

476 ^eNS stands for “not significant”

477

478 Table 3. Disparities in COVID-19 Vaccination Uptake Among College Students After Adjusting
 479 for Age, Sex Assigned at Birth and Food Security; Data Source: 2022 Spring ACHA-NCHA

Covariate^a	Comparison	Odds Ratio (95% Confidence Interval)
SGM Status (p=0.0001)	SGM vs. non-SGM	4.12 (2.01:8.40)
Race/ethnicity (p=0.0882)	NH Asian/Asian American vs.	6.41 ^b
	NH Black/African American vs NH White	0.71 ^b
Being concerned (over the past 30 days) that someone close will get COVID-19 (p=0.0021)	Extremely or very concerned vs. slightly or not at all concerned	2.26 (1.12:4.58)^c
	Moderately concerned vs. slightly or not at all concerned	0.75 (0.38:1.48) ^c
Current tobacco use (p=0.0431)	Yes vs. no	0.54 (0.29:0.98)
Program type (p=0.0063)	Graduate vs. undergraduate	5.14 (1.59:16.64)
Overall level of stress (p=0.0843)	High vs. other	1.71 ^b

480 ^aResults significant at the 5% level are bold. In addition, the model included age (p=0.7766), sex
 481 assigned at birth (p=0.1140), food security (p=0.1904) and indicators of ever having COVID-19
 482 (p=0.3992) that were not significant even at 10% level; the detailed results are not reported

483 ^b95% simultaneous confidence band or 95% confidence interval is not reported because the
 484 effect was significant overall at the 10% level only

485 ^c95% simultaneous confidence band

486

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488 Figure 1. Pandemic-Specific Concerns Among College Students (Over The Past 30 Days;
489 Standard Errors: 1.7—2.0%)

490

491 **Appendix A: Definition of Measures**

492 Vaccination status was defined using responses to the survey item “How would you describe
493 your COVID-19 vaccination status (not including "boosters")?” The possible responses included
494 “received all doses required to be fully vaccinated”, “started the vaccination process, but need
495 another dose”, “will get vaccinated as soon as possible”, “will only get vaccinated if required”,
496 and “will not get vaccinated”. In this study, vaccination status differentiated between fully
497 vaccinated students (i.e., those who reported that they have received all doses required to be fully
498 vaccinated) and the other students.

499 The SGM status variable differentiated between SGM students (transgender/gender non-binary,
500 any sexual minority) and non-SGM students (heterosexual cisgender women and heterosexual
501 cisgender men, i.e., students who reported “cisgender woman” or “cisgender men” for their
502 gender identity and “heterosexual/straight” for their sexual orientation). **Race/ethnicity**
503 differentiated among five racial/ethnic groups which are listed in Table 1.

504 The pandemic-specific financial stress measure was defined using responses to the survey
505 question “How has your current financial situation been affected by the COVID-19 pandemic?”
506 and differentiated between “a lot more stressful” and the other responses (i.e., “somewhat more
507 stressful”, “no significant change”, “somewhat less stressful” and “a lot less stressful”). The
508 pandemic-specific overall stress measure was defined similarly using responses to the question
509 “How has your current overall level of stress been impacted by the COVID-19 pandemic?” and
510 differentiated between “significantly increased my level of stress” and the other responses (i.e.,
511 “somewhat increased my level of stress”, “no change in my level of stress”, “somewhat
512 decreased my level of stress” and “significantly decreased my level of stress”).

513 The measures of pandemic-specific concerns were based on the question “Over the past 30 days,
514 on average, how much have you been concerned with the following...” followed by a list of
515 possible concerns including how long the COVID-19 pandemic will last, getting COVID-19
516 (first time or again), that someone close (to the student) will get COVID-19, that someone close
517 will die from COVID-19, and uncertainty about the future. Each measure of concern
518 differentiated among three groups of students: those who reported being extremely or very
519 concerned, those who were moderately concerned, and those who were slightly concerned or not
520 at all concerned.

521 Each tobacco use measure was defined via pooling responses to questions regarding ever-use of
522 tobacco or nicotine delivery products and use in the past three months (“never”, “once or twice”,
523 “monthly”, “weekly”, “daily or almost daily”), and differentiated between current users and non-
524 users.

525 The overall level of stress was defined using responses to the survey question “Within the last 30
 526 days, how would you rate the overall level of stress you have experienced?” and differentiated
 527 between students who reported a high level of stress and the others (that is, those who reported
 528 moderate, low or no stress).

529

530 **Appendix B: Exploratory Analysis Results That Informed Primary Analyses**

531 Table 2 indicates that some gender identity and sexual orientation statuses had insufficient
 532 sample sizes (i.e., less than 5) for creating cross-groups. Thus, in the primary analysis, SGM
 533 status was included instead of specific gender identity and sexual orientation statuses. All
 534 pandemic-specific concern measures were collinear; thus only one of these measures—concerns
 535 that someone close will get COVID-19—was included in the primary analysis. Because both
 536 tobacco-use measures were significantly associated with vaccination status we considered them
 537 separately in the primary analysis. Among secondary measures, the level of overall stress was
 538 significant at the 10% level ($CS=3.29$, $df=1$, $p=0.0699$). Moreover, the program type (i.e.,
 539 graduate versus undergraduate; see Table 1) appeared to be significantly associated with the
 540 vaccination status (but there was insufficient sample size for one cross-group to test this). Thus,
 541 overall stress level and program type were included as covariates in the primary analysis.

542

