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Social Media Use and COVID-19: A Cross-Sectional Study Examining Health Behaviors, Knowledge, and Mental Health Among University of Nevada, Reno Students

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Abstract

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Keywords

COVID-19, social media, mental health, student, pandemic, public health

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Abstract

Reliance on social media for health information is widespread, yet impacts of social media use (SMU) on health behaviors during infectious disease pandemics are poorly understood. We used a random sample from a university student directory to invite students to take a cross-sectional online survey during the coronavirus pandemic. Survey questions assessed adherence to public health guidelines, knowledge of COVID-19/SARS-CoV2, and mental health symptoms. Students were classified based on their level of SMU for information on COVID-19 as: (1) none, (2) some use, or (3) main source. Weighted regressions were used to relate SMU to adherence (five-point scale) and knowledge (six-point scale), with higher scores representing higher adherence/knowledge, and to mental health (PHQ-8 and GAD-7 scales). The weighted prevalence of SMU for COVD-19 information was 71.3%, and 17.1% of students identified SMU as their main source of COVID-19 information (total $N = 181$). Mean adherence ranged from 3.71±0.17 (SEM) for none, to 3.94±0.14 (SEM) for main source, and differences were not statistically significant at the 95% confidence level. Knowledge scores decreased from 5.44±0.11 (SEM) for none, to 5.38±0.08 for some, and 5.23±0.16 for main source ($p = 0.056$). The weighted prevalence of depression was 38.7%, 43.1%, and 51.9% for none, some use, and main source; weighted prevalence of anxiety was 19.7%, 27.0%, and 36.7%, respectively. Effects of SMU for information during pandemics on health behavior merits further research, especially regarding adherence to public health guidelines. In the case of COVID-19, SMU may be negatively correlated with knowledge and mental health.

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Background

On March 11th, 2020, the World Health Organization declared COVID-19 a pandemic (WHO, 2020). COVID-19 is a community spread respiratory disease and individuals who are asymptomatic may not be aware that they have the virus (Centers for Disease and Control and Prevention [CDC], 2020). These disease characteristics led governments around the world to issue stay-at-home orders and social distancing guidelines. The COVID-19 pandemic is a major public health challenge and there is an urgent need for investigation into health behaviors of the public that influence the spread of the disease.

Pandemics are rapidly evolving situations where social media use (SMU) may play an important role in how the public perceives and responds to public health guidelines. There is an increasing reliance on social media for health information and currently > 30% of adults use social media to seek health information (Zhao & Zhang, 2017). Uncertainty associated with pandemics may make social media an even more popular source of health information than during non-pandemic times: Users can see what conclusions their friends, families, and role models are drawing from emerging information, considering that accepted scientific information is still being established (Alaszewski, 2005; Strekalova, 2017). The Ebola outbreak in 2014 provided evidence of social amplification of risks through SMU and suggested that this amplification can lead to increased anxiety (Strekalova, 2017). In addition to amplifying risks, social media is known to amplify misinformation (Wang et al., 2019). Misleading posts about the Zika virus (circa 2016) were far more popular on Facebook than factual posts (Sharma et al., 2017). Research is needed to evaluate how SMU for information on COVID-19 can impact adherence to public health guidelines, understanding of the disease, and mental health outcomes.

Relative to older adults, younger school-age individuals have higher SMU overall and for health information (Thackeray et al., 2013), and tend to have denser social networks that may increase transmission of respiratory infections (Hoang et al., 2019). Therefore, research on relationships between SMU and COVID-19 health behaviors, knowledge, and mental health status in young people is crucial.

This study describes how SMU for information on COVID-19 by students at the University of Nevada, Reno (UNR), was related to: (1) Adherence to the guidelines put into place to reduce community transmission of COVID-19, (2) knowledge regarding the disease and the virus that causes it, and (3) the prevalence of depression and anxiety. This is one of the first studies to examine the relationships between students' SMU for information on COVID-19 and concurrent understanding of the disease and health behaviors.

Methods

Study Setting

On March 12th, 2020, Nevada's Governor declared a state of emergency due to COVID-19, ordered all K-12 schools and non-essential businesses to close, and signed a directive asking Nevadans to practice social distancing. On March 23rd, 2020, UNR announced a transition to online instruction through the end of the semester and a closure of buildings. We collected data from May 4th - 30th, 2020, when the UNR campus was closed, mandates for social distancing were in place, and only a few specific types of low-transmission risk businesses had been allowed to reopen, and with heavy restrictions.

Study Design

We implemented a cross-sectional survey design online using Qualtrics software (Qualtrics, Provo, UT). Students aged ≥ 18 years old and enrolled at UNR were eligible to participate. A random sample from the student directory, which contained email address and demographic data for 96.2% of all UNR students during the survey period (Table 1), was used to invite 1,570 undergraduate and graduate students to participate. Our sample size calculation was based on a desired power of 0.80, 95% confidence, an effect size of 0.2, and a response rate of ~50% (Porter & Umbach, 2006). In the email invitation to the study, potential participants were informed that the study was voluntary, that responses were confidential, and that the survey was approved by the university's human subjects' protection board. Age and willingness to participate were confirmed in the first two survey questions. This study was conducted with approval from the Institutional Review Board of UNR.

Table 1

Demographic Data of University of Nevada Reno (UNR) Student Body Compared to Survey Sample

Variable	Level(s)	UNR, *%(n)*	Sample, *%(n)*	*P*-value†
Gender[a]	Male	46.0 (8,226)	27.1 (49)	< 0.0001
	Female	54.0 (9,652)	72.9 (132)	
Race/ Ethnicity[b]	White	57.0 (9,631)	56.5 (104)	< 0.0001
	Asian	9.2 (1,550)	17.9 (33)	
	Other	33.9 (5,728)	25.5 (47)	
Age[c] (years)	18-24	75.4 (13,494)	76.1 (140)	< 0.0001
	25-34	17.1 (3,059)	18.5 (34)	
	≥ 35	7.4 (1,332)	5.4 (10)	
Class Standing[d]	Freshman	13.0 (2,330)	19.0 (35)	0.1284
	Sophomore	16.2 (2,897)	13.0 (24)	
	Junior	20.2 (3,619)	20.7 (38)	
	Senior	29.8 (5,333)	26.1 (48)	
	Graduate	17.8 (3,183)	16.8 (31)	
	Other	2.9 (523)	4.3 (8)	

Note. †Chi-square p-value; [a]Gender nonresponse & nonbinary/other: UNR = 7; Sample = 11; [b]Race/ethnicity nonresponse: UNR = 976; Sample = 8; [c]Age nonresponse: UNR = 0; Sample = 8; [d]Class standing nonresponse: UNR = 0; Sample = 8.

Measurements

Established survey instruments and novel questions were used in this study. For novel survey questions we conducted informal cognitive interviews with family, friends, and colleagues prior to survey administration to enhance clarity and precision of questions. The survey examined how COVID-19 was impacting students personally, academically, and professionally, and how students were responding to the disruption. A subset of survey questions was used in this analysis: SMU for information on COVID-19, adherence to physical distancing guidelines, knowledge about COVID-19 and the virus that causes it, and student mental health symptoms.

Independent variables. Our main independent variable of interest was SMU. Participants were asked how they had been seeking information regarding COVID-19 in a “check all that apply” question with seven options: County/state/federal government announcements, social media (such as Instagram, Facebook, Twitter, etc.), national/ international new media outlets (such as Fox, CNN, BBC), local news media outlets (state or county), word-of-mouth, UNR announcements, or “Other”. In the next question, participants were asked to rank the sources they had identified in order from most to least used. We then coded SMU for information on COVID-19 with three categories (1) none, (2) sometimes, or (3) main source for information.

The survey also asked for demographic characteristics of gender, race/ethnicity, age, and class standing.

Dependent variables. Adherence to physical distancing was assessed using five questions (Table 2).

Table 2

Survey Responses Overall and Stratified by Level of Social Media Use with Chi-square P-values

Topic	Question	Overall	No Use	Some use	Main source	*p*-value
Adherence[a]	Avoiding groups ≥ 10 people, *n (%)*	91.3 (167)	92.2 (48)	88.9 (89)	97.0 (30)	0.693†
	Maintaining a six-foot distance from others, *n (%)*	79.6 (147)	74.6 (40)	77.3 (78)	95.2 (29)	0.143
	Avoiding all unnecessary trips, *n (%)*	81.4 (150*)	81.5 (42*)	80.0 (81)	85.2 (27)	0.825
	Cleaning/disinfecting more frequently than before COVID-19, *n (%)*	82.8 (152**)	79.3 (43*)	82.5 (81*)	89.3 (28)	0.646
	Did not enter home of friend or family member, *n (%)*	38.5 (70*)	33.8 (20)	45.6 (42*)	24.8 (8)	0.220
Knowledge[b]	Virus can live on surfaces (T), *n (%)*	96.1 (175)	96.6 (51)	97.4 (95)	91.3 (29)	0.625†
	Only elderly/those w/ pre-existing conditions get very sick (F)	88.3 (159)	88.0 (44)	89.1 (88)	86.4 (27)	0.613†
	A vaccination exists (F), *n (%)*	97.3 (177)	100.0 (52)	97.4 (95)	92.8 (30)	0.438
	More infectious than seasonal flu (T), *n (%)*	84.0 (155)	84.3 (45)	85.1 (83)	80.3 (27)	0.924
	More deadly than seasonal flu (T), *n (%)*	74.6 (135)	76.1 (39)	78.3 (77)	60.5 (19)	0.156
	All races equally likely to be immune (T), *n (%)*	96.3 (171**)	100.0 (52)	93.9 (89**)	97.6 (30)	0.114
Depression[c] (PHQ-8)	Little interest or pleasure in doing things, *n (%)*	31.9 (63*)	23.9 (14*)	33.0 (38)	41.7 (11)	0.388
	Feeling down, depressed, or hopeless, *n (%)*	29.4 (57*)	26.5 (13*)	26.0 (32)	44.8 (12)	0.437
	Trouble falling/staying asleep or sleeping too much, *n (%)*	46.1 (89*)	42.6 (24*)	48.6 (51)	44.2 (14)	0.738
	Feeling tired or having little energy, *n (%)*	44.7 (84*)	34.5 (19*)	46.5 (50)	56.2 (15)	0.273
	Poor appetite or overeating, *n (%)*	34.2 (69***)	25.4 (14**)	39.8 (44*)	31.6 (11)	0.113
	Feeling bad about oneself/disappointing, *n (%)*	30.0 (53***)	27.8 (12*)	25.1 (29)	46.7 (12**)	0.244
	Trouble concentrating, *n (%)*	34.2 (72*)	29.5 (17*)	35.0 (43)	39.7 (12)	0.454
	Moving very slow or opposite of being very fidgety, *n (%)*	11.3 (24*)	8.1 (6*)	15.1 (16)	5.4 (2)	0.343
	PHQ-8 score, *mean (SE)*	9.77 (0.45)	8.98 (0.88)	10.17 (0.60)	9.81 (1.08)	0.391††
Anxiety[d] (GAD-7)	Feeling nervous, anxious, or on edge, *n (%)*	30.7 (62*)	21.7 (12*)	32.8 (39)	39.1 (11)	0.139
	Not being able to stop worrying, *n (%)*	26.1 (55*)	23.2 (13*)	26.7 (33)	29.0 (9)	0.577
	Worrying too much about different things, *n (%)*	34.1 (66*)	23.9 (14*)	38.7 (42)	36.7 (10)	0.154
	Trouble relaxing, *n (%)*	24.3 (48**)	19.2 (10**)	29.6 (34)	16.3 (4)	0.025
	Being so restless that it is hard to sit still, *n (%)*	19.3 (36*)	17.4 (9*)	19.0 (21)	23.7 (6)	0.857
	Becoming easily annoyed or irritable, *n (%)*	33.3 (63*)	33.9 (17*)	33.4 (36)	32.0 (10)	0.863
	Feeling afraid as if something awful might happen, *n (%)*	18.4 (41*)	17.7 (9*)	18.9 (26)	18.4 (6)	0.416
	Mean GAD-7 score, *mean (SE)*	7.69 (0.42)	6.61 (0.77)	8.36 (0.58)	7.39 (0.97)	0.252††

Note. †Fisher's exact *p*-values; ††ANOVA *p*-values; [a]*n* = # students who agree/strongly agree to following each guideline, except for "Did not enter..." *n* = # who did not enter another's home; [b]*n* = # students who answered knowledge-based question correctly, answers are indicated as True (T) or False (F); [c]*n* = # of students reporting presence of symptoms on ≥ half the days/nearly every day during previous two weeks; *One, **two, or ***three missing responses

The first four questions were preceded with the statement, "To what extent do you agree with the following statements, "Since the Governor's order in mid-March, ..." followed by public health guidelines phrased as first-person perspective statements to which students could respond on a five-point Likert scale ("strongly agree" to "strongly disagree"). We coded Likert-responses to binary outcomes with "agreed to adhering = 1" ("strongly agree" and "agree") or "did not agree to adhering = 0" ("neutral"," disagree", and "strongly disagree"). The fifth question asked whether students had entered the home of a friend/family member since physical distancing measures were issued ("yes/no" coded as 0/1). Results from adherence questions were summed to create a scale that ranged from 0-5, with higher scores representing higher adherence.

COVID-19 knowledge was assessed using six true/false questions ("correct = 1" or "incorrect = 0"; Table 2), summed to create a knowledge scale, with higher scores representing better understanding.

We assessed student mental health using the PHQ-8 and GAD-7 screening questionnaires. These are well-validated screening tools for depression and anxiety, and their cut-offs have been validated for university students (Bártolo et al., 2017; Kroenke et al., 2010; Lee & Kim, 2019). Results were calculated based on standardized methods: We (1) converted Likert responses using "none at all = 0", "several days = 1", "more than half the days = 2", "nearly every day = 3"; (2) summed the numeric values for the questions on each scale; and (3) coded summed scores ≥ 10 as presence of depression/generalized anxiety and scores < 10 as absence of depression/generalized anxiety (Kroenke et al., 2009; Spitzer et al., 2006). Cronbach's alpha for the PHQ-8 is often high (~ 0.90) and the GAD-7 generally shows excellent Cronbach's alpha values (~0.92-0.93), although lower values have been found among college students (~0.84: Bártolo et al., 2017; Spitzer et al., 2006). In our study, Cronbach's alpha was 0.892 for the PHQ-8 and 0.920 for the GAD-7.

Data Analysis

Univariate regressions were used to test relationships between SMU and the outcome variables, and we subsequently applied multivariable ordinal regressions to re-test relationships while adjusting for demographics. In the multivariable analysis of adherence, we also adjusted for knowledge scores. For all regressions, we used R's MASS package (Venables & Ripley, 2002): The polr function was used to model adherence and knowledge as ordinal outcomes while the glm function was used to model depression and anxiety as binary outcomes. We express results as odds ratios (OR) with 95% confidence intervals (95% CI) and *p*-values. Significance was assessed at $\alpha = 0.05$ but trends under $\alpha = 0.10$ are noted.

Results

A total of 232 surveys were returned resulting in a response rate of 14.8%. Data cleaning resulted in 51 surveys being removed due to missing data (Table 1). The age and class standing composition in our sample and the UNR student body were highly similar (mean difference = 1.4±0.4% and 2.6±0.8% SEM, respectively), but our sample was over-representative of female (18.9% higher) and Asian students (8.7% higher: Table 1). Therefore, we weighted our results based on gender and race/ethnicity to account for possible nonresponse bias; weights ranged from 0.336 for Asian female students to 2.271 for "Other" race/ethnicity male students.

Our sample sizes were 181 for adherence/knowledge outcomes and 180 for depression/anxiety outcomes (one person skipped the mental health sections: Tables 3-5). Sample sizes were the same for multivariable tests because there was no item non-response for age/class standing, we required gender and ethnicity responses for weighting, and we treated missing data as "didn't adhere/not correct/no symptom" for the adherence/knowledge/mental health scales. The structure of the ordinal regressions (adherence/knowledge outcomes) was the most complex and required the largest sample sizes of our inferential tests. *Post hoc* power analyses showed that given a sample size of 181, 95% confidence, and the four outcome levels/distributions, ORs for small (1.1), medium (1.3), and large (1.5) effect sizes resulted in statistical power of approximately 0.05, 0.16, and 0.31 (Cohen, 1988; Harrell et al., 2020).

Table 3

Adherence Scores (Mean ± SEM) and Results of Univariable & Multivariable Weighted Ordinal Regressions (N = 181 in all cases)

		Adherence	Univariable		Multivariable[b]	
Variable	**Levels**	**Mean[a] ± SE**	**OR [95%CI]**	***p*-value**	**aOR [95%CI]**	***p*-value**
Social Media Use	No use	3.71 ± 0.17	*ref*	*ref*	*ref*	*ref*
	Some use	3.79 ± 0.13	1.41 [0.76-2.63]	0.275	1.51 [0.76-3.02]	0.237
	Main Source	3.94 ± 0.14	1.33 [0.61-2.90]	0.476	1.46 [0.61-3.50]	0.395
Gender	Female	3.83 ± 0.10	*ref*	*ref*	*ref*	*ref*
	Male	3.67 ± 0.18	0.81 [0.47-1.38]	0.434	0.79 [0.45-1.40]	0.430
Race/ Ethnicity	Caucasian	3.69 ± 0.12	*ref*	*ref*	*ref*	*ref*
	Asian	4.09 ± 0.19	1.59 [0.62-4.17]	0.336	1.67 [0.63-4.56]	0.303
	Other	3.80 ± 0.16	0.94 [0.52-1.68]	0.845	0.89 [0.49-1.64]	0.719
Age	18-24	3.72 ± 0.11	*ref*	*ref*	*ref*	*ref*
	25-34	3.97 ± 0.17	1.18 [0.60-2.33]	0.633	0.93 [0.33-2.70]	0.896
	≥ 35	4.10 ± 0.23	1.07 [0.36-3.30]	0.903	1.11 [0.27-4.53]	0.882
Class Standing	Freshman	3.29 ± 0.27	*ref*	*ref*	*ref*	*ref*
	Sophomore	3.74 ± 0.20	1.61 [0.62-4.23]	0.326	1.55 [0.56-4.33]	0.399
	Junior	4.13 ± 0.14	**4.77 [2.02-11.52]**	**0.0004**	**5.50 [2.15-14.41]**	**0.0004**
	Senior	3.77 ± 0.19	**2.53 [1.10-5.88]**	**0.030**	**2.65 [1.04-6.83]**	**0.041**
	Graduate	4.10 ± 0.15	**2.57 [1.05-6.41]**	**0.040**	2.48 [0.65-9.53]	0.183
	Other	3.38 ± 0.46	1.38 [0.29-6.50]	0.685	2.12 [0.38-11.99]	0.389
Knowledge	3/6 correct	2.60 ± 0.93	*ref*	*ref*	*ref*	*ref*
	4/6 correct	3.13 ± 0.31	1.05 [0.17-6.39]	0.954	0.43 [0.06-3.07]	0.402
	5/6 correct	3.78 ± 0.16	2.59 [0.46-14.56]	0.272	1.16 [0.17-7.26]	0.876
	All correct	4.01 ± 0.10	3.62 [0.67-19.72]	0.131	1.67 [0.26-10.32]	0.581

Note. [a]Adherence to physical distancing scores range from zero (not adhering to any) to five (strongly adhering to all); [b]Multivariable model includes all six variables; Bold text indicates significance at $\alpha = 0.05$.

Table 4

COVID-19 Knowledge Scores (Mean ± SEM) and Results of Univariable & Multivariable Weighted Ordinal Regressions (N = 181 in all cases)

		Knowledge	**Univariable**		**Multivariable[b]**	
Variable	**Levels**	**Mean[a] ± SE**	**OR [95%CI]**	***p*-value**	**aOR [95%CI]**	***p*-value**
Social Media Use	No use	5.44 ± 0.11	*ref*	*ref*	*ref*	*ref*
	Some use	5.38 ± 0.08	0.84 [0.43-1.64]	0.620	0.90 [0.42-1.86]	0.769
	Main Source	5.23 ± 0.16	0.44 [0.19-1.02]	0.056*	0.43 [0.17-1.06]	0.068*
Gender	Female	5.38 ± 0.07	*ref*	*ref*	*ref*	*ref*
	Male	5.35 ± 0.13	1.06 [0.60-1.87]	0.844	1.11 [0.61-2.05]	0.729
Race/ Ethnicity	Caucasian	5.45 ± 0.08	*ref*	*ref*	*ref*	*ref*
	Asian	5.33 ± 0.14	0.70 [0.27-1.93]	0.477	0.65 [0.24-1.87]	0.415
	Other	5.22 ± 0.13	0.61 [0.33-1.12]	0.111	0.54 [0.28-1.03]	0.061*
Age	18-24	5.31 ± 0.07	*ref*	*ref*	*ref*	*ref*
	25-34	5.53 ± 0.11	1.91 [0.93-4.16]	0.089*	2.44 [0.71-9.92]	0.179
	≥ 35	5.60 ± 0.16	1.54 [0.47-5.89]	0.490	1.39 [0.29-7.55]	0.689
Class Standing	Freshman	5.12 ± 0.18	*ref*	*ref*	*ref*	*ref*
	Sophomore	5.52 ± 0.16	**3.21 [1.08-10.43]**	**0.041**	3.34 [1.09-11.14]	**0.040**
	Junior	5.39 ± 0.12	2.00 [0.84-4.81]	0.117	2.31 [0.95-5.72]	0.066*
	Senior	5.43 ± 0.12	2.30 [0.99-5.47]	0.056*	2.39 [0.97-5.98]	0.059*
	Graduate	5.55 ± 0.09	**2.57 [1.04-6.49]**	**0.042**	1.46 [0.31-6.40]	0.620
	Other	4.88 ± 0.30	0.63 [0.99-5.47]	0.542	0.48 [0.10-2.32]	0.350

Note. [a]Knowledge scores range from zero (none correct) to six (all answers correct); [b]Multivariable model includes all five variables; $*p \leq 0.10$; Bold text indicates significance at $\alpha = 0.05$.

Adherence to Guidelines

Students generally agreed that they were adhering to social distancing measures (range: 79.6-91.3% overall), but only 38.5% of students reported that they had not entered the homes of friends/family (Table 2). Mean adherence scores were 3.71±0.17 for no use, 3.79±0.13 for some use, and 3.94±0.14 SEM for main source. These differences were not significant in univariable or multivariable regressions (Table 3), but class standing was related to adherence in both regressions: Juniors and seniors showed higher odds of adhering than freshmen (~5x and 2.5x higher, respectively), and graduate students showed 2.6x greater odds of adherence than freshmen in the univariable test (Table 3).

COVID-19 Knowledge

The percentages of correct answers to knowledge questions were generally high (range: 74.6-96.3%; Table 2). Over 90% of students knew that [at the time of the survey] there was no vaccine, the virus could live on surfaces for hours, and people of different race/ethnicity had the same level of natural immunity. Fewer students understood that not only the elderly and individuals with pre-existing conditions can become very sick due to the virus (88.3%), or that the virus is more infectious (84.0%) and deadly (74.6%) than the seasonal flu (Table 2).

There was evidence of a negative association between knowledge scores and SMU (no use: 5.44±0.11 SEM; some use:

Table 5

Weighted Logistic Regression Results on Depression and Anxiety among Students (N = 180 in All Cases)

Variable	Levels	Prevalence %[a] (n/N)	Univariable OR [95%CI]	Univariable *p*-value	Multivariable[b] OR [95%CI]	Multivariable[b] *p*-value
Depression (PHQ-8)						
Social Media Use	No use	38.7 (21/51)	*ref*	*ref*	*ref*	*ref*
	Some use	43.1 (48/98)	1.20 [0.60-2.43]	0.603	0.90 [0.41-1.96]	0.786
	Main Source	51.9 (15/31)	1.71 [0.70-4.26]	0.244	1.42 [0.52-3.91]	0.498
Gender	Female	48.8 (65/131)	*ref*	*ref*	*ref*	*ref*
	Male	37.0 (19/49)	0.62 [0.34-1.12]	0.112	0.52 [0.26-1.02]	0.063*
Race/ Ethnicity	Caucasian	48.0 (49/102)	*ref*	*ref*	*ref*	*ref*
	Asian	48.2 (17/33)	1.01 [0.35-2.91]	0.99	0.87 [0.28-2.73]	0.813
	Other	34.4 (18/45)	0.57 [0.29-1.09]	0.10*	0.55 [0.27-1.13]	0.109
Age	18-24	43.7 (65/136)	*ref*	*ref*	*ref*	*ref*
	25-34	49.9 (17/34)	1.28 [0.60-2.73]	0.519	0.62 [0.14-2.26]	0.483
	≥ 35	15.8 (2/10)	0.24 [0.03-1.13]	0.118	0.10 [0.01-0.81]	0.054*
Class Standing	Freshman	45.8 (15/34)	*ref*	*ref*	*ref*	*ref*
	Sophomore	61.3 (15/23)	1.87 [0.63-5.83]	0.266	1.81 [0.58-5.89]	0.313
	Junior	38.2 (15/38)	0.73 [0.29-1.85]	0.511	0.71 [0.26-1.87]	0.484
	Senior	31.5 (19/47)	0.54 [0.22-1.35]	0.193	0.54 [0.20-1.46]	0.231
	Graduate	52.2 (17/31)	1.29 [0.49-3.43]	0.607	2.69 [0.54-15.52]	0.245
	Other	43.1 (3/7)	0.89 [0.13-5.54]	0.904	1.00 [0.13-7.28]	0.999
Anxiety (GAD-7)						
Social Media Use	No use	19.7 (12/51)	*ref*	*ref*	*ref*	*ref*
	Some use	27.0 (34/98)	1.51 [0.68-3.56]	0.332	1.33 [0.55-3.39]	0.532
	Main Source	36.7 (10/31)	2.36 [0.87-6.55]	0.095*	2.10 [0.70-6.49]	0.189
Gender	Female	35.3 (47/131)	*ref*	*ref*	*ref*	*ref*
	Male	16.5 (9/49)	0.36 [0.17-0.73]	**0.006**	0.30 [0.13-0.64]	**0.003**
Ethnicity	Caucasian	31.3 (35/102)	*ref*	*ref*	*ref*	*ref*
	Asian	30.5 (11/33)	0.96 [0.28-2.88]	0.950	0.84 [0.22-2.81]	0.782
	Other	17.7 (10/45)	0.47 [0.21-1.01]	0.062*	0.42 [0.18-0.96]	**0.048**
Age	18-24	26.7 (43/136)	*ref*	*ref*	*ref*	*ref*
	25-34	29.4 (11/34)	1.14 [0.48-2.57]	0.755	0.25 [0.03-1.23]	0.137
	≥ 35	15.8 (2/10)	0.51 [0.05-2.43]	0.465	0.10 [0.005-1.18]	0.102
Class Standing	Freshman	20.6 (9/34)	*ref*	*ref*	*ref*	*ref*
	Sophomore	26.3 (7/23)	1.38 [0.37-4.91]	0.622	1.29 [0.33-4.84]	0.706
	Junior	33.7 (13/38)	1.96 [0.70-5.85]	0.210	2.21 [0.74-6.95]	0.165
	Senior	18.4 (11/47)	0.87 [0.28-2.68]	0.803	0.81 [0.25-2.66]	0.724
	Graduate	37.3 (14/31)	2.29 [0.78-7.07]	0.139	10.68 [1.54-130.0]	**0.030**
	Other	26.5 (2/7)	1.39 [0.12-9.59]	0.751	1.62 [0.14-12.82]	0.661

Note. [a]Percentage of students with depression/anxiety weighted for gender/ethnicity; [b]Multivariable model includes all five variables; *$p \leq 0.10$; Bold text indicates significance at $\alpha = 0.05$.

5.38±0.08 SEM; main source: 5.23±0.16 SEM), but these differences did not reach significance at the 95% confidence level in univariable (main source vs. no use: p = 0.056) or multivariable regressions (main source vs. no use: p = 0.068; Table 4). However, class standing was related to knowledge: Relative to freshman students, sophomores showed higher odds of correct answers in both regressions, graduate students showed higher odds in the univariate regression, and nonsignificant trends of higher understanding were indicated for juniors and seniors in both tests (Table 4).

Mental Health

The prevalence of depression among students who reported no SMU for information on COVID-19 was 38.7% (N = 21/51), for students who reported some SMU it was 42.1% (N = 48/98), and over half of the students who used social media as their main source of information were categorized as having depression (N = 15/31). However, there was not a significant relationship between SMU and depression (in all cases $p \geq 0.244$; Table 5). In the multivariable model, depression was slightly higher among females than males, and among older individuals than younger ones, but these trends were also not significant at the 95% confidence level (in both cases $p \geq 0.054$; Table 5).

The prevalence of anxiety among students who reported no SMU for information on COVID-19 was 19.7% (N = 12/51), for students who reported some use it was 27.0% (N = 37/98), and for students who reported SMU as their main source of COVID-19 information it was 36.7% (N = 10/31). There was some evidence of a relationship between SMU and anxiety in the univariable (p = 0.095) but not multivariable test (p = 0.189; Table 5). We found lower odds of anxiety among males compared to females (OR 0.36 and 0.30), and among "Other" ethnicities relative to Caucasians (OR = 0.06 and 0.048), and higher odds of anxiety among graduate relative to freshman students in multivariable regressions (OR = 10.68; Table 5).

Academic Discipline

We explored whether students' academic majors may have impacted results using *post-hoc* descriptive statistics for class standing, SMU, adherence, and knowledge scores based on academic discipline. We collapsed majors reported by students into nine disciplines based on the bepress taxonomy guide (Disciplines: Digital Commons, 2020). The number of students in each discipline ranged from 9-39 and the mean was 20±3.5 (SEM) students. Variability in knowledge and adherence scores between disciplines was high (Figure 1).

We used Pearson r correlations to check whether associations at the individual level held at the discipline level. We regressed the proportion of freshman students in each discipline against mean adherence and knowledge scores to see if higher proportions were associated with lower scores. The relationship was in the expected direction and significant for adherence (r = -0.704, p = 0.034) but not knowledge (r = -0.457, p = 0.216). We also calculated mean SMU for each discipline (using "1 = none", "2 = some", and "3 = main source"), and regressed it against adherence and knowledge scores to check if SMU was related to adherence or knowledge at the discipline level. As with the individual-level tests, there was evidence of a negative relationship between SMU and knowledge (r = -0.664, p = 0.051) but not adherence (r = -0.287, p = 0.454).

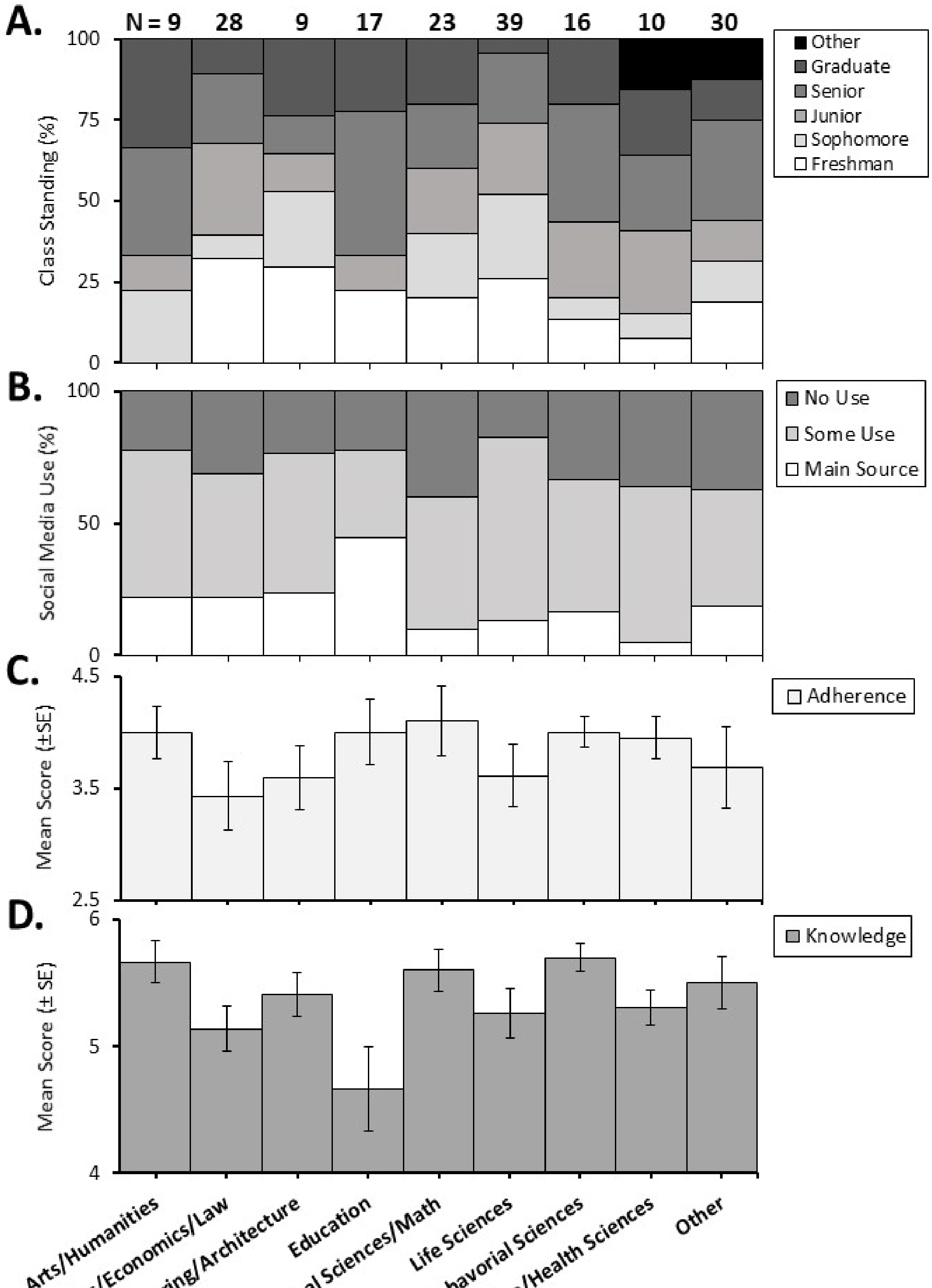

Figure 1. Student Characteristics by Academic Discipline: Class Standing (A) and SMU (B) Percentages; Mean Adherence (C) and Knowledge (D) Scores (± Standard Error)

Discussion

COVID-19 has been a time of public health crisis and a unique period of our history during which to monitor SMU as a factor related to how different individuals experience and respond to the emerging health threat. To the best of our knowledge, this study is among the first to use a single cohort to assess SMU for health information seeking and corresponding adherence to public health guidelines, health knowledge, and mental health symptoms. Our findings provide evidence that SMU for information about COVID-19 may be negatively associated with understanding of the disease/virus and positively associated with anxiety. The theory of social amplification of risks supports a positive relationship between SMU for information on COVID-19 and anxiety (Garfin et al., 2020; Kasperson et al., 1988), and social media platforms are known to amplify/disseminate misinformation (Chou et al., 2018; Sharma et al., 2017; Wang et al., 2019), which supports the trends between SMU and knowledge/anxiety that we found at both the individual and discipline levels. Our study is one of the first to be conducted on SMU and mental health during COVID-19 outside of China, but growing evidence from China during the pandemic (Drouin et al., 2020; Gao et al., 2020; Ni et al., 2020) and elsewhere prior (Kelly et al., 2018; Lin et al., 2016; Stanton et al., 2017; Sujarwoto et al., 2019) has shown a correlation between higher SMU and higher prevalence of anxiety/depression (Drouin et al., 2020; Gao et al., 2020; Ni et al., 2020). However, it should be noted that these findings come from cross-sectional studies that assessed correlation rather than causation (Keles et al., 2020). The preliminary results observed in this study fit well with current understanding of social media influences on the dissemination of scientific information and associations with mental health, and provide a novel assessment of how these factors are related to health behaviors and knowledge during an emerging infectious disease pandemic.

Students reported high overall adherence to social distancing guidelines, but most students gathered with friends/family members in their homes during social distancing mandates. Because agreement was lowest for “avoiding gathering in indoor environments” and some outdoor areas closed during the study period, it is possible that increased outdoor recreation options during future shutdowns may improve adherence and reduce transmission. Students forced out of closing dorms or who lost their jobs during the shutdowns may have needed to return home to live with their family, and those students may have benefited from fewer distractions, lower exposure risk, and better access to nutrition-rich food. Research is needed to clarify what factors led students to observe most health guidelines yet enter the homes of their family/friends, and whether the net effect of entering others’ homes was beneficial or harmful for health.

Our finding that freshman students, relative to upperclassmen, understood less about COVID-19 and were less likely to follow guidelines, has important implications for university environments. Our results indicate that the relationships observed between class standing and COVID-19 adherence/knowledge are unlikely to be due to differences in age between cohorts: Student age was not significantly related to adherence or knowledge and we found trends between class standing and adherence to public health guidelines at both the individual (freshman/upperclassman) and discipline (proportion of freshmen) levels. Unlike other students, freshmen are coping with the demands of transitioning to college and confront many changes to their lives and social networks (De Clercq et al., 2018), with about 30% not returning for their second year

(Miller, 2019). Being occupied with adjusting to the transitions to college might have contributed to this group being less knowledgeable about the virus and less adherent compared with students in higher grade levels. A recent study found that students who were in their sophomore or junior year scored higher than those in their freshman year for changing COVID-19 related health behaviors (e.g., hand-washing habits), and class standing appeared to impact health behaviors through perceived susceptibility, severity, and barriers (Li et al., 2021). Increased monitoring for freshman adherence to health guidelines and tailoring messaging to freshman students may reduce the spread of COVID-19.

Limitations & Future Research

Limitations that should be considered include that the realized sample in this study was small ($N = 181$) and focused on students at a single university. For non-significant tests, type II error rates may be high because statistical power was generally low. A small sample was obtained due to high non-response and in retrospect, we should have attempted to recruit more students. It is possible that disruption due to the pandemic may have contributed to the lower response rate because students were still adjusting to the pandemic and may not have been as available to respond to surveys, while also being asked to participate in more surveys than normal. However, we had very low coverage error because our sampling frame contained 96% of the target population, and our respondents were representative of the sampling pool. The only meaningful differences between our sample and the UNR student population were a higher number of women and Asians, which were controlled by weighting. Although our sample was drawn from one university, similar shutdowns occurred in many states and countries. By March of 2020, over 100 countries had ordered school closures to reduce COVID-19 transmission (Viner et al., 2020). Future research may benefit from anticipating lower-than-normal response rates during pandemics (even in areas with low disease incidence), testing relationships between academic discipline and SMU associations with health knowledge/behaviors, and sampling students from multiple universities.

Asking subjects to rank a list of sources in order of what they go to first/use most is an established approach to quantifying health information seeking behavior (Basch et al., 2018; Lambert & Loiselle, 2007), but future research that defines SMU in more detail would be beneficial. Individuals who use reputable social media sites (e.g., WHO's Facebook page) for information should be differentiated from those using opinion posts or information from sites that lack scientific support. Relationships between level/ intensity of SMU and specific resources used are poorly understood (e.g., whether heavy users utilize different SM features than light users), but the type of health information sought can relate to the method used for seeking information. For example, SM is more likely to be used for information on the impact of health conditions on lifestyles and general understanding of medical procedures than web search engines (De Choudhury et al., 2014). Therefore, future research would benefit from a more detailed assessment of SMU and should aim to measure platforms used, sites visited, and the type of information sought by users.

Another consideration when interpreting our results is that the psychometric properties of the PHQ-8 and GAD-7 may not be the same during pandemic and non-pandemic times. For example, when campuses closed, students could not use the university gym to exercise and no longer needed to wake up for asynchronous classes, and these changes may have altered sleep habits and increased PHQ-8 scores. However, our findings are largely consistent with other studies, which lends evidence of credibility to the validity of these scales despite societal changes. For example, we found higher depression and anxiety among females compared with males, which is consistent with well-established gender differences in mental health reporting from non-pandemic times (McLean & Anderson, 2009; Piccinelli & Wilkinson, 2000). We found higher anxiety among Caucasian students than "other" ethnicities, which is common for U.S. students and adults (Asnaani et al., 2010, Jones et al., 2018). We also found higher anxiety among graduate than freshman students, although graduate students normally have lower levels of anxiety than freshman/undergraduates (Chappell et al., 2005; Nienaber & Goedereis, 2015). A recent study on Chinese students during COVID-19 campus shutdowns also found higher anxiety among graduate students (Fu et al., 2021), but like our work the study was cross-sectional and pre-COVID anxiety levels would be needed to evaluate whether atypical trends in mental health symptoms are due to differential impacts of COVID-19 or other causes such as altered psychometric properties of standard scales.

This study relied on self-reported data which presents the risk of information bias. However, it is important to note that students in our study were blinded to the exposure of interest: They were asked to rank sources of COVID-19 information from most to least used, and responses were used to construct the SMU groups. Thus, dependent errors due to self-reporting of exposure and outcome are less likely. Moreover, SMU associations with knowledge at the individual level were consistent at the discipline level and this consistency is unlikely under a high SMU misclassification scenario. Reporting bias for the knowledge, depression, and anxiety outcomes are also unlikely because knowledge cannot be forged (only ignorance which seems improbable), and the depression/anxiety scales are well-validated and showed high internal consistency in our study. However, self-reporting of adherence may be vulnerable to social desirability bias and dependent errors (if SMU relates to social desirability bias) and should be interpreted cautiously.

Lastly, our results were cross-sectional and represent a snapshot in time early in the pandemic. Because we measured the exposure and outcome at the same time only correlation can be considered and reverse causation cannot be ruled out (Aalbers et al., 2019). Like our study, most research on SMU and health/heath behavior has been cross-sectional and longitudinal studies are needed (Keles et al., 2020). Moreover, other variables like social support, mental health history, and substance use may also be important but were not measured in this study. Because this survey was administered before mask-wearing requirements were issued, we did not include mask wearing in our assessment of adherence although this remains a highly important health behavior that should be investigated regarding SMU.

Linking adherence data to monitoring of SMU directly and over time would be a valuable avenue of future research that could remove self-reporting issues and temporal effects while also addressing differences between various social media platforms and information sources.

Conclusions

Increasing human populations, encroachment on wildlife habitat, and globalization are likely to increase the frequency of pandemics in the future (Jones et al., 2008; Morse, 1995), and SMU for health information continues to increase rapidly (Moorhead et al., 2013; Zhao & Zhang, 2017). Our study provides novel evidence of the relationships between SMU for information on an emerging pandemic and individuals' health literacy, and reveals trends between SMU and anxiety/knowledge which complement significant findings from other studies (Drouin et al., 2020; Gao et al., 2020; Ni et al., 2020). Future research should be conducted with the goal of facilitating the development of social media tools that increase understanding of, and adherence to, public health guidelines while also strategically addressing and minimizing negative impacts on mental health during infectious disease outbreaks. Resources should be used to design social media campaigns that account for life stage differences to counter misinformation (Drouin et al., 2020; Moorhead et al., 2013; Wang et al., 2019). Our results complement these objectives and add novel evidence that university freshmen may be a particularly important group for tailored social media campaigns to increase understanding and decrease transmission of infectious diseases on university campuses. In the case of COVID-19, these campaigns should: (1) emphasize that young healthy people can become sick, (2) explain why COVID-19 is different than the seasonal flu, and (3) encourage young people to meet with family/friends in outdoor environments.

Discussion Questions

1. We suggest that high reliance on social media for information on COVID-19 may be negatively associated with knowledge about the disease/virus and positively associated with adverse mental health outcomes. When public health practitioners develop social media campaigns to foster understanding and adherence to health guidelines during infectious disease pandemics, what should be done to avoid possibly increasing symptoms of anxiety among viewers?

2. Our findings suggest that college freshmen are a high-risk group for spreading infectious respiratory diseases due to lower health literacy and low adherence to public health guidelines relative to other classes of university-level students. What are some ways in which universities and public health agencies could develop tailored social media campaigns to inform and improve adherence to guidelines among college freshmen?

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