Impact of the Covid-19 Pandemic on Physical Activity, Depression, and Anxiety among Graduate Students in the United States

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IMPACT OF THE COVID-19 PANDEMIC ON PHYSICAL ACTIVITY, DEPRESSION, AND ANXIETY AMONG GRADUATE STUDENTS IN THE UNITED STATES

By

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ABSTRACT

Billions of people have been impacted by the COVID-19 pandemic since we initially became aware of its existence in December 2019. Studies have been done since the emergence of the COVID-19 virus to assess its effect on people (e.g., Duan & Zhu, 2020; Rubin & Wesseley, 2020). Specifically, several health organizations, including the World Health Organization (WHO), have reported their concerns about the effects on an individual’s mental health (WHO, 2020) as well as one’s physical health (Centers for Disease Control and Prevention [CDC], 2021).

While a variety of studies have focused more on undergraduate students (e.g., Bertrand et al., 2021; Gallo, T. F. Gallo, Young, Moritz, & Akison, 2020; Meyer et al., 2020), this study is an investigation of graduate students in the United States. There has been a significant lack of research regarding graduate students (Keating, Jianmin, Pinero, & Bridges, 2005), and more importantly, a lack of research regarding COVID-19’s impact on graduate student’s mental health in potential relation to physical activity levels. According to previous studies, graduate students are already predisposed for having a high risk of developing mental health issues due to the nature of their educational careers (Evans, Bira, Gastelum, Weiss, & Vanderford, 2018; Fogg, 2009; Hyun, Quinn, Madon, & Lustig, 2006). Master’s and doctoral students are reportedly more likely to experience higher levels of depression, anxiety, financial stress, career uncertainty, and higher workloads (Eisenberg, Gollust, Golberstein, & Hefner, 2007; Gewin, 2012; L. Wang, 2015), while also having lower levels of physical activity and exercise participation, which has now become exacerbated by many governments’ stringent COVID-19 reduction measures (Barkley et al., 2020; Srivastav, Sharma, & Samual, 2021).
Physical activity has been shown for decades to help reduce mental health issues and increase mental well-being (Abu-Omar, Rütten, & Lehtinen, 2004; Camacho, Roberts, Lazarus, Kaplan, & Cohen, 1991; Goodwin, 2003). In this study, the association between physical activity and mental health of graduate students was examined during the pandemic. Information regarding pre-COVID-19 and current COVID-19 levels was attained for comparison. I examined the differences in the levels of physical activity, depression, and anxiety among graduate students in the United States before (February 2020) and after the outbreak of the COVID-19 pandemic (May 2021). A second purpose of this study was to examine whether differences in physical activity levels before and during COVID-19 are associated with differences in the levels of depression and anxiety among graduate students in the U.S., after controlling several variables, specifically financial stress, alcohol use, sleep quality, and sociodemographic characteristics (e.g., age, gender, ethnicity, and education status).

The following analyses were conducted in the current study: (1) paired sample t-test analysis to examine changes in levels of physical activity, depression, and anxiety before and after the outbreak of COVID-19 among graduate students in the U.S.; and (2) multiple linear regression analysis to examine whether changes in physical activity levels influenced changes in level of depression and anxiety.

The participants’ level of physical activity significantly decreased, and the level of depression and anxiety significantly increased in May 2021 when compared to February 2020. In addition, the mean change in moderate metabolic equivalent of task (MET) was significantly and negatively associated with the mean change in depression, after controlling for variables including financial stress, alcohol consumption, sleep quality, and sociodemographic characteristics (e.g., age, gender, ethnicity, and education status). However, no relationship was
observed between the mean change in physical activity and the mean changes in depression and anxiety, except for the negative relationship between the mean change in moderate MET and the mean change in depression.

Given that mental health problems can persist for several years if not treated well (Zivin et al., 2009), and that low rates of university students receive treatment after being diagnosed with mental disorders (Eisenberg, Hunt, Speer, & Zivin, 2011), it is crucial for universities to not only provide adequate treatment but also pave the way for improving environments in which students feel comfortable when seeking help. Universities should take steps to develop programs and activities which are geared towards graduate student participation and promote more moderate physical activities.
CHAPTER 1

INTRODUCTION

1.1 Background of the Study

1.1.1 COVID-19 Impact on Mental Health among Graduate Students

Individuals around the globe have been significantly affected by the outbreak of COVID-19, including physically, socially, and psychologically. To combat the virus, several pandemic prevention measures were introduced to mitigate the spread of the virus. This included the mandatory shut down of schools and of all nonessential businesses and productions (F. K. Ayittey, Ayittey, Chiwero, Kamasah, & Dzuvor, 2020). Regardless of whether these measures succeeded in controlling the outbreak, they have been affecting individuals’ daily life, inevitably causing psychological effects. (Duan & Zhu, 2020; Rubin & Wessely, 2020).

The World Health Organization (WHO) has already come forward with its concerns on how the pandemic will affect mental health and psycho-social consequences (WHO, 2020). It postulated that preventive measures to combat COVID-19, such as self-isolation and quarantine, have affected day-to-day life tremendously. The WHO report emphasized that routines, usual activities, and livelihoods of people are being greatly impacted and can possibly lead to an increase in anxiety, depression, loneliness, insomnia, drug use, harmful alcohol, and self-harm or suicidal behavior (WHO, 2020).

For instance, in a study of 1,210 participants aged 12-59 from 194 cities in China in January and February 2020, C. Wang et al. (2020) found that 54% of participants rated the psychological impact of COVID-19 as moderate or severe; 29% showed moderate to severe anxiety symptoms; and 17% showed moderate to severe depressive symptoms. In addition to
these findings, Pierce et al. (2020) conducted a survey with 17,452 participants aged 16 or older, and reported that clinically significant levels of mental disorder increased from 18.9% in 2018-19 to 27.3% in April, 2020. In terms of the mental health impact on the population globally, psychologists and mental health specialists have surmised that the pandemic would produce an increase in cases of suicide, depression, and self-harm (Moukaddam, & Shah, 2020; Li et al., 2020; Yao, Chen, & Xu, 2020).

Wu et al. (2020) also conducted a meta-analysis of 66 studies with 221,970 participants, including seven different populations, individuals aged 18 or older, noninfectious chronic disease patients, physicians and nurses, students, COVID-19 patients, quarantined individuals, and non-medical staff. They found that overall pooled prevalence of depression and anxiety are 31.4% and 31.9%, respectively. With these results, they concluded that the worldwide COVID-19 pandemic has caused significant mental health problems throughout society, including those who work in the field of healthcare, those who are infected with the virus and quarantined, and those who suffer from other chronic diseases (Wu et al., 2020).

A number of studies examined the prevalence of mental health during COVID-19 among individuals, including, but not limited to, COVID-19 patients, medical staff, and individuals aged 18 or older. Nevertheless, there is still a lack of research with graduate students. After the outbreak of COVID-19, studies examining mental health issues among university students primarily focus on undergraduate students. These issues include, but are not limited to, increased concerns about academic performance (Son, Hedge, Smith, Wang, & Sasangohar, 2020), anxiety (X. Wang et al., 2020; Zhai & Du, 2020), and depression (Chi et al., 2020; X. Wang et al., 2020; Wilson, Holland, Elliott, Duffey, & Bopp, 2021).
Compared to the general population graduate students are more likely to experience depression and anxiety (Bernstein, LeBlanc, Bentley, Barreira, & McNally, 2020; Evans et al., 2018; Levecque, Anseel, De Beuckelaer, Van der Heyden, & Gisle, 2017) due to difficulty establishing an appropriate work life balance (Yusuf, Saitgalina, & Chapman, 2020), lack of financial confidence (Hyun et al., 2006), competitive environment (Barreira, Basilico, & Bolotnyy, 2018), and future uncertainty (Woolston, 2015). In addition, graduate students are more likely to experience stress than undergraduate students (Wyatt & Oswalt, 2013). When it comes to the affect of mental health on academic performance, graduate students reported more disruptions of thesis, research, dissertation, or practicum than undergraduate counterparts (Wyatt & Oswalt, 2013). Thus, it is crucial to study graduate students’ mental health during the pandemic.

1.1.2 COVID-19 Impact on Physical Activity among Graduate Students

In addition to its effect on mental health, COVID-19 led to changes in physical activity and sedentary behavior. Because of the COVID-19 pandemic, over 100 countries have been enforcing social distancing to help reduce the rate at which the virus transmits between individuals. This is also known as a ‘lockdown’. Depending on which country a person is in, the extremity of a lockdown varies greatly. Even between different regions, with some countries limiting the distance that people can travel from their homes, and some banning all unnecessary outdoor activities. Whatever the case may be, there is no denying that these lockdowns have greatly affected many people’s education, work, travel and recreation, and ensuing levels of physical activity and sedentary behaviors (Hossain, Sultana, & Purohit, 2020).

Stockwell and colleagues (2021) conducted a meta-analysis across 66 studies and reported that changes in physical activity were found in a majority of studies, showing a decrease
in physical activity and an increase in sedentary behaviors during each of their own respective lockdowns across several populations including adolescents, individuals aged older than 18 years, and patients with medical conditions such as type I diabetes. With cross-sectional data collected from 3,052 US adults aged 18 or older from all 50 states between 3rd and 8th April 2020, Meyer et al. (2020) reported that self-reported physical activity was lower among participants that had reported being active before the COVID-19 pandemic (mean change: −32.3% [95% CI: −36.3%, −28.1%]); however, among participants that were previously inactive, results remained mostly unchanged (+2.3% [−3.5%, +8.1%]). In a study of 125 university students (i.e., 64 of undergraduate and 61 postgraduate), Bertrand et al. (2021) reported that the minutes per week spent participating in moderate to vigorous physical activity decreased significantly by about 20% and the hours per day spent in sedentary activities increased significantly by three hours during the COVID-19 pandemic.

While several researchers have focused on changes in physical activity levels among undergraduate students (Gallè et al., 2020; Gallo, Gallo, Young, Moritz, & Akison, 2020; Romero-Blanco et al., 2020; Wilson et al., 2021) or mixed populations of undergraduate and graduate students (Bertrand et al., 2021; Coughenour, Gakh, Pharr, Bungum, & Jalene, 2020; Page, 1987; Pinto & Marcus, 1995), there is still very little attention given to the physical activity levels of graduate students (Keating et al., 2005). Considering that graduate students are likely to be heavily pressured to deal with their lives and schoolwork that may result in mental illnesses, participating in physical activity is an appealing choice for increasing the individuals’ mental well-being.

Page (1987) examined the prevalence of insufficient physical activity with 247 students, including undergraduate and graduate students. In this study, it was found that a total of 65% of
the participants were physically inactive. However, because this study was mixed with undergraduate and graduate students, the percentage of physically inactive graduate students was unclear. Another example can be found in a study conducted by Pinto and Marcus (1995) with a total of 800 university students (500 undergraduate students; 300 graduate students). They observed that 46% of the participants did not work out for 20 minutes or longer, three or more times a week. Although the definition for a higher education does include undergraduate and graduate students, studies in the area of physical activity among college students have tended to focus primarily on undergraduate student’s physical activity levels, which makes it difficult to properly assess and understand graduate student’s physical activity levels. Given the fact that preventative measures for COVID-19 have restricted the level of physical activity (Lesser & Nienhuis, 2020), it is vital to examine the physical activity level of graduate students to develop strategies to promote physical activity accordingly.

1.1.3 Physical Activity and Mental Health of Graduate Students during COVID-19

Physical activity is associated with a great number of health benefits (CDC, 2021c). Evidence shows that the absence of physical activity is associated with the increased probability of premature mortality, several chronic medical conditions such as depression, diabetes, cancer, obesity, and osteoporosis (Warburton & Bredin, 2017), Alzheimer’s disease and dementia (Reiner, Niermann, Jekauc, & Woll, 2013). Along with physical health benefits, psychological benefits of physical activity have also been studied. Several have reported an inverse relationship between the engagement of physical activity and the incidence of depressive symptoms (Rebar et al., 2015; Stathopolou, Powers, Berry, Smits, & Otto, 2006; Stephens, 1998). The relationship between physical activity and reduced levels of anxiety symptoms also has been found (Conn, 2010; Goodwin, 2003; Wipfli, Rethorst & Landers, 2008).
The outbreak of the COVID-19 pandemic negatively impacted individuals’ mental health status across the world. As one of the most effective coping strategies, physical activity has been highlighted with evidence suggesting a positive relationship between physical activity and alleviation of symptoms associated with anxiety and depression (Martinsen, 2008; Schuch & Stubbs, 2019; Schuch et al., 2018; Ströhle, 2008). Several researchers stressed the importance of physical activity to reduce the level of anxiety and depression among individuals of all ages (Yang & Zhang, 2020), as well as some particular populations such as adolescents (Kang et al., 2021; Xiao, Yan, & Zhao, 2020; X. Zhang et al., 2020), university students (Coyle, Ghazi, & Georgiou, 2020; Rogowska et al., 2020; Y. Zhang, Zhang, Ma, & Di, 2020), and older adults (Callow et al., 2020; Carriedo, Cecchini, Fernandez-Rio, & Méndez-Giménez, 2020; Goethals et al., 2020). Taken together, while there is irrefutable evidence of the advantages of physical activity in the prevention of mental illness among a wide range of populations during the COVID-19 pandemic, the changes of physical activity levels and mental health and the association between physical activity levels and mental illness symptoms during the pandemic among graduate students have not been studied very well.

1.2 Statement of Problem

For the last few decades, several researchers have highlighted physical activity as a way to assuage the level of depression and anxiety among university students even before the outbreak of COVID-19. For example, Tyson et al. (2010) found that engaging in physical activity is important for undergraduate students’ mental well-being. VanKim and Nelson (2013) also reported that college students who met vigorous physical activity recommendations were less likely to experience poor mental health, and perceived stress than those who did not meet recommendations. Moreover, engaging in regular physical activity was found to be inversely
associated with self-reported depression, anxiety, and also had a positive influence on quality of life and positive affect in a study with 185 university students aged 24 to 33 (Herbert, Meixner, Wiebking, & Gilg, 2020). Additionally, Herbert et al. (2020) highlighted that a six-week aerobic exercise intervention led to significant improvements in self-reported depression, and overall stress.

There have been a number of studies examining the prevalence of mental health during COVID-19 among individuals including older adults aged 65 and older (Buenaventura, Ho, & Lapid, 2020), adolescents (Kang et al., 2021), medical staff (deJonge, Omran, Faulkner, & Sabiston, 2020), individuals aged 18 and above (Pieh, Budimir, & Probst, 2020), as well as university students (Chi et al., 2020; Ge et al., 2020; Son et al., 2020; X. Wang et al., 2020; Wilson et al., 2021; Zhai & Du, 2020). Several researcher have found that depression and anxiety significantly increased after the outbreak of COVID-19 (Ayaz et al., 2020; Chirikov, Soria, Horgos, & Jones-White, 2020; Ettman et al., 2020; Twenge & Joiner, 2020). Given the psychological benefits of physical activity, it is crucial for people to be physically active, especially during the pandemic.

Little has been done, however, when it comes to focusing on the relationship between physical activity and mental health among graduate students in the United States. Researchers who have examined the relationship between physical activity and mental health primarily focused on undergraduate students and thus, there is a dearth of studies that have uniquely focused on graduate students.

Changes in the level of physical activity has been observed in many university students since the outbreak of COVID-19. University campuses are ideal places where students can establish healthy habits, and develop positive self-esteem and social relationship by providing
In a study with 33,522 students (12% of graduate students) with a median age of 22 years, Forrester (2015) found that approximately 75% of university students took advantage of the facilities and programs made available by universities at least once a week. In other words, most of these students opted to utilize on-campus facilities when it comes to participating in physical activity. The COVID-19 pandemic initially resulted in many schools closing their doors temporarily, and this closure meant that students would not be able to continue using those provided facilities (Stanford et al., 2020).

After the first several months of COVID-19, many schools began to reopen their doors with a mix of in-person and online classes in August 2020 to meet social distancing restrictions (Madhusoodanan, 2020). As campuses reopened, campus recreation programs and facilities came up with strategies to allow students to participate in various programs and use facilities safely. For example, as of March 2021, the Leach Center at Florida State University (FSU) allowed fewer students and for shorter periods of time by using a reservation system. They also required students to wear face masks, have personal water bottles, check their wellness on the myFSU App, and have a reservation for priority access (FSU Campus Recreation, n.d.).

COVID-19 has changed not only the way medical service is provided, but also the way people engage in physical activity. In response to stringent restrictions of the pandemic, many have turned to at-home fitness. With no lack of available fitness products, videos, and applications, the convenience and safety of exercising at home has increased (Nyenhuis, Greiwe, Zeiger, Nanda, & Cooke, 2020). Although there is not much information available yet, some studies found an increase in physical activity during COVID-19. With 16,137 participants from 99 countries with a mean age of 34.4, Brand and colleagues (2020) found that a large number of
participants increased (31.9%), or maintained (44.2%) their levels of exercise, and only 23.7% reported a decrease in exercise levels.

Despite the introduction of home-based fitness products, school closures, opening campus recreation facilities with restricted occupancy numbers, and reduced operating hours might affect a decrease in physical activity among university students, considering the previous usage of campus facilities.

1.3 Research Purpose and Significance of the Study

In order to address these research gaps, I examined: (1) the changes in the level of physical activity, depression, and anxiety among graduate students in the United States before and after the outbreak of the COVID-19 pandemic; and (2) whether changes in physical activity levels before and during COVID-19 were associated with changes in the level of depression and anxiety among graduate students in the U.S., after controlling confounding variables (i.e., financial stress, alcohol use, and sleep quality). According to Hussar et al. (2020), the total number of post-baccalaureate students in the U.S. increased from 2.2 million to 3.0 million between 2000 and 2018, and the number of students expected to enroll in 2029 is 3.1 million. It has been reported that experiencing depression and anxiety is six times more likely in graduate students compared to the general population (Evans et al., 2018). Without studies solely focused on graduate students, it is unclear how the potential benefits of physical activity may influence levels of depression and anxiety among graduate students in the U.S. At the university level, this research would provide concise implications to help shine light on the prospective need for promoting physical activity programs to encourage the inclusion of graduate students which could potentially enhance graduate students’ mental health.
1.4 Research Questions

The current research included the following research questions:

1. Did the level of physical activity among graduate students in the United States change during the COVID-19 pandemic?
2. Did the level of depression among graduate students in the United States change during the COVID-19 pandemic?
3. Did the level of anxiety among graduate students in the United States change during the COVID-19 pandemic?
4. Are the changes in the level of physical activity associated with changes in the level of depression among graduate students in the U.S.?
5. Are the changes in the level of physical activity associated with changes in the level of anxiety among graduate students in the U.S.?

In Chapter 1, the impact of COVID-19 on the level of physical activity, depression, and anxiety among graduate students in the U.S. was discussed. Chapter 2 includes a comprehensive literature review on the physical activity, depression, and anxiety of graduate students and presents five hypotheses related to the research questions.
CHAPTER 2

LITERATURE REVIEW

2.1 Physical Activity among Graduate Students

Schools across the globe shut down and closed due to the COVID-19 pandemic. This, with the social regulations that were implemented (e.g., quarantining, social distancing), has influenced college students’ lives around the world. Evidence suggested that social distancing and other restrictions, that were and are still needed to help reduce the spread of COVID-19, have exacerbated mental health (Chirikov et al., 2020; Huckins et al., 2020; Son et al., 2020; C. Wang et al., 2020), increased engagement in sedentary behavior (Barkley et al., 2020; Luciano, Cenacchi, Vegro, & Pavei, 2020; Romero-Blanco et al., 2020), increased alcohol consumption (Charles, Strong, Burns, Bullerjahn, & Serafine, 2021; Gavurova, Ivankova, & Rigelsky, 2020; Lechner et al., 2020), disrupted sleep patterns (Gupta et al., 2020; S. Yang et al., 2020), and decreased level of physical activity among university students (Gallè et al., 2020; López-Valenciano, Suárez-Iglesias, Sanchez-Lstra, & Ayán, 2021; Srivastav et al., 2021).

2.1.1 Physical Activity Services at Universities

Universities have provided students with various campus recreation programs to help increase students’ level of physical activity, retention rate, and improve students’ physical and psychological health (Forrester, 2014; Powers, Trauntvein, Barcelona, & Hartman, 2019). University students have opportunities to participate in several programs offered by universities, which typically include fitness and wellness programs, cardio-vascular training, racquet sports, personal training, intramural and club sports, and outdoor and adventure programs (Forrester, 2014).
Over the last several decades, on-campus recreation has become more of priority to the development of universities in the U.S. (Daprano, Pastore, & Costa, 2008). Campuses offer a variety of comprehensive programs, typically including fitness programs, sports clubs, intramural sports, aquatics programs, and outdoor recreation (Zhang, DeMichele, & Connaughton, 2004). The purpose of offering several recreational activities is to enhance the quality of life for university students. Universities have invested a large amount of money on recreation facilities for their students’ well-being. Doing so has resulted in a positive impact on students’ health and wellness (Lewis, Barcelona, & Jones, 2001). Not only has campus recreation promoted the overall quality of life of students, but it also has reduced the number of destructive activities on campus while enhancing academic environments (McLean & Hurd, 2011). Improvements to recreation facilities and programs have enriched students’ on-campus life, the benefits of which have increased the importance of these programs offered by universities (Turman & Hendel, 2004).

The COVID-19 pandemic initially caused these facilities/programs to cancel; however, after reopening, universities have introduced several strategies not only to offer campus recreation services but also to protect students from COVID-19. When looking at some of the strategies adopted by Leach Center at FSU, they include reducing capacity limits from 300 to 160, limiting time that users are allowed inside of the facility from unlimited to 75 minutes, and requiring students to wear masks all the time and to bring personal water bottles. Additionally, they have reduced operation hours and relocated in-person physical activity programs to outside where only 10 to 12 individuals can participate. They also offered virtual physical activity programs through Zoom. These same changes also applied to intramural sports and club sports (FSU Campus Recreation, n.d.).
2.2 COVID-19 Pandemic

According to the CDC, an influenza pandemic occurs when novel influenza A viruses emerge that are easily transmitted from person to person and spread between individuals efficiently and sustainably (CDC, 2020). Coming from different animals, influenza A viruses are typically transmitted by air and do not normally infect humans. However, because they are constantly changing, relatively rare event viruses can adapt in such a way that they can easily infect people. The most recent global pandemic witnessed in 2009 when a novel strain of influenza A (H1N1) emerged. This virus was designated as the H1N1 pandemic influenza A virus. The 2009 H1N1 pandemic was estimated to be associated with more than 150,000 to more than half a million deaths worldwide during its first year of circulation.

In the last two decades, we have witnessed three different coronaviruses emerge and spread like wildfire across the globe causing considerable health concerns, including Severe Acute Respiratory Syndrome Coronavirus (SARS), Middle East Respiratory Syndrome Coronavirus (MERS), and COVID-19 (Coronavirus Disease). Previous researchers have shown that both SARS and MERS are closely related to depression, anxiety, emotional distress as well as post-traumatic stress disorder (PTSD), fear, greater rates of suicide (Chan, Chiu, Lam, Leung, & Conwell, 2006; S. M. Lee, Kang, Cho, Kim, & Park, 2018; H. Y. R. Yu, Ho, So, & Lo, 2005).

The COVID-19 pandemic has become linked with MERS and SARS. For instance, according to Sohrabi et al. (2020), although COVID-19’s mortality rate is roughly 3.4 percent compared SARS’ 9.6 percent, they share similar features, including fever and shortness of breath. However, their incubation periods differ, with COVID-19 remaining between 2 to 14 days while SARS at between 2 to 7 days. Also, despite MERS’ 34.4 percent mortality rate, Sohrabi et al. (2020) indicated that COVID-19 has depicted a “mean incubation period of 5.2
days and a median duration from the onset of symptoms to death of 14 days” (p. 73). Although their mortality rates are different, choosing quarantine has become a similar approach towards dealing with COVID-19, SARS, and MERS. However, since the pandemic was continuing to ravage the world, there was the push to incorporate other strategies to mitigate and slow its spread.

The pandemic started on the date of December 31st, 2019 following 27 cases of pneumonia of unknown etiology identified in Wuhan City, China (Stratton, Tang, & Lu, 2020). According to Sohrabi et al. (2020), due to the city’s leading population in central China, which is over 11 million, the cases spread fast, with patients presenting clinical symptoms, such as “dry cough, dyspnea, fever, and bilateral lung infiltrates on imaging” (p. 71). Researchers showed that the many cases became linked to Wuhan’s Huanan Seafood Wholesale Market due to its trading of fish and other live animal species, such as “poultry, bats, marmots, and snakes” (Sohrabi et al., 2020, p. 71). Following the growing cases, the Chinese Centre for Disease Control and Prevention (CCDC) conducted tests on throat swab samples collected, identifying its causative agent on 7th January 2020 and later renaming it Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) (Sohrabi et al., 2020). However, the WHO renamed the disease COVID-19 and declared it a Public Health Emergency of International Concern (PHEIC) on 30th January 2020 (Sohrabi et al., 2020). Despite the availability of information on the pandemic, it has continued to ravage the world, limiting individuals’ activities.

According to Pak et al. (2020), by March 2020, the WHO had recorded roughly 3 million cases globally, with over 200,000 deaths in approximately 213 countries. However, that number has increased, with the WHO (2021) indicating that over 120 million people have become infected globally, with roughly 2.8 million deaths recorded in over 219 nations (WHO, 2021).
According to the CDC (2021b), in the U.S. alone, more than 29 million people are infected, resulting in more than 540,000 deaths. COVID-19 affects individuals differently. People who have COVID-19 have reported a wide breadth of symptoms from mild (e.g., fever, headache, tiredness, sore throat) to severe illness (loss of speech or movement, difficulty breathing, chest pain, etc), reported the WHO (n.d.).

The new strain of coronavirus, SARS-CoV-2, is believed to be transmitted through respiratory droplets from person to person. To manage the increasing numbers of cases and deaths, non-pharmaceutical interventions (NPIs) have been focused to contain COVID-19 due to the unavailability of vaccine or medicine by several countries with aims to limit the spread of COVID-19. NPIs include all strategies taken other than vaccination or medication to slow the spread of influenza in a population. Although they vary from country to country, they include social distancing, border closures, and school closures to ultimately reduce the rates of person-to-person transmission. More specifically, NPIs focus on reducing the infection of individuals (e.g., wearing masks, sanitizing hands), restricting the international spread (e.g., travel restrictions and screening), cutting down on national and local spread (e.g., social distancing measures, banning mass gatherings, closing schools, isolating and treating infected individuals, tracking patients), and educating the public on risk (World Health Organization Writing Group, 2006).

Roberts (2020) pointed out that since there has been a push for countries to introduce lockdowns, their respective economies have declined, with businesses worldwide closing and others having furloughed or laid off employees. Socially, COVID-19 has brought restrictions, including travel bans and lockdowns, limiting individuals’ activities. Although countries like the U.S. has lifted some travel bans and opening their economies as of March 2021, the pandemic has devastated people’s interactions. For instance, Callow et al. (2020) indicate that COVID-19
has changed older people’s ways of life in the U.S. and Canada, with many forced into isolation. Through such economic and social effects, the COVID-19 pandemic has changed how individuals conduct themselves globally.

Countries have taken different approaches to mitigate coronavirus spread based on the WHO and CDC’s directives. Sohrabi et al. (2020) argue that apart from encouraging their citizens to avoid traveling to high-risk areas, nations like Japan have developed an artificial intelligence-powered chatbot (Bebot) to provide up-to-date information on the pandemic’s outbreaks. According to Sohrabi et al. (2020), the US suspended non-immigrants’ and immigrants’ entry into the country, with the UK introducing a lockdown. Sahu and Kumar (2020) argued that the U.S. government has also encouraged its citizens to embrace self-quarantine due to the overwhelmed healthcare facilities. Since the pandemic’s effective vaccine or antiviral treatment is not yet available, countries rely on preventive measures to mitigate its spread.

The community has also become involved in mitigating and slowing the COVID-19 pandemic’s spread. According to Sahu and Kumar (2020), the local communities remain encouraged to avoid spreading fake news or rumors concerning the pandemic. Maintaining social distancing has also remained critical towards reducing its spread, with citizens informed to avoid crowded places or social gatherings. Putting on facemasks has also become a crucial policy to reduce coronavirus’ spread, with many also encouraged to frequently clean their hands using alcohol-based hand sanitizers (Sahu & Kumar, 2020). Although COVID-19 continues to spread, the strategies have become geared towards containing and reducing the spread.
In March 2020, U.S. states and territories started adopting different policies on community mitigation strategies to slow the spread of COVID-19 and to protect all individuals. The community mitigation strategies include the following:

- cancellation and suspension of events with super-spreader potential;
- using social distancing measures to reduce direct and close contact between individuals in the community;
- restricting travel, including reduced flights and public transport and route restrictions without compromising essential services;
- quarantining at home voluntarily;
- changes in funeral services to minimize crowd size and exposure to body fluids of the diseased;
- communicating clearly from national and international health authorities to ensure verified information and avoid fake news, rumors, and panic (Ebrahim, Ahmed, Gozzer, Schlagenhauf, & Memish, 2020).

These strategies, including NPIs and the community mitigation strategies, are designed to contribute to the delay of transmission until a medicine or vaccine becomes available. This, of course, means that any large gatherings should be limited, as sufficient crowd density can facilitate spread of infection.

2.2.1 COVID-19 Impact on Higher Education

Similar to SARS and MERS occurred in 2002 and 2012, respectively, studies provide evidence that COVID-19 has similar clinical features. According to Wu et al. (2020), SARS became what it is from a strain of coronavirus named SARS-CoV while MERS came from MERS-CoV. These pandemics also dealt with quarantine and social isolation and/or distancing. Wu et al. (2020) indicated that approximately 35% of SARS survivors in Hong Kong, and 31.2% of individuals in Toronto who quarantined during SARS exhibited mental disorders, including anxiety and/or depression. The authors also reported that after one year of the SARS’ outbreak, survivors continued to show symptoms of “higher levels of depression, anxiety, and posttraumatic symptoms” (Wu et al., 2020, p.95). Additionally, Chan et al. (2006) highlighted
the suicide rate for those age 60 and above in Hong Kong went up 31.7% from the year of 2002, and the most dramatic increase was observed in April, the same month that the SARS was at its peak. MERS had a similar impact on mental health, which led to depressive and anxious symptoms to manifest (Sohrabi et al., 2020).

Countries all over the world have developed unique countermeasures following the COVID-19 pandemic, the most popular ones being quarantine and isolation. Wu et al. (2020) argued that individuals who were quarantined and isolated during the COVID-19 pandemic, including students and physicians, exhibited exceptionally high levels of stress. COVID-19 may put people across all ages at risk for psychological problems similar to SARS and MERS. The impact of the COVID-19 virus has been felt globally; however, its effect varies across population demographics. Despite the fact that they are generally at lower risk for the disease resulting in complications and mortality, college students are facing severe mental, physical, and financial impacts (K. Nelson et al., 2020; Savage et al., 2020). With the increasing number of the COVID-19 cases, many institutions of higher education rapidly switched to online courses. As schools moved to online courses and closed their campus, college students have undergone dramatic changes in a short span of time, including leaving campus, adapting to online learning formats, and changing lifestyles (Garre-Olmo et al., 2021).

Although it was inevitably introduced to curve the COVID-19 cases, school closure has had a detrimental effect on students’ learning. A study of 358 students in India revealed that 65.9% of the participants feel better in the physical classroom than online education (Chakraborty, Mittal, Gupta, Yadav, & Arora, 2020). Similarly, Aguilera-Hermida (2020) found that one of the major challenges is to adapt to the online environment where students reported, “It is just very hard,” and “Staring at a screen made me tired.” (p.5). The participants also
mentioned that the lack of resources and difficulties in communicating with professors make it hard for them to study efficiently.

In response to these changes caused by the pandemic, studies have emerged in the field of education, aiming to assess the impact of COVID-19 on higher education students’ experiences and expectations (Aucejo, French, Araya, & Zafar, 2020). A study of approximately 1,500 undergraduate students (50% female; 61% White) from Arizona State University (ASU) conducted in late April 2020 showed that 13% of students anticipated a delay in graduation, and students from lower socioeconomic backgrounds were 55% more likely than those from higher socioeconomic groups to experience an academic delay due to COVID-19 (Aucejo et al., 2020).

Abrupt school closure contributed to the uncertainty and disruption of the 2020 spring semester which caused students to experience distress, leading to anxiety. It was found that remote learning after the spring break followed by the disruption of academic routine caused college students to experience detrimental mental health (Agnew, Poole, & Khan, 2019). Liu et al. (2020) conducted a study with 898 young adults aged 18 to 30 years attending a U.S. institution to observe factors related to depression, anxiety, and post-traumatic stress disorder (PTSD) symptomatology during the COVID-19 pandemic. They found that the participants showed high levels of depression (43.3%), anxiety (45.4%), and PTSD symptoms (31.8%). Additionally, high levels of loneliness, COVID-related worry, and low levels of distress tolerance were found (Liu, Zhang, Wong, & Hyun, 2020). College students reported an increased level of anxiety, stress, somatization, suicidality, and depression in spring 2020 during the pandemic in the U.S. (Kecojevic, Basch, Sullivan, & Davi, 2020; X. Wang et al., 2020).

In addition to mental health, school closure due to the pandemic had an adverse impact on physical activity level of college students. Physical inactivity which can result in physical
health concerns is one of the most common problems witnessed across the world. A study of 1,430 students (mean age 22.9 ± 3.5 years, 65.5% females) indicated that physical activity levels of college students of three different universities in Italy significantly decreased during the COVID-19 lockdown, with walking decreased the most (~365.5 min/week) (Gallè et al., 2020). In congruence with the previously mentioned study, Coughenour and colleagues (2020) observed that participants’ weekly minutes of physical activity substantially decreased from an average of 409 min to 330 min after the stay-at-home order was issued.

2.3 Physical Activity

2.3.1 Definition

Physical activity and exercise share several common elements and are often used interchangeably. Nevertheless, they are not synonymous, but distinct. Physical activity is defined as “any bodily movement produced by skeletal muscles, resulting in energy expenditure” (Caspersen, Powell, & Christenson, 1985. p. 126).

<table>
<thead>
<tr>
<th>Physical Activity</th>
<th>Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bodily movement via skeletal muscles</td>
<td>1. Bodily movement via skeletal muscles</td>
</tr>
<tr>
<td>2. Results in energy expenditure</td>
<td>2. Results in energy expenditure</td>
</tr>
<tr>
<td>3. Energy expenditure (kilo-calories) varies continuously from low to high</td>
<td>3. Energy expenditure (kilo-calories) varies continuously from low to high</td>
</tr>
<tr>
<td>4. Positively correlated with physical fitness</td>
<td>4. Very positively correlated with physical fitness</td>
</tr>
<tr>
<td>5. Planned, structured, and repetitive bodily movement</td>
<td>5. Planned, structured, and repetitive bodily movement</td>
</tr>
<tr>
<td>6. An objective is to improve or maintain physical fitness component(s)</td>
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</table>

One of the simplest ways to categorize the term involves physical activity that occurs while sleeping, at work, and at leisure (Montoye, 1974). Exercise, on the other hand, is a type of physical activity “that is planned, structured, repetitive, and purposive in the sense that
improvement or maintenance of one or more components of physical fitness” (Caspersen et al., 1985, p. 128). Table 2.1 presents elements of physical activity and exercise.

Physical fitness refers to a set of attributes or characteristics that individuals have or achieve (Caspersen et al., 1985). These attributes or characteristics are frequently separated into two groups: health- and skill-related components of physical fitness (Pate, 1983). Table 2.2 presents health- and skill-related components of physical fitness.

### Table 2.2 Health- and skill-related components of physical fitness (Caspersen et al., 1985, p.128)

<table>
<thead>
<tr>
<th>Health-Related Physical Fitness Components</th>
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</thead>
<tbody>
<tr>
<td>• Cardiorespiratory endurance: the ability of the circulatory and respiratory systems to supply oxygen during sustained physical activity and to eliminate fatigue products after</td>
</tr>
<tr>
<td>• Body composition: the relative amounts of muscle, fat, bone, and other vital parts of the body</td>
</tr>
<tr>
<td>• Muscular strength: the ability of muscle to exert external force</td>
</tr>
<tr>
<td>• Muscular endurance: the ability of muscle to continue to exert force</td>
</tr>
<tr>
<td>• Flexibility: the range of motion available at a joint</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skill-Related Physical Fitness Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Agility: the ability to change the position of the entire body in space with speed and accuracy</td>
</tr>
<tr>
<td>• Coordination: the ability to use the senses, such as sight and hearing, together with body parts in performing tasks smoothly and accurately</td>
</tr>
<tr>
<td>• Balance: the maintenance of equilibrium while stationary or moving</td>
</tr>
<tr>
<td>• Power: the rate at which one can perform work</td>
</tr>
<tr>
<td>• Reaction time: the time elapsed between stimulation and the beginning of the reaction to it</td>
</tr>
<tr>
<td>• Speed: the ability to perform a movement within in a short period of time</td>
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</tbody>
</table>

In addition to defining physical activity, it is vital to clearly define the wide range of intensities related to physical activity. One of useful methods used for estimating intensities is metabolic equivalents (METs). METs are an efficient, convenient, and standardized method of measuring the absolute intensity of various activities. Light intensity activity is defined as < 3.0 METs (e.g., walking at a slow or leisurely pace, washing dishes, darts, fishing), moderate as 3.0 to 5.9 METs (e.g., walking at very brisk pace, mowing lawn, recreational badminton, shooting basketball), and vigorous as ≥ 6.0 METs (e.g., jogging, running, heavy farming, basketball game,

2.3.2 Physical Activity Recommendation

For over 20 years now, physical activity and health have been the main topic and correlated study for the ACSM and the CDC. Starting in 1995, the ACSM and the CDC have been recommending that “every U.S. adult should accumulate 30 minutes of moderate physical activity on most, preferably all, days of the week” (Pate et al., 1995). Just a year later, in 1996, the Physical Activity and Health: A Report of the Surgeon General, came out with details and a plethora of information regarding the health benefits that coincide with regular physical activity (HHS, 1996). These recommendations are intentionally published to increase public awareness of the health-related benefits of moderate-intensity physical activity.

Moving on to 2007, the recommendations were updated slightly by the ACSM and American Heart Association (AHA) due to there being some confusion with the previous recommendations. After the publication of the recommendations of the ACSM and AHA, the 2008 Physical Activity Guidelines Advisory Committee submitted their report summarizing the scientific evidence on physical activity and health, which resulted in the first edition of the Physical Activity Guidelines for Americans by the government in 2008. The Physical Activity Guidelines Advisory Committee Report (2008) made two primary conclusions which are attributed to the development of the 2008 Physical Activity Guidelines for Americans. First, an extreme amount of health benefits surface by engaging in a moderate amount of physical activity every day, or at least most of the days throughout the week. Second, its recommendation is just a minimum, and with a greater amount and/or intensity of physical activity there are additional health benefits that can be obtained.
The 2018 Physical Activity Guidelines Advisory Committee was convened after a substantial amount of research and implementation of the *Physical Activity Guidelines* to review the scientific evidence on physical activity and health from the 2008 *Physical Activity Guidelines for Americans*. The committee found more evidence that supported the positive aspects of physical activity on health. The *2018 Physical Activity Guidelines Advisory Committee Scientific Report* includes additional conclusions as to the benefits of physical activity with health. They are, but not limited to, the following: those who are physically inactive can get health benefits by engaging in physical activity at any intensity (light, moderate, or vigorous); substantial health benefits can be obtained by engaging in a single bout of moderate-to-vigorous physical activity (MVPA); any bout of MVPA can go towards the recommended daily or weekly amount of physical activity to meet current recommendations, regardless of duration (Physical Activity Guidelines Advisory Committee, 2018).

The second edition of *Physical Activity Guidelines for Americans* also suggested the primary physical activity recommendations for adults. First, it is suggested that adults should sit less throughout the day and move more. Adults who stay seated less and do any amount of MVPA gain some health benefits. Second, adults should do at least 150 minutes to 300 minutes a week of moderate-intensity, or 75 minutes to 150 minutes a week of vigorous-intensity aerobic physical activity to gain a substantial amount of health benefits. One can also gain health benefits through an equivalent combination of moderate- and vigorous-intensity aerobic activity. However, it is preferred that aerobic activity should be spread throughout the week. Third, by engaging in physical activity beyond the equivalent of 300 minutes of moderate-intensity physical activity a week, additional health benefits can emerge. Lastly, adults should participate in muscle-strengthening activities of moderate or greater intensity, involving all major muscle
groups on two or more days a week, as these activities offer additional health benefits (HHS, 2018).

Compared to the 2008 guidelines, one of the interesting changes reflected in the 2018 guidelines is the elimination of a specific duration of time during physical activity. The requirement of the 2008 guidelines stated that aerobic activities must occur in bouts of more than 10 minutes in duration to bring about important health benefits (Physical Activity Guidelines Advisory Committee, 2008). However, it has been changed with recent evidence that bouts of physical activity of fewer than 10 minutes in duration are still aligned with favorable results for an array of health-related matters (HHS, 2018).

2.3.3 COVID-19 and Physical Activity

The COVID-19 pandemic has attracted many stringent restrictions, such as social distancing, and stay-at-home orders. While these restrictions are necessary to control the spread of the virus, they can have a negative impact on psychological well-being (Brooks et al., 2020), as well as certain behaviors that help mental health, such as physical activity (Morgan, 1997). Decreased level of physical activity has been witnessed in different population, including adolescents (Bates et al., 2020), adults aged 18 and older (Deschasaux-Tanguy et al., 2020; Meyer et al., 2020; Wilke et al., 2021), undergraduate students (Barkley et al., 2020; Karuc, Sorić, Radman, & Mišigoj-Duraković, 2020; Sañudo, Fennell, & Sánchez-Oliver, 2020; Savage et al., 2020; Srivastav et al., 2021), as well as graduate students (Barkley et al., 2020; Srivastav et al., 2021). Barkley et al. (2020) included both undergraduate and graduate students in their study and concluded that the university closure significantly contributed to an increased in sitting time. Srivastav et al. (2021) also conducted a study with university students as the sample (undergraduate, interns, postgraduate, and doctorate students) with a purpose to examine
physical activity level before and during lockdown period. They reported that the participants spent more time in vigorous (−57.3%) and moderate (−63.5%) physical activity before the lockdown period compared to during the lockdown.

As aforementioned, Forrester (2015) found that approximately 75% of university students use on-campus recreational facilities, and programs to engage in physical activity. Although specific information about graduate students’ use of these services is not available, school closures and changes in physical activity-related services offered by universities (e.g., limited capacity, and reduced operating hours) has affected all university students, including graduate students. Taken together, the following hypothesis was established:

H1: The level of physical activity among graduate students in the U.S. significantly decreased after the outbreak of the COVID-19 pandemic.

2.4 Mental Health

2.4.1 Definition

When asked the question “What is mental health?” one may find it difficult trying to conjure up clear and definitive definitions. There have been many organizations that have stepped forward with their own definitions of mental health. One example is the Department of Health, Social Services and Public Safety (DHSSPS; 2003) which defined having good mental health as having: “. . .the emotional and spiritual resilience which enables us to enjoy life and survive pain, disappointment, and sadness. It is a positive sense of well-being and an underlying belief in our own and others’ dignity and worth” (p.8). It is generally agreed that mental health is not just about one being without mental illness but is much deeper than that. In the U.S., the Surgeon General’s Report described mental health as “a state of successful performance of
mental function, resulting in productive activities, fulfilling relationships with other people, and
the ability to adapt to change and to cope with adversity” (Rockville, 1999, p.7).

The idea that mental health is a ‘positive sense of well-being’ suggests that mental health
exists outside of the field of mental illness. In other words, one’s mental health is not necessarily
impacted by mental illness. To give a more understandable explanation, someone could have a
mental illness, such as bipolar, and still be able to live a comfortable life with a sense of ease and
a high level of well-being. On the other hand, someone might not have any mental illness but
still experience a negative sense of well-being. According to the WHO (2007), positive mental
health is “a state of well-being in which the individual realizes his or her own abilities, can cope
with the normal stresses of life, can work productively and fruitfully, and is able to make a
contribution to his or her community (p.1). With these definitions in mind, Jackson and Hill
(2006) listed good mental health as the ability to start, keep and if necessary, end relationships;
work or attend college/school; look after oneself and others; sleep; laugh and cry; eat; avoid
problems with substances; deal with what others think about you; accept failure and deal with
success; function sexually, if wished; learn; deal with loss; express good feelings; and manage
negative feelings.

There are many people who believe that they are free from mental health conditions;
however, this is not always the case. Mental illnesses are significantly embedded in the U.S., as
demonstrated in the following statistics (CDC, 2018):

- More than 50% will be diagnosed with a mental illness or disorder at some point in their
  lifetime.
- One in five Americans will experience a mental illness in a given year.
- One in five children, either currently or at some point during their life, have had a
  seriously debilitating mental illness.
- One in 25 Americans lives with a serious mental illness, such as schizophrenia, bipolar
  disorder, or major depression.
The CDC (2018) reported that several factors can cause individuals to suffer from mental illness, including early adverse life experiences, experiences associated with other ongoing (chronic) medical condition, biological factors, consumption of recreational drugs or alcohol, having few friends, and having feeling of loneliness or isolation.

Mental illness can be broadly classified into two categories: Any Mental Illness (AMI) and Serious Mental Illness (SMI). AMI includes all recognized mental illness, whereas SMI is a smaller and more severe subset of AMI (National Institute of Mental Health [NIMH], 2021). NIMH defines AMI as a mental, behavioral, or emotional disorder, ranging from no impairment to mild, moderate, and even severe impairment and SMI as a mental, behavioral, or emotional disorder leading to serious functional impairment, which substantially restricts or limits one or more major life activities.

Consistent with the CDC report, NIMH (2021) reported similar findings regarding the prevalence of mental illness, including AMI and SMI, in the U.S. Table 2.3 presents statistical results from NIMH (2021).

<table>
<thead>
<tr>
<th>Any Mental Illness (AMI)</th>
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<tbody>
<tr>
<td>In 2019, there were an estimated 51.5 million adults aged 18 or older in the United States with AMI. This number represented 20.6% of all U.S. adults.</td>
<td></td>
</tr>
<tr>
<td>The prevalence of AMI was higher among females (24.5%) than males (16.3%).</td>
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</tr>
<tr>
<td>Young adults aged 18-25 years had the highest prevalence of AMI (29.4%) compared to adults aged 26-49 years (25.0%) and aged 50 and older (14.1%).</td>
<td></td>
</tr>
<tr>
<td>The prevalence of AMI was highest among the adults reporting two or more races (31.7%), followed by White adults (22.2%). The prevalence of AMI was lowest among Asian adults (14.4%).</td>
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</table>

<table>
<thead>
<tr>
<th>Serious Mental Illness (SMI)</th>
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<tbody>
<tr>
<td>In 2019, there were an estimated 13.1 million adults aged 18 or older in the United States with SMI. This number represented 5.2% of all U.S. adults.</td>
<td></td>
</tr>
<tr>
<td>The prevalence of SMI was higher among females (6.5%) than males (3.9%).</td>
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</tr>
<tr>
<td>Young adults aged 18-25 years had the highest prevalence of SMI (8.6%) compared to adults aged 26-49 years (6.8%) and aged 50 and older (2.9%).</td>
<td></td>
</tr>
<tr>
<td>The prevalence of SMI was highest among the adults reporting two or more races (9.3%), followed by AI/AN adults (6.7%). The prevalence of SMI was lowest among NH/OPI adults (2.6%).</td>
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</table>
Among symptoms caused by mental illnesses, some researchers foresaw increases in depression and anxiety due to the COVID-19 pandemic. Social isolation is one of the primary strategies that have been taken by several countries to mitigate the spread of the virus. Although it can be beneficial to curve the pandemic, socially isolating individuals also has side effects in terms of mental health. For example, social isolation is a well-recognized trigger of several mental health issues, including anxiety disorders (Lim, Rodebaugh, Zyphur, & Gleeson, 2016), and major depressive disorder (Barger, Messerli-Bürgy, & Barth, 2014).

Twenge and Joiner (2020) backed up the aforementioned information by comparing U.S. adults in April and May 2020 to U.S. adults in 2019 utilizing U.S. Census Bureau-administered nationally representative probability samples of 336,525 participants. They found that U.S. adults in April and May 2020 were more than three times as likely to be diagnosed for depressive disorders, anxiety disorders, or one or both (Twenge & Joiner, 2020). Furthermore, in a meta-analysis of 66 studies with 221,970 participants during COVID-19 pandemic in different populations, Wu et al. (2020) observed that the overall pooled prevalence of depression and anxiety were 31.4% and 31.9%, respectively. Based on the results a higher prevalence of mental health disorders has been witnessed after the outbreak of COVID-19. The results align with the Mental Health America (MHA) report, which states that individuals in the U.S. seeking help, mainly with anxiety and depression, have risen steeply. MHA (2021) shows that compared to 2019, there is a 93% and 62% increase of individuals who have undergone anxiety and depression screenings, respectively. In sum, depression and anxiety disorders are currently severe mental health issues in the U.S.
2.4.2 Depression

Depression is generally defined as a mood disorder that causes a wide range of symptoms, which can vary from mild to severe depending on the number and severity of symptoms (American Psychiatric Association [APA], 2020). Depression is not the same thing as a passing low mood; however, it can cause a serious health condition including loss of interest, feeling sad, trouble sleeping, changes in appetite, difficulty thinking, thoughts of death, and/or suicidal thoughts (APA, 2020). Unfortunately, depression has impacted more than 264 million people globally (James et al., 2018). In the U.S., depression affects an estimated one in 15 adults (6.7%) in any given year. And one in six people (16.6%) will experience depression at some time in their life (APA, 2020). Depression can happen to anyone at any moment in time, but generally, depression first starts to develop during one’s late teens to mid-20s.

2.4.3 Anxiety

According to Barlow (2002), anxiety is “a future-oriented mood state in which one is ready or prepared to attempt to cope with upcoming negative events” (p.64). This is a great definition of what anxiety is and how it encapsulates one’s life completely. Anxiety is something that everyone deals with from time to time. One might feel anxious with life, with work, with a test at school, or even before life altering decisions. All of these scenarios are great examples of common times for one to experience anxiety. This is normal, however, there are people with anxiety disorders. These disorders result in someone experiencing a deep struggle with intense and out-of-control feelings of fear, worry, and/or panic (APA, 2013). These feelings are serious and should be dealt with immediately as they can interfere with one’s daily life and could last for years if untreated. There are different types of anxiety disorders as well. That includes
Obsessive-Compulsive Disorder (OCD), Generalized Anxiety Disorder (GAD), Social Phobia, Post-Traumatic Stress Disorder (PTSD), and Panic Disorder (HHS, 2014).

The WHO (2017) had reported that 3.6% of the global population has an anxiety disorder as of 2015. Like depression rates, anxiety disorders are mostly seen among females as opposed to males (4.6% compared to 2.6% at a global level). The total estimated number of people in the world living with an anxiety disorder is around 264 million.

2.4.4 Prevalence of Depression and Anxiety among Graduate Students

Fogg (2009) described graduate school as an “incubator for anxiety and depression” induced by social alienation, financial pressure, lack of structure, and the expectation to produce innovative work. With this statement, Fogg (2009) eloquently provides a mental image to what life is like for graduate students. This metaphor is a great example of how depression and anxiety slowly start to incubate and form within students as life and school responsibilities pile on top of them.

Graduate students around the world now are highly in need of support as they are dealing with critical mental health issues such as depression, and anxiety (Gewin, 2012; Levecque et al., 2017). In particular, graduate students experience high levels of stress in the face of uncertain job opportunities and are vulnerable to developing mental health disorders (Evans et al., 2018; Garcia-Williams, Moffitt, & Kaslow, 2014; Gewin, 2012; L. Wang, 2015). This, of course, can lead to issues with being able to graduate on time or even graduate at all.

There is a lot of pressure on graduate students today. From the expectations of creating great research projects, meeting deadlines, becoming independent problem solvers, expanding their own knowledge and skills, and still searching and building job opportunities. Kreger (1995) found that self-esteem has negative correlations while stress has positive correlations in terms of
graduate students and depression. In all probability, research environments that challenge a student’s self-esteem while also instigating stress into the equation are more likely to contribute to depressive symptoms amidst graduate students (Kreger, 1995).

Gewin (2012) specifies that signs of depression and anxiety that can be found among postgraduates, including decreased motivation, inability to do research or even attend classes, sleep disturbances, increased social withdrawal, changed in appetite, and difficulty concentrating. Without its diagnosis and treatment, depression can hinder an individual’s progress in life, especially excessive levels of stress. Particularly over prolonged periods of time, an excessive amount of stress that is not being taken care of and are poorly controlled, leads to damaging of one’s physical and mental well-being.

Major struggles that graduate students often face are not only their coursework, but also adapting to a decreased level of community, a new stage in life, multiple responsibilities in school/life, financial problems, and competition between peers, which all can cause mental health issues (Hyun et al., 2006). Calling attention to the gravity of these challenges that graduate students face, Eisenberg et al. (2007) reported that 41.2% of 1,662 graduate students that responded to a survey indicated that mental health struggles had negatively affected their academic performance. Moreover, a study of 790 graduate students from all disciplines at the University of California Berkeley (UCB) showed that approximately 47% of Ph.D. students and 37% of master’s students could be identified as depressed clinically (Panger, Tryon, & Smith, 2014). In accordance with the result from UCB, the 2015 University of Arizona Report also found that most doctoral students reported "more than average" current stress or "tremendous" stress and endorsed issues related to school and education as the most critical contributors to their stress (Smith & Brooks, 2015).
While we need to be cautious before concluding that graduate school causes depression, studies have frequently found that graduate students in Economics PhD programs have a higher incidence of mental health issues than the comparable individuals aged 25 to 34 (Barreira et al., 2018). In fact, a recent study conducted by Evans and colleagues (2018), a survey of 2,279 graduate students (90% Ph.D. students and 10% Master’s students) from different fields of the study, found that 39% of graduate students had mild to extreme depression as compared to 6% of individuals with a mean age of 48.9 years. Moreover, 41% of the participants scored moderate to extreme anxiety as opposed to 6% of individuals with a mean age of 48.4 years.

2.4.5 COVID-19 and Mental Health

The COVID-19 pandemic has been a distressing and traumatic experience for most people. Following these traumatic events, people might have experienced a decrease in their feelings of security and safety, in turn negatively affecting their mental health (Özdin & Bayrak Özdin, 2020). Furthermore, there has been confusion and disinformation regarding the pandemic. Many people want to know when it will end and what are the necessary steps to end it. There is an unending amount of new information about the virus and its effects. According to Özdin and Bayrak Özdin (2020), the forced decrease in social interactions with others and restrictions, such as how one should stay at home as much as possible, can all affect one’s mental health unfavorably. For instance, a study of 1,210 respondents aged 12 to 59 in China found that 54% of participants rated that the COVID-19 outbreak had a moderate to severe emotional/psychological impact on them; 29% reported moderate to severe anxiety symptoms; and 17% reported moderate to severe depressive symptoms (Wang et al., 2020).

University students are not free from these issues. With over a thousand universities and educational departments, classes, and campus activities abruptly being closed and cancelled,
millions of students have been left negatively impacted (Billy, 2020). Such sudden cancellations of student life can provoke feelings of unpredictability with one’s educational or professional career and can decrease university students’ mental health (Hung et al., 2021; Mei, Yu, He, & Li, 2011). This is especially true for graduate students who often are already experiencing persistent mental health problems, which in turn are being intensified by the abrupt changes occurring due to the instability brought on by the pandemic.

Symptoms of depression, fear, anxiety, stress, and sleep disorders are becoming increasingly more prevalent during the COVID-19 pandemic among university students (Torales, O’Higgins, Castaldelli-Maia, & Ventriglio et al., 2020). For example, Cao et al. (2020) conducted a study with undergraduate students and revealed that about 24.9% of undergraduate students have experienced anxiety due to the outbreak of the COVID-19 pandemic. Furthermore, Meda et al. (2021) collected data on a total of 358 university students aged 18 to 30 in Italy in October 2019 and, six months later, April 2020. They revealed that the participants’ depression levels were significantly increased during lockdown than 6 months before, with those who have no established diagnosis of psychopathology being impacted the most. Taken together, the following hypotheses were established:

H2. The level of depression among graduate students in the U.S. significantly increased after the outbreak of the COVID-19 pandemic.

H3. The level of anxiety among graduate students in the U.S. significantly increased after the outbreak of the COVID-19 pandemic.

2.5 Physical Activity and Mental Health

Physical activity is correlated with a variety of health benefits. According to the CDC (2019), the absence of physical activity can lead to harmful effects and well-being, increasing the
probability of diabetes, certain cancers, coronary heart disease, hypertension, obesity, and even possibly death. These findings by the CDC stressed that physical activity is a great way to prevent illnesses and to make sure that people stay healthy. Physical activity was also associated with reducing depression and anxiety symptoms.

There is a plethora of epidemiological and clinical studies that have reported interrelations between symptoms of depression and anxiety and physical activity in cross-sectional and prospective longitudinal studies (Abu-Omar, Rütten, & Lehtinen, 2004; Camacho, Roberts, Lazarus, Kaplan, & Cohen, 1991; Goodwin, 2003; Lampinen, Heikkinen, & Ruoppila, 2000; Motl, Birnbaum, Kubik, & Dishman, 2004; Stephens, 1988; Ströhle et al., 2007). For example, Stephens (1998) conducted a study with representative samples from the U.S. and Canada collected from individuals aged 10 to 74 (N = 55,979) and discovered that physical activity was associated with improved mental health. The results included fewer symptoms of anxiety and depression, after controlling physical illness, social economic status, and education. In another study, Abu-Omar et al. (2004) conducted a cross-national study across 15 member states of the European Union, and found that physical activity has a tremendously positive effect on mental health. In other words, individuals who worked out more or just generally stayed more active found themselves in better mental health.

As to prospective longitudinal studies, Lampinen et al. (2000) examined the change in physical activity levels over time and its association with depression and noted that individuals who reduced physical activity over time were more than ten times more likely to develop depression. Camacho and colleagues (1991) measured the activity levels and depression levels of participants aged 20 and above in 1965, 1974, and 1983. At the first follow-up, individuals who were physically inactive at baseline were found to be at greater risk for severe depression.
compared to those who reported active. Interestingly, participants who increased their activity level between 1965 and 1974 were at no greater risk for depression in 1983 than those who had been highly active throughout the period.

The Physical Activity Guidelines Advisory Committee (2008) found population-level correlational evidence that those who participate in regular physical activity have approximately 45% lower chances of developing clinical depression symptoms, and between 28% and 48% lower chances of developing clinical anxiety symptoms. In alignment with the Physical Activity Guidelines Advisory Committee (2008), Rebar and colleagues (2015) pointed out that physical activity participation is significantly associated with the level of depression and anxiety with a non-clinical adult population in their meta-analysis. Given the strength of the evidence, Rebar et al. (2015) concluded that the increase in physical activity levels in non-clinical populations is negatively associated with symptoms of depression and anxiety, as well as may offer protective effects against the development of clinical depression and anxiety.

With 2,458 participants (aged 14 to 24), the primary findings of Ströhle and colleagues (2007) showed that physical activity can play a role as a protective factor of mental health from both cross-sectional and longitudinal results. Cross-sectional results showed that those participants who participated in regular physical activity had lower odds of meeting criteria for DSM-IV psychiatric disorders (especially anxiety disorders) and had lower odds of having comorbid conditions compared to inactive participants. Correspondingly, the longitudinal data revealed that individuals with regular physical activity were more likely to have a lower risk of anxiety disorders compared to those who were inactive.

When it comes to the higher education settings in the U.S., to examine an individual's level of physical activity and its association with reduced levels of depression and anxiety, Xiang
et al. (2020) conducted a study with 1,314 undergraduate and 82 graduate students during the COVID-19 outbreak. Significant differences in the level of depression and anxiety were witnessed depending on physical activity level. There was a significant relationship between individuals who engaged in a high level of physical activity and lower levels of anxiety. Additionally, individuals with moderate to high levels of physical activity were shown to have reduced levels of depression.

Taking these results into account, the following hypothesis is established:

H4. Changes in the level of physical activity are negatively associated with changes in the level of depression and anxiety among graduate students in the United States after the COVID-19 pandemic, after controlling financial stress, alcohol consumption, sleep quality, and sociodemographic characteristics (i.e., age, ethnicity, gender, education status).

H5. Changes in the level of physical activity are negatively associated with changes in the level of anxiety among graduate students in the United States after the COVID-19 pandemic, after controlling financial stress, alcohol consumption, sleep quality, and sociodemographic characteristics (i.e., age, ethnicity, gender, education status).

In Chapter 2, I conducted a comprehensive literature review about COVID-19, physical activity, depression, and anxiety levels of graduate students in the U.S. Based on the literature review, I established a total of five hypotheses. In the following chapter, the design of the study, procedures of data collection, and data analysis will be disclosed. Additionally, questionnaires for each variable will be discussed, as well as control variables (financial stress, alcohol consumption, and sleep quality) that might have a negative impact on mental health.
CHAPTER 3

METHODS

3.1 Study Overview and Design

This study included an examination of whether there were changes in physical activity, depression, and anxiety among graduate students in the United States before and after the outbreak of the COVID-19 pandemic, and whether changes in physical activity were associated with the changes in depression and anxiety. The study was quantitative, non-experimental, and cross-sectional research. I used a crowdsourcing recruitment method via Prolific Academic (ProA) to obtain the sample. Section 3.2.1 includes a further explanation of this method.

The current study addressed five research questions:

1. Did the level of physical activity among graduate students in the United States change between before and after the COVID-19 pandemic?

2. Did the level of depression among graduate students in the United States change between before and after the COVID-19 pandemic?

3. Did the level of anxiety among graduate students in the United States change between before and after the COVID-19 pandemic?

4. Are the changes in the level of physical activity associated with the changes in the level of depression among graduate students in the U.S.?

5. Are the changes in the level of physical activity associated with the changes in the level of anxiety among graduate students in the U.S.?

This study including testing of five hypotheses:
H1. The level of physical activity among graduate students in the U.S. significantly decreased after the outbreak of the COVID-19 pandemic.

H2. The level of depression among graduate students in the U.S. significantly increased after the outbreak of the COVID-19 pandemic.

H3. The level of anxiety among graduate students in the U.S. significantly increased after the outbreak of the COVID-19 pandemic.

H4. Changes in the level of physical activity are negatively associated with changes in the level of depression among graduate students in the U.S. after the COVID-19 pandemic, after controlling financial stress, alcohol consumption, sleep quality, and sociodemographic characteristics (i.e., age, ethnicity, gender, education status).

H5. Changes in the level of physical activity are negatively associated with changes in the level of anxiety among graduate students in the U.S. after the COVID-19 pandemic, after controlling financial stress, alcohol consumption, sleep quality, and sociodemographic characteristics (i.e., age, ethnicity, gender, and education status).

3.2 Data Collection

3.2.1. Sample Recruitment Strategy

Participants were recruited using convenience sampling, which is a nonprobability sampling method applicable to quantitative studies (Etikan, Musa, & Alkassim, 2016). Data were collected by distributing self-administered questionnaires through an online survey platform, Qualtrics, which generates the anonymous link. The survey was available on ProA from May 1, 2021 to May 10, 2021. Utilizing an online crowdsourcing platform to administer survey research is preferable as it enables researchers to swiftly and readily obtain data from a diversified pool of people (Truell, Bartlett, & Alexander, 2002).
Peer et al. (2017) conducted a study where they compared ProA to MTurk, one of the largest sampling platforms. They concluded that, “ProA provides data quality that is comparable or not significantly different than MTurk’s, and ProA’s participants seem to be more naïve to common experimental research tasks and offer a more diverse population in terms of geographical location, ethnicity, etc” (Peer, Brandimarte, Samat, & Acquisti, 2017, p.161).

ProA offers a service where users can apply a custom prescreening function, making it possible for me to recruit eligible participants: graduate students in the United States. Eligible participants were able to access the link to take part in the survey. Within this link, they received a letter of consent along with the purpose of the current study and directions on completing the survey (see Appendix A). In the letter of consent, participants were informed that the current study was voluntary and that they could discontinue the survey at any time if they felt uncomfortable. Participants were also asked to answer the following three questions: (1) “Do you agree to participate in this study?” (2) “Were you a graduate student in the United States in February 2020?” (3) “Were you a graduate student in the United States in April 2021?” Participants who answered all questions with “Yes” were able to complete the survey. Otherwise, they were redirected to the end of the survey page and excluded.

The participants were compensated for the completion of the survey which consists of a total of 138 questions with $12.14 per hour on average after they submitted a code that Qualtrics randomly generates. I expected that it would take a maximum of 25 minutes for the participants to answer all questions, which results in total compensation of $5.06 for each participant.

In order to capture the differences in levels of physical activity, depression, and anxiety before and after the COVID-19 pandemic, I asked respondents to complete two sets of questionnaires – one for February of 2020 and one for May of 2021. Because I collected cross-
sectional data, recall bias can be a concern. Many people have acknowledged that there is a correlation between an individual’s ability to recall events with accuracy and the amount of time that has passed since the event occurred; there is a greater likelihood of inaccurate recall the longer it has been since the event took place. A recall is, of course, dependent on the gravity of the event being reported and the time over which the event happened (Clarke, Fiebig, & Gerdtham, 2008). This means that a retrospective study may result in self-reported questionnaires that contain recall errors.

Various recall errors can result in inaccurate reporting of activities/events and emotions/feelings. Some of these are recall-decay (when events are no longer able to be recalled with any accuracy and no longer able to be reported), telescoping (where the time period in which an event took place is incorrectly remembered, moving the event either forward or backward in time), and heaping (when some events are grouped together incorrectly into a singular point in time; e.g. “about 6 months ago”) (Beegle, Carletto, & Himelein, 2011; Sudman & Bradburn, 1974).

The likelihood of an event being recalled vividly is tied to the strength of emotion during the time when the event took place (Reisberg & Heuer, 1992). More emotional memories tend to be more commonly remembered and recalled (Bohannon III, 1988; Christianson & Loftus, 1990). In other words, events with a more neutral emotionality were not as likely to be remembered. When individuals have memories that are strong and vivid, and tied to highly emotional or consequential events, these individuals can create a “snapshot” moment, also known as a flashbulb memory (Brown & Kulik, 1977). There have been several historical events resulting in flashbulb memories, including the assassinations of John F. Kennedy (Brown & Kulik, 1977), Martin Luther King, Jr. (Brown & Kulik, 1977), and the terrorist attacks on
September 11th of 2001 (Talarico & Rubin, 2003). Given that COVID-19 is a critical event for every person globally, it is reasonable to expect most people would remember their behaviors/moods in the weeks leading up to March 2020.

According to Galesic and Bosnjak (2009), as fatigue and boredom accumulate throughout the survey, the respondents may be less and less willing to invest the effort needed for good quality answers. To minimize the recall bias and maximize good quality answers, pre-COVID-19 questionnaires were placed before questionnaires about experiences during the COVID-19 pandemic.

3.2.2 Sample Size

The research design of this study included the paired sample t-test analysis and multiple linear regression analysis to examine the relationship between changes in physical activity and changes in depression and anxiety, after controlling for alcohol consumption, financial stress, sleep quality, age, ethnicity, gender, and education status.

Figure 3.1. Screenshot of the G*Power analysis for required sample size (Faul et al., 2007)
In order to determine a minimum number of participants, a priori power analysis 
G*Power was utilized (Faul, Erdfelder, Lang, & Buchner, 2007). To achieve a medium effect 
size ($f^2 = .15$), with an alpha level at .05, and a power level (1-β) of .95 (see Erdfelder, Faul, & 
Buchner, 1996), the G*Power analysis projected the minimum sample size of 129 participants. 
Figure 3.1 presents the result of the G*power a priori calculation. Given potential dropouts, a 
total of 150 graduate students were recruited.

3.3 Measures

3.3.1 Main Variables

3.3.1.1 Physical Activity

Developed by a group of experts in 1998 (International Physical Activity Questionnaire 
[IPAQ], 2002; Lee et al., 2011), the short form of the International Physical Activity 
Questionnaire (IPAQ-SF) was used to evaluate physical activity level. Consisting of seven 
questions, the IPAQ-SF is a self-report survey used to measure participants’ level of physical 
activity and sitting time (see Appendix B).

I modified the scale to assess the level of physical activity prior to the pandemic by 
adjusting the instruction language to compare participants’ physical activity level before and 
after the outbreak of the COVID-19 pandemic. For example, instead of using the phrase “During 
the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, 
digging, aerobics, or fast bicycling?” the statement designed to measure participants’ level of 
physical activity before the pandemic read, “During February 2020 before COVID-19, on how 
many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast 
bicycling?” (see Appendix B). Regarding the questionnaire measuring participants’ level of 
physical activity after the outbreak of COVID-19, no modification was applied.
Microsoft Excel spreadsheet of the IPAQ-SF, developed by Cheng (2016), was used to convert participants’ responses into a total score to assess their overall level of physical activity, using metabolic equivalent (MET) intensity levels. Depending on scores of the IPAQ-SF, participants can be categorized into three different levels: low (a total physical activity of lower than 600 MET-minutes/week), moderate (a total physical activity of at least 600 MET-minutes/week), and high (a total physical activity of at least 3,000 MET-minutes/week) (IPAQ Research Committee, 2005).

According to Craig et al. (2003), there is evidence of validity for the IPAQ-SF survey for individuals ranging between the years of 15-69 for assessing various intensity levels pertaining to physical activity and sedentary behavior, while also measuring the duration and frequency of any single activity. Previous researchers exhibited that the intra-class correlation coefficients ranged from .71 to .89, suggesting acceptable reliability of the IPAQ-SF (Dinger, Behrens, & Han, 2006). There is also evidence of concurrent validity ($r = .86$) and internal consistency ($\alpha = .89$) with university populations (Farren, Zhang, Martin, & Thomas, 2017).

### 3.3.1.2 Depression

The Patient Health Questionnaire-9 (PHQ-9) was used for this study to screen graduate students for depression (see Appendix B). This instrument is a 9-item self-report scale utilized to monitor and assess the severity of depression (Kroenke & Spitzer, 2002). The PHQ-9 was developed as a screening tool for depression symptoms; however, it is also used as a diagnostic measure of major depressive disorder (Kroenke, Spitzer, & Williams, 2001; Kroenke & Spitzer, 2002). For the PHQ-9, the items correspond to the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM–IV–TR; APA, 2000), which is used to diagnose major depressive symptoms.
For each of the nine items participants are instructed to rate on a 4-point scale (0 = Not at all, 1 = Several days, 2 = More than half the days, and 3 = Nearly every day.) how often they may have undergone depressive symptoms over the last two weeks. Responses to each item are summed to provide a participant’s level of depression severity, with a possible range of 0 to 27: minimal (0-4), mild (5-9), moderate (10-14), moderately severe (15-19) and severe (20-27). There is a question at the end of the instrument on which respondents rate their overall experience concerning their own day-to-day lives and whether or not it is an impediment issue for them. This is presented on the 4-point scale (1 = not difficult at all to 4 = extremely difficult).

I modified tenses to compare participants’ depression levels before and after the outbreak of the pandemic. For example, the question “Over the last 2 weeks, how often have you been bothered by any of the following problems?” was modified to “Over the last 2 weeks in February 2020 before COVID-19, how often had you been bothered by any of the following problems?” (see Appendix B). When it comes to the questionnaire designed to measure participants’ current level of depression, no modification was applied.

The construct validity of the PHQ-9 can be seen in several systematic reviews that set the standard for the criterion validity of the scale against alternative measurements of depression. Examples include the Structured Clinical Interview for DSM disorders (SCID; Cannon et al., 2007; Thekkumpurath et al., 2011), the Beck Depression Inventory (BDI) (Cameron, Cardy, & Crawford, 2011; Martin, Rief, Klaiberg, & Braehler, 2006), and the Hamilton Rating Scale for Depression (HRSD, Cameron et al., 2011). The scale shows high internal consistency (Chronbach's alpha between .86 and .88; Kroenke et al., 2001) and high test-retest reliability (Chronbach's alpha between .84 and .95; Adewuya, Ola, & Afolabi, 2006; Dinger et al., 2006; Keum, Miller, & Inkelas, 2018; Kroenke et al., 2001; Löwe et al., 2004).
Sensitivity ranged from 77% to 88%, and specificity ranged from 88% to 94%, respectively (Gilbody, Richards, Brealey, & Hewitt, 2007; Kroenke et al., 2001; Wittkampf, Naeije, Schene, Huyser, & van Weert, 2007). In addition, Kroenke and colleagues (2001) found a significant inverse relationship between the severity of PHQ-9 depression and the functional status of the Medical Outcomes Study Short-Form General Health Survey (SF-20). Eack, Greeno, and Lee (2006) also found that the PHQ-9 is quite effective and provided evidence of validity with community samples; evidence of validity has also been reported with psychiatric patients (Inoue et al., 2012) as well as university students (Klein, Ciotoli, & Chung, 2011; Keum et al., 2018).

### 3.3.1.3 Anxiety

The Generalized Anxiety Disorder scale (GAD-7) is a 7-item self-report scale developed to determine the severity of generalized anxiety disorders (Spitzer, Kroenke, Williams, & Löwe, 2006). The GAD-7 consists of seven self-report items that assess symptoms of anxiety experienced over the past two weeks on a 4-point Likert scale: 0 = Not at all, 1 = several days, 2 = more than half the days, and 3 = nearly every day (see Appendix B). Higher scores reflect more severe GAD symptoms, with a possible scoring ranging from 0 to 21. Ratings are then tallied for a summary score with the following norms: less than 4 indicates no anxiety although mild endorsement of symptoms, between 5 and 9 is considered mild anxiety, between 10 and 14 is considered moderate anxiety, and greater than 15 is considered severe anxiety. Finally, there is a summary question that has patients rate how difficult these symptoms have made it for the individual to accomplish work, get along with other people, or take care of things at home on a 4-point scale. Responses range from “not difficult at all” to “extremely difficult” (Spitzer et al., 2006).
I modified tenses to examine any changes in the level of anxiety among graduate students before and after the outbreak of COVID-19. For instance, the question “Over the last 2 weeks, how often have you been bothered by any of the following problems?” was modified to “Over the last 2 weeks in February before COVID-19, how often had you been bothered by any of the following problems?” (see Appendix B). In terms of the questionnaire designed to measure participants’ current level of anxiety, no modification was applied.

The GAD-7 is based on the DSM-IV GAD diagnosis criteria; however, due to very minimal changes to the GAD diagnosis criteria, it has been shown that the GAD-7 is clinically applicable and constructive with the updated DSM-5 (Locke, Kirst, & Shultz, 2015). Based on previous research, the GAD-7 is a reliable screening tool for social anxiety, panic, and PTSD disorder (Kroenke, Spitzer, Williams, & Löwe, 2010; Kroenke, Spitzer, Williams, Monahan, & Löwe, 2007). Good internal consistency of the GAD-7 (Cronbach's alpha between .89 and.92) has been found (Kertz, Bigda-Peyton, & Bjorgvinsson, 2013; Löwe et al., 2008; Spitzer et al., 2006), as well as evidence of convergent validity when compared to two anxiety scales: the Beck Anxiety Inventory ($r = .72$), and the anxiety subscale of the Symptom Checklist 90 (SCI-90) ($r = .74$) (Spitzer et al., 2006). There is also evidence that studies provide for good sensitivity (83%-89%) but questionable specificity (46%-82%) (Kertz et al., 2013; Spitzer et al., 2006). For the GAD-7 evidence of validity has been reported with community samples (Donker, van Straten, Marks, & Cuijpers, 2011), psychiatric patients (Dear et al., 2011) as well as university students (Bártolo, Monteiro, & Pereira, 2017; Lee & Kim, 2019; Naeinian, Shairi, Sharifi, & Hadian, 2011).
3.3.2 Control Variables

3.3.2.1 Financial Stress

It is well known that lower socioeconomic status is correlated with mental illness in the general population (Yu & Williams, 1999) as well as university students (Richardson, Elliott, Roberts, & Jansen, 2017). According to Hyun et al. (2006), graduate students who felt less financially secure were more likely to experience mental health problems. Although graduate students face a wide range of different stress factors, one particular stressor is to manage the financial aspects of their lives (Nelson, Dell’Oliver, Koch, & Buckler, 2001; Short et al., 2019). Indeed, a considerable proportion of mental health, such as depression and anxiety, are attributable to stress (De Kloet, Joëls, & Holsboer, 2005; Willner, 1997).

A recent study conducted by the Council of Graduate Schools (CGS) with over 13,000 graduate students included the finding that 60% of master’s students and 55% of doctoral students reported feeling stressed about their finances (Denecke, Feaster, Okahana, Allum, & Stone, 2016). In addition, 38% of master’s students and 36% of doctoral students reported they were concerned about meeting monthly expenses. Therefore, financial stress was included as a control variable by using the Financial Stress Scale-College Version (FSS-CV) developed by Northern et al. (2010). The FSS-CV originally consisted of 22 items; however, a 13-item scale is recommended because of nine of the items being less relevant to university students. The instrument includes various financial elements related to a student’s financial condition and level of stress (Northern, O’Brien, & Goetz, 2010). Each item requires participants to rate their personal experience of financial stress on a 4-point scale (1 – never to 4 – all the time), with a possible range of 13 (very low financial stress) to 52 (very high financial stress).
To examine changes in the level of financial stress before and after the outbreak of COVID-19, the instructions were modified by using different tenses. For example, the instruction “Consider the past six month” was modified to “Consider the last six month before March 2020” for the questionnaire designed to measure participants’ financial stress levels before the pandemic\(^1\). Regarding a questionnaire designed to measure participants’ current financial stress, no modification was applied (see Appendix B).

Evidence of the validity of the FSS-CV has been found in previous studies (Northern et al., 2010). Additionally, the instrument exhibited good internal consistency with Cronbach’s alpha between .87 to .89 (Northern et al., 2010; Robb, 2017). Evidence of convergent validity has also been shown as FSS-CV scores were significantly associated with the Multidimensional Index of Life Quality (MILQ) \((r = -.455;\) Northern et al., 2010).

### 3.3.2.2 Alcohol Use

Alcohol consumption is associated with higher levels of anxiety and depression (Boschloo et al., 2012; Caldwell et al., 2002); therefore, it was included as a control variable in the current study. Designed by the WHO (2001), the Alcohol Use Disorder Identification Test (AUDIT) is a 10 item self-report measure developed to screen for hazardous alcohol consumption over the past year. Three subscales are in the AUDIT: alcohol consumption, dependence symptoms, and harmful alcohol use (WHO, 2001). There are three items about alcohol consumption (e.g., “How often do you have a drink containing alcohol?”), three items about alcohol dependence (e.g., “During the past year, how often have you found that you were not able to stop drinking once you had started?”), and four items about harmful alcohol use (e.g., “During the past year, how often have you had a feeling of guilt or remorse after drinking?”).

\(^1\) This instrument measured from September 2019 to February 2020, prior to March 2020.
Respondents were asked to rate items on a 5-point scale (0 - Never to 4 - Daily or almost daily) for the first 8 questions and on a 3-point scale for the last two questions (1 - No, 2 - Yes, but not in the past year, and 3 - Yes, during the past year). The scores are summed up to assess one’s alcohol use disorder: the higher the scores, the greater the alcohol use disorder. Specifically, scores between 8 and 15 are deemed as a medium level of alcohol problems (WHO, 2001).

I modified each question to examine changes in alcohol use behaviors before and after the outbreak of the COVID-19 pandemic. The questions that measure participants’ alcohol use behavior before the pandemic were modified by changing the tense of each question into past tense. For example, one question, “How often do you have a drink containing alcohol” was modified to “how often did you have drinks containing alcohol in February 2020 before COVID-19.” Regarding the questionnaire designed to measure participants’ current alcohol use behavior, no modification was applied (see Appendix B).

The AUDIT has been known as a valid and reliable measurement when it comes to alcohol consumption among university students (Kokotailo et al., 2004; Oei & Jardim, 2007). Evidence of construct validity has been reported for the AUDIT (Allen, Litten, Fertig, & Babor, 1997), and also evidence of convergent validity with self-report measures of alcohol behavior, including the Michigan Alcohol Screening Test ($r = .88$; Bohn, Babor, & Kranzler, 1995).

### 3.3.2.3 Sleep Quality

Sleep quality was included as a control variable because it is likely that individuals with insomnia have a greater chance of experiencing depression and anxiety (Lohitashwa, Kadli, Kisan, Sindhuja, & Deshpande, 2015; Taylor, Lichstein, Durrence, Reidel, & Bush, 2005). The previously validated Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds III, Monk, Berman, & Kupfer, 1989) was utilized to assess an individual’s sleep quality. The PSQI is a 24-
item survey consisting of 19 self-report questions and five questions that are rated by a roommate or the bed partner if available. For the purpose of this study, only 19 self-report questions were collected and included in the scoring, similar to previous research by Ghrouz and colleagues (2019).

The final 19 self-report items were combined to generate seven components, including (1) subjective sleep quality, (2) sleep latency, (3) sleep duration, (4) habitual sleep efficiency, (5) sleep disturbances, (6) use of sleep-promoting medications, and (7) daytime dysfunction due to sleepiness. Each of the seven component scores ranged from 0 (no difficulty) to 3 (severe difficulty). They are summed to yield a global score ranging from 0 (no difficulty) to 21 (severe difficulty) points. The global scores of 5 or less are considered as good sleep quality, whereas scores above 5 indicate poor sleep quality (Buysse et al., 1989).

To examine changes in the sleep quality of participants before and during the outbreak of COVID-19, modification was performed by changing the wording in each question from “during the past month” to “during February 2020 before COVID-19” for the questionnaire asking participants’ sleep quality before the pandemic. In addition, I changed the tense of each question into past tense; for example, from “cannot get to sleep within 30 minutes” to “could not get to sleep within 30 minutes.” Regarding the questionnaire designed to measure participants’ current sleep quality, no modification was applied (see Appendix B).

In both non-clinical and research settings, the PSQI is one of the most widely used sleep assessment tools (Manzar et al., 2018). In a meta-analysis, Wang and colleagues (2019) indicated that the PSQI has been used more than any other sleep assessment. Evidence of validity for the instrument has been reported with different populations, including university students (Aloba, Adewuya, Ola, & Mapayi, 2007; Buysse et al., 1989; Kim, 2017; Lund, Reider, Whiting, &
There is also evidence of internal consistency and reliability for the PSQI (Cronbach's alpha between .80 and .87) for its seven components (Backhaus, Junghanns, Broocks, Riemann, & Hohagen, 2002; Carpenter & Andrykowski, 1998; Smyth, 2008).

### 3.3.2.4 Sociodemographic Characteristics

Sociodemographic factors are significantly associated with health-related quality of life, including age (Pappa, Kontodimopoulos, Papadopoulos, & Niakas, 2009), ethnicity (Lahana, Pappa, & Niakas, 2010), gender (Prause et al., 2005), and education status (Kivits, Erpelding, & Guillemin, 2013). Therefore, these factors were also included as control variables in the current study.

### 3.3.3 Summary of the Instruments and Modification

The scales that were used in this study are presented in Table 3.1.

<table>
<thead>
<tr>
<th>Category</th>
<th>Instrument</th>
<th>Subscales</th>
<th>Number of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic characteristics</td>
<td>IPAQ-SF (IPAQ, 2002)</td>
<td>Age, Ethnicity, Gender, Education status, Zip code, Major</td>
<td>6</td>
</tr>
<tr>
<td>Physical activity</td>
<td>IPQ-9 (Kroenke &amp; Spitzer, 2002)</td>
<td>N/A</td>
<td>7</td>
</tr>
<tr>
<td>Depression</td>
<td>PHQ-9 (Kroenke &amp; Spitzer, 2002)</td>
<td>N/A</td>
<td>9</td>
</tr>
<tr>
<td>Anxiety</td>
<td>GAD-7 (Spitzer et al., 2006)</td>
<td>N/A</td>
<td>7</td>
</tr>
<tr>
<td>Financial stress</td>
<td>FSS-CV (Northern et al., 2010)</td>
<td>N/A</td>
<td>13</td>
</tr>
<tr>
<td>Alcohol use</td>
<td>AUDIT (WHO, 2001)</td>
<td>Alcohol consumption, Dependence symptoms, Harmful alcohol use</td>
<td>10</td>
</tr>
<tr>
<td>Sleep quality</td>
<td>PSQI (Buysse et al., 1989)</td>
<td>Subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, step disturbances, use of sleeping medication, and daytime dysfunction</td>
<td>19</td>
</tr>
</tbody>
</table>
The questionnaire includes demographic characteristics, physical activity, depression, anxiety, financial stress, alcohol use, and sleep quality. As previously mentioned, items in each questionnaire were modified to meet the purpose of the study (see Appendix B).

3.4 Data Analysis

All the data obtained from the participants were reviewed and analyzed using IBM SPSS Statistics Version 27. Two screening questions were inserted: one after “Level of Anxiety in February 2020” section and the other after “Level of Depression” section. This was to make sure that participants were paying attention to the survey (see Appendix B). If the participants checked the wrong answers on either of the screening questions, they were forced to exit the survey immediately. Because all questions were coded as mandatory completion on the survey platform using the force response option in Qualtrics, there was no missing data.

3.4.1 Descriptive Analysis

The descriptive analysis were conducted with the demographic characteristics: age, ethnicity, gender, education status, zip code, and major.

3.4.2. Paired Sample t-test Analysis

The first research purpose was to examine the changes in the level of physical activity, depression, and anxiety among graduate students in the United States before and after the COVID-19 pandemic. The paired sample t-test analysis was used to test hypothesis 1, 2, and 3.

3.4.3. Regression Analysis

The purpose of the second question is to examine whether changes in the level of physical activity were associated with changes in the level of depression and anxiety among graduate students in the United States before (February 2020) and after the start of COVID-19 pandemic (May 2021). Multiple linear regression analysis was used with one independent
variable, physical activity, two dependent variables, depression and anxiety, and eight control variables: financial stress, alcohol use, sleep quality, age, gender, ethnicity, and education status. The multiple linear regression analysis allowed me to test hypotheses 4 and 5.

Testing of assumptions is critical when using multiple regression. Pedhazur (1997) noted, “Knowledge and understanding of the situations when violations of assumptions lead to serious biases, and when they are of little consequence, are essential to meaningful data analysis” (p.33).

There are four major assumptions in terms of multiple regression: linearity, normality, multicollinearity, and homoscedasticity (Osborne & Waters, 2002; Williams, Grajales, & Kurkiewicz, 2013). First, regression analysis includes the assumption that the relationship between independent and dependent variables is linear. If the relationship is not linear, the results of the regression analysis will not be able to estimate the true relationship. Linearity can be checked by examining a scatterplot of independent variables and an outcome variable; the assumption is satisfied when the scatterplot shows no curvilinear relationship between the variables. A second assumption is that residuals between observed and predicted values should be normally distributed. Normality can be examined by looking at a histogram of residuals. When the residuals are normally distributed, the assumption is satisfied. A third assumption is that there is no multicollinearity, which occurs when the independent variables are too highly correlated. A way to check the assumption of multicollinearity is to examine the variance inflation factor (VIF) score; the assumption is satisfied when the VIF value is below 10. Lastly, there is an assumption of homoscedasticity when conducting multiple linear regression, meaning the variance of errors is the same across all levels of the independent variables. Homoscedasticity can be checked by looking at a normal predicted–probability plot of residuals;
the assumption is satisfied when the residuals do not have a clear pattern, but equally spread around zero on the X-axis and the Y-axis.

In Chapter 3, the research methods, including study design, data collection procedure, measurements, and statistical analysis, were discussed. Results obtained from the analysis are discussed in the following chapter.
CHAPTER 4

RESULTS

4.1 Sample Characteristics

4.1.1 Data Screening

The surveys were distributed online through ProA platform from May 1, 2021 to May 10, 2021 and were collected through Qualtrics. During this period, a total of 210 individuals participated the survey; however, 60 were not eligible to take part in the survey. These 60 participants answered “No,” regarding the screening questions (i.e., “Were you a graduate student in the United States in February 2020?” and “Were you a graduate student in the United States in April 2021?”). These participants were redirected to the end of the survey page immediately and excluded from the analysis. The final sample used for analysis was 150 responses, which met the minimum required sample size ($N = 129$).

4.1.2 Descriptive Analysis

Several demographic characteristics were measured, including age, gender, ethnicity, academic program in February 2020 and April 2021, current academic major, and the U.S. postal code in which an individual resided in April 2021. Table 4.1 contains the frequency analyses for the collected demographic characteristics.

A total of 150 responses consisted of 66 from females (44.0%) and 84 from males (56.0%). With an age range from 21 years to 55 years, the mean age was 33.28 ($SD = 6.21$). The majority of the participants described themselves as White, Caucasian, Anglo (not Hispanic) ($n = 87; 58$%). The next largest majority was Black or African American ($n = 38; 25.3$%). The
majority of the participants were in a master’s program both in February 2020 ($n = 100; 66.7\%$) and April 2021 ($n = 84; 56\%$).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>66</td>
<td>44.0</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>84</td>
<td>56.0</td>
</tr>
<tr>
<td>Age</td>
<td>Mean: 33.28</td>
<td>150</td>
<td>SD: 6.21</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Arab American/Middle Eastern</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>Asian, Asian American, or Pacific Islander</td>
<td>12</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td>Black or African American</td>
<td>38</td>
<td>25.3</td>
</tr>
<tr>
<td></td>
<td>Hispanic or Latin American</td>
<td>9</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>White, Caucasian, Anglo (not Hispanic)</td>
<td>87</td>
<td>58.0</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>3</td>
<td>2.0</td>
</tr>
<tr>
<td>Academic Program in February 2020</td>
<td>Master’s Program</td>
<td>100</td>
<td>66.7</td>
</tr>
<tr>
<td></td>
<td>Ph.D. Program</td>
<td>41</td>
<td>27.3</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>9</td>
<td>6.0</td>
</tr>
<tr>
<td>Academic Program in April 2021</td>
<td>Master’s Program</td>
<td>84</td>
<td>56.0</td>
</tr>
<tr>
<td></td>
<td>Ph.D. Program</td>
<td>53</td>
<td>35.3</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>13</td>
<td>8.7</td>
</tr>
</tbody>
</table>

An infographic map of states where the participants resided in April 2021 is shown in Figure 4.1.
There were participants from 28 different states in the United States though most were from New York (n = 36; 24%) and California (n = 22; 14.7%). The was no primary (or majority) major reported by the participants. The major with the largest percentage of participants was Business Administration (n = 21; 14.0%), followed by Computer Science (n = 13; 8.7%). The frequency analysis for the participants’ major is presented in Table 4.2.

<table>
<thead>
<tr>
<th>Major</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounting</td>
<td>11</td>
<td>7.30</td>
</tr>
<tr>
<td>Analysis</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Architecture</td>
<td>2</td>
<td>1.30</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Biology</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Business Administration</td>
<td>21</td>
<td>14.00</td>
</tr>
<tr>
<td>Chemistry</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Communication</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Computer Science</td>
<td>13</td>
<td>8.70</td>
</tr>
<tr>
<td>Construction</td>
<td>3</td>
<td>2.00</td>
</tr>
<tr>
<td>Counseling</td>
<td>2</td>
<td>1.30</td>
</tr>
<tr>
<td>Criminal Justice</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Curriculum and Instruction</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Cybersecurity</td>
<td>2</td>
<td>1.30</td>
</tr>
<tr>
<td>Dentistry</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Economics</td>
<td>2</td>
<td>1.30</td>
</tr>
<tr>
<td>Education</td>
<td>6</td>
<td>4.00</td>
</tr>
<tr>
<td>Engineering</td>
<td>2</td>
<td>1.30</td>
</tr>
<tr>
<td>English</td>
<td>3</td>
<td>2.00</td>
</tr>
<tr>
<td>Epidemiology</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Finance</td>
<td>10</td>
<td>6.70</td>
</tr>
<tr>
<td>Future Studies</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Genetics</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Health Science</td>
<td>3</td>
<td>2.00</td>
</tr>
<tr>
<td>High Speed Wireless Communication</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Horticulture</td>
<td>2</td>
<td>1.30</td>
</tr>
<tr>
<td>Information Technology</td>
<td>6</td>
<td>4.00</td>
</tr>
<tr>
<td>Languages</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Law</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Literature for Children and Young Adults</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Management</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>2</td>
<td>1.30</td>
</tr>
<tr>
<td>Marketing</td>
<td>3</td>
<td>2.00</td>
</tr>
<tr>
<td>Medicine</td>
<td>8</td>
<td>5.30</td>
</tr>
<tr>
<td>Not Applicable</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Organizational Leadership</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Petroleum Engineering</td>
<td>1</td>
<td>0.70</td>
</tr>
</tbody>
</table>
Table 4.2 – continued

<table>
<thead>
<tr>
<th>Major</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmaceutics</td>
<td>3</td>
<td>2.00</td>
</tr>
<tr>
<td>Philosophy</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Physical Therapy</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Physics</td>
<td>3</td>
<td>2.00</td>
</tr>
<tr>
<td>Political Data</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Process Engineering</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Psychology</td>
<td>7</td>
<td>4.70</td>
</tr>
<tr>
<td>Public Administration</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Public Health</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Recreation Management</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>School Leadership</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Sociology</td>
<td>4</td>
<td>2.70</td>
</tr>
<tr>
<td>Software Engineering</td>
<td>2</td>
<td>1.30</td>
</tr>
<tr>
<td>TESOL</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Theology</td>
<td>1</td>
<td>0.70</td>
</tr>
<tr>
<td>Web Development</td>
<td>1</td>
<td>0.70</td>
</tr>
</tbody>
</table>

Table 4.3 presents descriptive statistics of each component of physical activity, depression, anxiety, financial stress, alcohol consumption, and sleep quality before (February 2020) and after the outbreak of COVID-19 (May 2021). The mean Total IPAQ MET (min*wk\(^{-1}\)) for the sample \(N = 150\) was considered high both in February 2020 \((M = 5,235.40, SD = 3,603.38, Min = 99.00, Max = 17,598.00)\), and May 2021 \((M = 3,013.46, SD = 2,636.58, Min=0.00, Max=13,758.00)\). The participants had minimal levels of depression in February 2020 \((M = 4.82, SD = 5.34)\) and moderate levels of depression in May 2021 \((M = 6.46, SD = 5.74)\). The participants showed minimal anxiety in February 2020 \((M = 3.94, SD = 4.52)\); however, they showed moderate anxiety in May 2021 \((M = 5.36, SD = 4.89)\). The participants had relatively low financial stress levels both in February 2020 \((M = 21.66, SD = 7.34)\) and May 2021 \((M = 21.89, SD = 8.69)\). The alcohol consumption levels of the participants in February 2020 \((M = 6.15, SD = 6.44)\) and May 2021 \((M = 5.70, SD = 6.73)\) showed that they were in low-risk drinking levels. Lastly, the sleep quality of the participants in February 2020 \((M = 5.34, SD = 3.31)\) and May 2021 \((M = 5.73, SD = 3.98)\) were considered as good.
Table 4.3 Descriptive statistics of physical activity, depression, anxiety, financial stress, alcohol consumption, and sleep quality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Period</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vigorous MET (min·wk⁻¹)</td>
<td>February 2020</td>
<td>150</td>
<td>2,541.70</td>
<td>2,228.02</td>
<td>0.00</td>
<td>100,80.00</td>
</tr>
<tr>
<td></td>
<td>May 2021</td>
<td>150</td>
<td>1,267.73</td>
<td>1,508.10</td>
<td>0.00</td>
<td>8,960.00</td>
</tr>
<tr>
<td>Moderate MET (min·wk⁻¹)</td>
<td>February 2020</td>
<td>150</td>
<td>1,390.88</td>
<td>1,327.67</td>
<td>0.00</td>
<td>5,040.00</td>
</tr>
<tr>
<td></td>
<td>May 2021</td>
<td>150</td>
<td>837.68</td>
<td>955.05</td>
<td>0.00</td>
<td>5,050.00</td>
</tr>
<tr>
<td>Walking MET (min·wk⁻¹)</td>
<td>February 2020</td>
<td>150</td>
<td>1,302.81</td>
<td>1,168.50</td>
<td>0.00</td>
<td>5,040.00</td>
</tr>
<tr>
<td></td>
<td>May 2021</td>
<td>150</td>
<td>914.14</td>
<td>973.17</td>
<td>0.00</td>
<td>4,158.00</td>
</tr>
<tr>
<td>Total IPAQ MET (min·wk⁻¹)</td>
<td>February 2020</td>
<td>150</td>
<td>5,235.40</td>
<td>3,603.28</td>
<td>99.00</td>
<td>17,598.00</td>
</tr>
<tr>
<td></td>
<td>May 2021</td>
<td>150</td>
<td>3,013.46</td>
<td>2,636.58</td>
<td>0.00</td>
<td>13,758.00</td>
</tr>
<tr>
<td>Sitting (min·wk⁻¹)</td>
<td>February 2020</td>
<td>150</td>
<td>2,425.17</td>
<td>1,223.07</td>
<td>105.00</td>
<td>5,033.00</td>
</tr>
<tr>
<td></td>
<td>May 2021</td>
<td>150</td>
<td>2,604.70</td>
<td>1,322.29</td>
<td>70.00</td>
<td>5,033.00</td>
</tr>
<tr>
<td>Depression</td>
<td>February 2020</td>
<td>150</td>
<td>4.82</td>
<td>5.34</td>
<td>0.00</td>
<td>24.00</td>
</tr>
<tr>
<td></td>
<td>May 2021</td>
<td>150</td>
<td>6.46</td>
<td>5.74</td>
<td>0.00</td>
<td>27.00</td>
</tr>
<tr>
<td>Anxiety</td>
<td>February 2020</td>
<td>150</td>
<td>3.94</td>
<td>4.52</td>
<td>0.00</td>
<td>21.00</td>
</tr>
<tr>
<td></td>
<td>May 2021</td>
<td>150</td>
<td>5.36</td>
<td>4.89</td>
<td>0.00</td>
<td>21.00</td>
</tr>
<tr>
<td>Financial Stress</td>
<td>February 2020</td>
<td>150</td>
<td>21.66</td>
<td>7.34</td>
<td>13.00</td>
<td>43.00</td>
</tr>
<tr>
<td></td>
<td>May 2021</td>
<td>150</td>
<td>21.89</td>
<td>8.69</td>
<td>13.00</td>
<td>48.00</td>
</tr>
<tr>
<td>Alcohol Consumption</td>
<td>February 2020</td>
<td>150</td>
<td>6.15</td>
<td>6.44</td>
<td>0.00</td>
<td>29.00</td>
</tr>
<tr>
<td></td>
<td>May 2021</td>
<td>150</td>
<td>5.70</td>
<td>6.73</td>
<td>0.00</td>
<td>31.00</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>February 2020</td>
<td>150</td>
<td>5.34</td>
<td>3.31</td>
<td>0.00</td>
<td>15.00</td>
</tr>
<tr>
<td></td>
<td>May 2021</td>
<td>150</td>
<td>5.73</td>
<td>3.98</td>
<td>0.00</td>
<td>20.00</td>
</tr>
</tbody>
</table>

**4.2 Reliability**

Cronbach’s alpha coefficients were calculated for the scales as evidence of reliability. Table 4.4 shows the reliability statistics of variables measured for February 2020 and May 2021. The Cronbach’s alphas scores are above .7, which is a recommended value to ensure sufficient reliability (Nunnally & Bernstein, 1994).

<table>
<thead>
<tr>
<th>Table 4.4 Reliability statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHQ-9</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Cronbach’s alpha</td>
</tr>
<tr>
<td>February 2020</td>
</tr>
<tr>
<td>May 2021</td>
</tr>
</tbody>
</table>
4.3 Paired Sample t-test Analysis

4.3.1 Differences in Physical Activity before and after COVID-19

To answer research question one: “Did the level of physical activity among graduate students in the United States change during the COVID-19 pandemic?” a paired sample t-test was conducted to compare self-reported physical activity levels in February 2020 and May 2021. The result of the analysis of physical activity level is presented in Table 4.5.

<table>
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<tr>
<th>Variable</th>
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<th></th>
<th>May 2021</th>
<th></th>
<th>t(df)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Vigorous MET (min-wk⁻¹)</td>
<td>150</td>
<td>2541.71</td>
<td>2228.02</td>
<td>1267.73</td>
<td>1508.10</td>
</tr>
<tr>
<td>Moderate MET (min-wk⁻¹)</td>
<td>150</td>
<td>1390.88</td>
<td>1327.68</td>
<td>837.68</td>
<td>955.05</td>
</tr>
<tr>
<td>Walking MET (min-wk⁻¹)</td>
<td>150</td>
<td>1310.01</td>
<td>1169.11</td>
<td>914.14</td>
<td>973.17</td>
</tr>
<tr>
<td>Total IPAQ MET (min-wk⁻¹)</td>
<td>150</td>
<td>5235.40</td>
<td>3603.38</td>
<td>3013.46</td>
<td>2636.59</td>
</tr>
<tr>
<td>Sitting (min-wk⁻¹)</td>
<td>150</td>
<td>2425.17</td>
<td>1223.07</td>
<td>2604.70</td>
<td>1322.29</td>
</tr>
</tbody>
</table>

*Note: *p < .05; ***p < .001

In order to check each component of physical activity, mean changes in vigorous, moderate, walking, total IPAQ MET minutes a week (min-wk⁻¹), and sitting (min-wk⁻¹) were separately analyzed. It was noted that the mean of vigorous MET (min-wk⁻¹) in February 2020 was 2,541.71 (SD = 2,228.02), and was 1,267.73 (SD = 1,508.10) in April 2020. A statistically significant change was found before and after the outbreak of COVID-19 (t(149) = 7.89, p < .001). The participants were more engaged in vigorous physical activity in February 2020 compared to May 2021. When it comes to moderate physical activity, the mean of moderate MET (min-wk⁻¹) in February 2020 was 1,390.88 (SD = 1,327.68), and the mean of moderate MET (min-wk⁻¹) in May 2021 was 837.68 (SD = 955.05). There was a significant difference in
moderate MET (min·wk⁻¹) before and after the outbreak of COVID-19 \( (t(149) = 5.90, p < .001) \).

A significant change was also observed in terms of walking before and after the outbreak of COVID-19 \( (t(149)=4.78, p < .001) \) with the mean of walking MET (min·wk⁻¹) was 1,310.01 \( (SD = 1,169.11) \) in February 2020 and 914.14 \( (SD = 973.17) \) in May 2021. To calculate the mean of total IPAQ MET (min·wk⁻¹), METs of walking, moderate, vigorous activity were summed to examine the overall change in participants’ total physical activity levels, similar to previous study by Ghrouz and colleagues (2019). A significant change was witnessed in the mean of total IPAQ MET (min·wk⁻¹) before and after the outbreak of COVID-19 \( (t(149)=9.51, p < .001) \). The mean of total IPAQ MET (min·wk⁻¹) in February 2020 was 5,235.40 \( (SD = 3,603.38) \) and was 3,013.46 \( (SD = 2,636.59) \) in May 2021. When it comes to sitting, the mean of sitting (min·wk⁻¹) increased from 2,425.17 (February 2020) to 2,604.70 (May 2021); a significant change was found \( (t(149)=2.16, p < .05) \).

In sum, the first hypothesis (the level of physical activity among graduate students in the U.S. significantly decreased after the outbreak of COVID-19) was supported.

4.3.2 Differences in Depression before and after COVID-19

To answer research question two: “Did the level of depression among graduate students in the United States change during the COVID-19 pandemic?” a paired sample \( t \)-test was used to compare the participants’ depression levels in February 2020 and May 2021. Table 4.6 shows the results of paired sample \( t \)-test analysis of depression.

The mean for depression was 4.83 \( (SD = 5.34) \) in February 2020 and was 6.46 \( (SD = 5.74) \) in May 2021. A significant change in the mean level of depression was observed before and after the outbreak of COVID-19 \( (t(149)=5.07, p < .001) \). In sum, the result of the paired sample \( t \)-test of depression revealed that the participants scored significantly higher on the
depression during the pandemic as compared to the pre-pandemic. Therefore, the second hypothesis (the level of depression among graduate students in the U.S. significantly increased after the outbreak of COVID-19) was supported.

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<td>PHQ-9 Total</td>
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*Note: ***p < .001

4.3.3 Differences in Anxiety before and after COVID-19

To answer research question three: “Did the level of anxiety among graduate students in the United States change during the COVID-19 pandemic?” a paired sample t-test was used to compare the level of anxiety in February 2020 and May 2021. The result of paired sample t-test analysis of anxiety is presented in Table 4.7.

<table>
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<td>GAD-7 Total</td>
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</table>

*Note: ***p < .001

It was found that the mean anxiety level increased from 3.95 (SD = 4.52) in February 2020 to 5.37 (SD = 4.90) in May 2021. There was a significant change in anxiety between February 2020 and May 2021 (t(149)=4.62, p < .001). The result of the paired sample t-test of anxiety indicated that the participants’ anxiety levels significantly increased in May 2021 compared to February 2020. In sum, the third hypothesis (the level of anxiety among graduate students in the U.S. significantly increased after the outbreak of COVID-19) was supported.
4.4 Multiple Linear Regression Analysis

To answer research question 4 and 5, multiple linear regression was conducted. Before running the analysis, the assumptions of multiple linear regression were checked for multicollinearity, linearity, normality, and homoscedasticity.

4.4.1 Assumption Test

4.4.1.1 Multicollinearity

Occurring when predictors variables are highly correlated with each other, multicollinearity was accessed by examining correlations among independent variables. According to Field (2009), correlations between predictor variables above .80 bring about less reliable probabilities when it comes to the effect of predictors. Table 4.9 (pre-COVID), 4.10 (post-COVID), and 4.11 (changes between pre and post COVID) shown in the following page present the correlations between the mean change in total IPAQ MET and change in vigorous MET were .867 ($p < .001$), .810 ($p < .001$), and .847 ($p < .001$), respectively.

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<td>Changes in Walking MET (min-wk$^{-1}$)</td>
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<td>Changes in Sitting (min-wk$^{-1}$)</td>
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<td>Change in Financial Stress</td>
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<td>Change in Alcohol Consumption</td>
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<td>Change in Sleep Quality</td>
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Table 4.9 Pearson correlation coefficients across all combinations of predictors before COVID-19

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*Note: 1. Pre_sitting MET (min-wk⁻¹); 2. Pre_vigorous MET (min-wk⁻¹); 3. Pre Moderate MET (min-wk⁻¹); 4. Pre_walking MET (min-wk⁻¹); 5. Pre_total IPAQ MET (min-wk⁻¹); 6. Pre_FSS-CV; 7. Pre_AUDIT; 8. Pre_PSQI; 9. Age; 10. Gender (female v. male); 11. Ethnicity (Arab v. White); 12. Ethnicity (Asian v. White); 13. Ethnicity (Black v. White); 14. Ethnicity (Hispanic v. White); 15. Ethnicity (other v. White); 16. Education status (other v. Master’s); 17. Education status (Ph.D. v. Master’s)

*p < .05; **p < .001
Table 4.10 Pearson correlation coefficients across all combinations of predictors after COVID-19

<table>
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<th>Variable</th>
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Note: 1. Post_sitting MET (min-wk⁻¹); 2. Post_vigorous MET (min-wk⁻¹); 3. Post_moderate MET (min-wk⁻¹); 4. Post_walking MET (min-wk⁻¹); 5. Post_total IPAQ MET (min-wk⁻¹); 6. Post_FSS-CV; 7. Post_AUDIT; 8. Post_PSQI; 9. Age; 10. Gender (female v. male); 11. Ethnicity (Arab v. White); 12. Ethnicity (Asian v. White); 13. Ethnicity (Black v. White); 14. Ethnicity (Hispanic v. White); 15. Ethnicity (other v. White); 16. Education status (other v. Master’s); 17. Education status (Ph.D. v. Master’s)

*p < .05; **p < .001
Table 4.11 Pearson correlation coefficients across all combinations of change in predictors before and after COVID-19

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*Note: 1. Change in sitting MET (min·wk⁻¹); 2. Change in vigorous MET (min·wk⁻¹); 3. Change in moderate MET (min·wk⁻¹); 4. Change in walking MET (min·wk⁻¹); 5. Change in total IPAQ MET (min·wk⁻¹); 6. Change in FSS-CV; 7. Change in AUDIT; 8. Change in PSQI; 9. Age; 10. Gender (female v. male); 11. Ethnicity (Arab v. White); 12. Ethnicity (Asian v. White); 13. Ethnicity (Black v. White); 14. Ethnicity (Hispanic v. White); 15. Ethnicity (other v. White); 16. Education status (other v. Master’s); 17. Education status (Ph.D. v. Master’s)

*p < .05; **p < .001
It suggested that there may be a problem with the assumption of multicollinearity. Thus, I removed the mean of change in total IPAQ MET from the regression analysis for both research questions 4 and 5. In addition, the VIF scores for the remaining independent variables are below 10 for both research questions 4 and 5, indicating that multicollinearity is not a concern for further analysis in the model. The VIF scores are shown in Table 4.8. In sum, the assumption of multicollinearity is met for research questions 4 and 5.

4.4.1.2 Linearity

In order to evaluate the predictor and outcome variables, and whether a linear relationship was present between them, the visual inspection of scatterplots was conducted (Field, 2009). Figure 4.2 (depression) and 4.3 (anxiety) present the scatterplots of each combination of the changes in the independent variables and the dependent variables. Among sociodemographic variables, gender, ethnicity, and education status are excluded from the linearity assumption test because they are categorical variables. All scatterplots in Figure 4.2 and 4.3 show no curvilinear relationships between the variables; therefore, the assumption of linearity is met for both research questions 4 and 5.

Figure 4.2. The scatterplots for the relationship between the changes in independent variables and depression (PHQ-9)
Figure 4.2. – continued

Figure 4.3. The scatterplots for the relationship between the changes in independent variables and anxiety (GAD-7)
4.4.1.3 Normality

To assess normality, the residuals between the predictor variables and the dependent variables are inspected by visually examining the histogram. The histograms of the residuals shown above appeared mostly normal, meaning the assumption of normality for research questions 4 and 5 is satisfied (see Figure 4.4 and 4.5).
Figure 4.4. The histogram for the residual for depression

Figure 4.5. The histogram for the residual for anxiety

4.4.1.4 Homoscedasticity

Homoscedasticity was examined by looking at a normal predicted–probability plot of residuals. The scatterplots (Figure 4.6 and 4.7) shown below have no clear pattern in the distribution, indicating the assumption of homoscedasticity is met for research questions 4 and 5.
In short, the assumption tests for a multiple linear regression are all satisfied with the assumption of multicollinearity, linearity, normality, and homoscedasticity, as shown above.

4.4.2 Results for Research Question 4

With all assumptions satisfied, a multiple linear regression was conducted to determine if the mean changes in physical activity were negatively associated with the mean changes in
depression after controlling the control variables. Only a change in moderate MET (min-wk⁻¹) was found to be significantly associated with a change in depression after controlling for financial stress, alcohol consumption, sleep quality, age, gender, ethnicity, and educational status. Table 4.12 presents the result of multiple linear regression for research question 4.

**Table 4.12 Regression coefficients for research question 4**

<table>
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<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>Beta</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
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<td>Change in Vigorous MET (min-wk⁻¹)</td>
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<td>.000</td>
<td>-.090</td>
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<td>Change in Moderate MET (min-wk⁻¹)</td>
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<td>-.177</td>
<td>-2.292*</td>
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<td>Change in Walking MET (min-wk⁻¹)</td>
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<td>.065</td>
<td>.854</td>
</tr>
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<td>Change in Sitting (min-wk⁻¹)</td>
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<td>.000</td>
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<td>.825</td>
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<td>FSS Total Change</td>
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<td>AUDIT Total Change</td>
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<td>.005</td>
<td>.067</td>
</tr>
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<td>PSQI Total Change</td>
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<td>1.601</td>
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<td>Age</td>
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<td>.050</td>
<td>.008</td>
<td>.100</td>
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<td>-.481</td>
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<td>Hispanic (v. White)</td>
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<td>.636</td>
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<td>.588</td>
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</table>

*Note: *p < .05; ***p < .001

To sum up, the fourth hypothesis (changes in the level of physical activity are negatively associated with changes in the level of depression among graduate students in the U.S. after the outbreak of COVID-19) was partially supported.

### 4.4.3 Results for Research Question 5

Multiple linear regression was conducted to determine if the mean changes in physical activity were negatively associated with the mean changes in anxiety after controlling the control variables (e.g., financial stress, alcohol consumption, sleep quality, age, gender, ethnicity, education status). A relationship between changes in physical activity and changes in anxiety was not observed. The result of multiple linear regression for research question 5 is shown in Table 4.13.
### Table 4.13 Regression coefficients for research question 5

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<td>Change in Walking MET (min-wk(^{-1}))</td>
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*Note: *p < .05; ***p < .001

In conclusion, the fifth hypothesis (changes in the level of physical activity are negatively associated with changes in the level of anxiety among graduate students in the U.S. after the outbreak of COVID-19) was not supported.

#### 4.4.4 Summary of the Hypotheses Testing

The current study involved five hypotheses. Each was tested for significance at a .05 alpha level. Results of the hypothesis testing from the current study are shown in Table 4.12. In summary, the first, second, and third hypotheses were supported. The fourth hypothesis was partially supported; however, the fifth hypothesis was not supported.

### Table 4.14 The results of the hypothesis test

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<thead>
<tr>
<th>Hypothesis</th>
<th>Result</th>
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<td>H1</td>
<td>The level of physical activity among graduate students in the U.S. significantly decreased after the outbreak of the COVID-19 pandemic.</td>
</tr>
<tr>
<td>H2</td>
<td>The level of depression among graduate students in the U.S. significantly increased after the outbreak of the COVID-19 pandemic.</td>
</tr>
<tr>
<td>H3</td>
<td>The level of anxiety among graduate students in the U.S. significantly increased after the outbreak of the COVID-19 pandemic.</td>
</tr>
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</table>
Table 4.14 - continued

| $H_4$ | Changes in the level of physical activity are negatively associated with changes in the level of depression among graduate students in the U.S. before and after the outbreak of COVID-19, after controlling financial stress, alcohol consumption, sleep quality, and sociodemographic characteristics (i.e., age, ethnicity, gender, education status). | Partially Supported |

| $H_5$ | Changes in the level of physical activity are negatively associated with changes in the level of anxiety among graduate students in the U.S. before and after the outbreak of COVID-19, after controlling financial stress, alcohol consumption, sleep quality, and sociodemographic characteristics (i.e., age, ethnicity, gender, education status). | Not Supported |

In Chapter 4, the results in terms of descriptive analysis, reliability, paired sample $t$-test, the assumption test, and multiple linear regression were detailed. A discussion of the results, limitations and recommendations for future research, and conclusions are discussed in Chapter 5.
CHAPTER 5

DISCUSSION

The current study has delivered significant results around the topic of the COVID-19 pandemic in terms of the levels of physical activity, depression, and anxiety for graduate students in the United States. The results of this study confirm that compared to February 2020 (before the outbreak of COVID-19), the participants’ level of physical activity significantly decreased, and the level of depression and anxiety substantially increased by May 2021 (after the outbreak of COVID-19). These results are consistent with previous studies examining the effect of COVID-19 on the decrease in the level of physical activity (Barkley et al., 2020), and the increase in the level of depression (X. Wang et al., 2020), and anxiety (Rudenstine et al., 2021). When it comes to the relationship between physical activity and depression, it was found that the decrease in the level of moderate physical activity was significantly associated with the increase in the level of depression, after controlling variables such as financial stress, alcohol consumption, sleep quality, and sociodemographic characteristics (i.e., age, gender, ethnicity, educational status, and major). However, no relationship was found between the level of physical activity and anxiety.

The present study extends previous research by examining only graduate students in the U.S. These results assist us in grasping the current levels of physical activity, depression, and anxiety among graduate students. This is vital because there has been a dearth of literature in terms of the prevalence of physical activity and its association with mental health, solely focusing on graduate students (Keating et al., 2005). Moreover, the COVID-19 pandemic affecting millions of individuals across the world has caused several sudden life changes,
including changes in levels of physical activity (Savage et al., 2020; Srivastav et al., 2021) and mental health (Özdin & Bayrak Özdin, 2020). The current study shows that being physically active, specifically doing moderate physical activity, may be an important means of staying mentally healthy, even during the pandemic, and explores the relationship between the changes in physical activity and the changes in depression and anxiety before and after the outbreak of the COVID-19 pandemic.

The mean of total IPAQ MET (min·wk⁻¹) obtained in the current study is considered as high both in February 2020 ($M = 5,235.40; SD = 3,603.38$) and May 2021 ($M = 3,013.46; SD = 2,636.59$) although it has significantly decreased between these time periods. The result of the current study in terms of participants’ high level of physical activity during the pandemic is not consistent with numerous studies observing lower levels of physical activity among undergraduate and graduate students (Barkley et al., 2020). The participants’ depression and anxiety levels significantly increased in May 2021 compared to February 2020; however, the mean levels of depression and anxiety are considered moderate or less in both time periods.

These results showing high levels of physical activity, and minimal to moderate range of depression and anxiety appear to contradict the results of previous research (Barkley et al., 2020; Chi et al., 2020; X. Wang et al., 2020) in that these studies presented that COVID-19 is likely to have substantial negative impacts on physical activity level, and mental health. The time at which data was collected could account for these discrepancies because the data of physical activity, depression, and anxiety from the aforementioned studies (e.g., Barkley et al., 2020; Rudenstine et al., 2021; X. Wang et al., 2020) were collected during April to June 2020, which quickly followed the public health emergency declared by the WHO. However, the data of the present study were obtained in May 2021 when vaccinations were available, and stringent
COVID-19 mitigating strategies (e.g., stay-at-home orders) were no longer being strictly enforced by most states. The lower levels of depression and anxiety reported by participants could also be a byproduct of relief they felt due to the result of the recent decrease in COVID-19 case, which had decreased by 94.4% when compared to its peak on January 10, 2021 ($N = 251,834$; CDC, 2021d).

When it comes to the relationship between the changes in physical activity level and the changes in the levels of depression and anxiety, the mean change in moderate MET was negatively associated with the mean change in depression, after controlling for variables such as financial stress, alcohol consumption, sleep quality, and sociodemographic characteristics (i.e., age, gender, ethnicity, education status). However, no relationship was observed between the mean change in the other types of physical activity such as vigorous physical activity, and walking and the mean change in depression. In addition, the mean change in every level of physical activity including vigorous physical activity, moderate physical activity, and walking was found to have no relationship with the mean change in anxiety. These findings are inconsistent with previous research where a significant negative relationship was reported between physical activity levels and levels of depression and anxiety (Xiang et al., 2020). The inconsistent results may be linked to the respondents’ different demographic characteristics and the power of financial stress on the level of depression and anxiety. First, the current study is only focusing on graduate students that have not been meticulously examined. In contrast, Xiang and colleagues (2020) mostly focused on undergraduate students, with a small number of graduate students included (82 out of 1,400). One of the biggest differences between undergraduate and graduate students is that graduate students are more likely to interact with their advisors than their counterparts. Interestingly, several studies found that a positive
relationship with an advisor is significantly associated with decreased mental disorders (i.e., depression and anxiety) among graduate students (Gottschall, 2014; C. Liu et al., 2019; Peluso, Carleton, & Asmundson, 2011; Schlosser, Lyons, Talleyrand, Kim, & Johnson, 2011).

Secondly, these results may be the result of financial stress significantly affecting the participants’ mean change in depression and anxiety. The participants of the current study reported moderate levels of financial stress both in February 2020 ($M = 21.67$) and May 2021 ($M = 21.89$). In fact, the mean change in financial stress was found to be not only significantly positively related to the mean change in depression ($F(1, 148) = 38.76, p < .001$) but also the mean change in anxiety ($F(1, 148) = 50.62, p < .001$) when I conducted an additional analysis. In regression analysis, it is reasonable and often necessary to control variables that are not of interest but may influence the outcomes of a study by holding them constant throughout the study (Arkes, 2019). However, it is essential to note that control variables can still have some possible effects on outcomes because they are being included in a regression equation.

5.1 Limitations and Recommendations for Future Research

One of the major limitations of this study is that the participants were asked to recall their memories of February 2020 to answer the questionnaires. As previously mentioned, memories that involve strong emotions are more likely to be remembered, known as the flashbulb memory (Brown & Kulik, 1977). However, retrospective contamination could be a problem, resulting in recall bias due to the distortion and/or degradation of memories due to the period of time between the memories formation and when it is being recalled (Geldhof et al., 2018; O’Brien & DeLongis, 1996; Schwartz & Sprangers, 2010). Applied to the current study, the participants may find it hard to recall their memories about the level of physical activity, depression, anxiety,
financial stress, alcohol consumption, and sleep quality in February 2020, possibly introducing recall bias into the outcomes.

Second, the current study is cross-sectional, non-experimental research meaning that the results may not be generalized to graduate students with different characteristics in the United States. For example, the ethnicity of the samples collected is disproportionally skewed to White, Caucasian, Anglo (not Hispanic) consisting of 87 out of 150, indicating that the ethnicity of the participants was somewhat biased. There have been studies where ethnicity is a significant factor in terms of mental disorders with reports of higher mental disorders in ethnic minorities than Caucasians (Gratch, Bassett, & Attra, 1995; Kuo, Chong, & Joseph, 2008). Future research should use a random sampling method to have representative and unbiased samples. 

Additionally, developing a study with a longitudinal research design would be much more functional and beneficial in assessing graduate students’ depression and anxiety levels, as well as their physical activity levels, when considering the impact of COVID-19.

Third, I did not ask whether the participants had any existing mental health issues before and after the outbreak of COVID-19, and whether they contracted COVID-19 or not. Therefore, the results could be skewed as bias due to potential pre-existing mental disorders or possible COVID-19 infections in populations of respondents. Anyone doing further research on these topics should consider obtaining information from participants which include their previous history of mental health disorders and diagnoses as well as whether the participant contracted COVID-19.

Lastly, I collected the zipcodes of the participants. They came from 28 states with the majority of them living in New York (n = 36), California (n = 22), Pennsylvania (n = 13), and Texas (n = 11). These four states make up 54.6% of all participants in the current study.
However, collecting zipcodes did not allow me to see the quality of services at schools in which the participants were enrolled. In general, service quality is positively related to customer satisfaction, intention to revisit, and recommendations (Mehta, 2011; Nadiri & Hussain, 2005). In other words, students from universities providing good quality facilities and/or services may obtain more benefits in terms of levels of physical activity and mental disorders than those from universities with poor quality facilities and/or services. Therefore, future research should collect information about universities where graduate students are enrolled to examine if there are differences in terms of levels of physical activity and mental disorders depending on the quality of facilities and/or services offered by universities.

5.2 Conclusions

The purpose of the present study was to examine the changes in the level of physical activity, depression, and anxiety among graduate students in the U.S. and to examine the potential impacts of the changes in physical activity levels on depression and anxiety levels. This study utilized much of the currently available literature that commonly reported that graduate students are at risk in terms of mental disorders such as depression and anxiety (Evans et al., 2019) and was constructed based on the importance of physical activity, which is beneficial for mental health in the context of COVID-19 (Xiang et al., 2020).

This study revealed that graduate students’ physical activity levels decreased (though still considered high), and the levels of depression and anxiety increased (considered moderate for both) since the outbreak of COVID-19. In addition, a decrease in moderate MET (min·wk$^{-1}$) was significantly associated with an increase in depression. However, the relationships between changes in vigorous and walking MET (min·wk$^{-1}$) and changes in depression were unconfirmed. Additionally, the changes in all components of physical activity MET and changes in anxiety
were also unconfirmed. This would seem to suggest additional variables (e.g., relationships with academic advisors, pre-existing mental disorders) that were not included in the study which may relate to the increased levels of depression and anxiety in graduate students. While it is a limitation to the current study, this deficit allows for future research to improve upon the current study and its design in order to build upon its findings. Future studies on this topic and the results of this study could be of interest to researchers who aim to study how COVID-19 has affected graduate students’ levels of physical activity, depression, and anxiety.

Most importantly, the results of the moderate level of depression and anxiety for the participants should not be interpreted as though graduate students are not at risk in terms of mental disorders. This is because, even several years later, mental health problems can persist if not treated properly. For example, conducting a longitudinal study with a total of 763 college students (undergraduate and graduate students), Zivin and colleagues (2009) stated, “60% of students who had a mental health problem in 2005 also had a problem in 2007” (p.184). Therefore, it is crucial to remain vigilant and continue to monitor, and make efforts to battle mental disorders, despite the moderate or lower levels of depression and anxiety shown in the present study.

Again, it is vital to not only provide adequate treatment but also make an environment where students feel comfortable to seek help in order to combat mental disorders at universities. According to previous research, only 36% of college students (10,489 undergraduate and 3,686 graduate students) had any treatment after receiving a positive diagnosis for one or more mental health problems (Eisenberg, Hunt, Speer, & Zivin, 2011), possibly due to fear of personal stigma, and lack of time (Eisenberg, Downs, Golberstein, & Zivin, 2009; Loya, Reddy, & Hinshaw, 2010). Not only that, it is crucial to continuously take measures for promoting physical
activity programs at universities with the aim of having graduate students whose level of physical activity has significantly decreased since the outbreak of COVID-19 participate in the programs.
APPENDIX A

LETTER OF CONSENT

Title of the Study: Impact of the COVID-19 Pandemic on Physical Activity, Depression, and Anxiety Among Graduate Students in the United States

Principal Investigator: Young Jin Joo (Master’s student, Department of Sport Management)
Faculty Advisor: Amy Chan Hyung Kim (Associate Professor, Department of Sport Management)

You are being invited to take part in a research study. Please find below information about this research for you to think about before you decide to take part. Ask us if you have any questions about this information or the research before you decide to take part.

Key Information for You to Consider

Statement of the Research Study. You are being invited to volunteer to take part in our research study. It is up to you whether you choose to take part or not. There will be no penalty or loss of benefits to you if you choose not to take part or decide later not to take part.

Purpose. The reason that we are doing this research is to examine differences in the level of physical activity, depression, and anxiety among graduate students in the United States before and after the COVID-19 pandemic.

Duration. We think that taking part in our study will last about 20-30 minutes.

Research Activities. You will be asked to answer online survey.

Risks: There is no risks or discomforts to you of taking part in this study. However, you can stop answering this questionnaire at any time if you feel uncomfortable.

Benefits: As a result of taking part in this research, you will receive $5.06 as compensation after submitting the completed survey. Also, you will help researchers learn more about graduate students’ levels of physical activity, depression, and anxiety before and after COVID-19.

What is this study about?
Researchers at Florida State University are studying changes in the level of physical activity, depression, and anxiety among graduate students in the United States before and after COVID-19. Researchers are interested in finding out the associations between the changes in the level of physical activity and the changes in the level depression and anxiety among graduate students in the United States during the pandemic. You are invited to take part in the study because you were a graduate student who was attending a higher educational institution(s) in the United States in both periods: February 2020 and April 2021. You are one of 150 individuals to take part in this study. Your involvement in the study is expected to last 20-30 minutes.
What will happen during this research?
If you agree to be in this research, your participation will include answering the questions via online survey. The survey includes questions about basic sociodemographic characteristics, levels of physical activity, depression, and anxiety, financial stress, alcohol use, and sleep quality.

What will you do to protect my privacy?
The results of the study may be published or presented, but no information that may identify you will ever be provided or released in publications or presentations. This survey is anonymous; you will not be asked to provide any identity-related information. The result of the questionnaire may not be discussed individually, so your information will remain private and confidential as determined by law. The collected data will be stored securely in a safe for two years, and only the members of the study team will have access to the data. The information collected as part of this research will not be used or distributed for future research studies, even if all of your identifiers are removed.

What are the risks of harms or discomforts associated with this research?
There is no risks or discomforts to you of taking part in this study. However, you can stop answering this questionnaire at any time if you feel uncomfortable.

How might I benefit from this research?
A personal benefit you will get from this study is that you will receive $5.06 as a compensation after submitting the completed survey.

What will happen if I choose not to participate?
It is your choice to participate or not to participate in this research. Participation is voluntary.

Is my participation voluntary, and can I withdraw?
Taking part in this research study is your decision. Your participation in this study is voluntary. You do not have to take part in this study, but if you do, you can stop at any time. Your decision whether to participate will not affect your relationship with anyone. There are no penalty, consequences, or loss of benefits to which you are otherwise entitled, if you do not participate.

You have the right to choose not to participate in any study activity or completely withdraw from continued participation at any point in this study without penalty, consequences, or loss of benefits to which you are otherwise entitled.

If you withdraw from the study, the data collected to the point of withdrawal will be deleted immediately.

Who do I talk to if I have questions?
If you have questions, concerns, or have experienced a research-related injury, contact the research team at:
The Florida State University Institutional Review Board (“IRB”) is overseeing this research. The FSU IRB is a group of people who perform official independent review of research studies before studies begin to ensure that the rights and welfare of participants are protected. If you have questions about your rights or wish to speak with someone other than the research team, you may contact:

Florida State University IRB
2010 Levy Drive, Suite 276
Tallahassee, Florida 32306
850-644-7900
humansubjects@fsu.edu

STATEMENT OF CONSENT

I have read and considered the information presented in this form. I confirm that I understand the purpose of the research and the study procedures. I understand that I may ask questions at any time and can withdraw my participation without prejudice. I have read this consent form. By clicking next button below, I consent to participate in this study.

Researcher’s Signature
I have fully explained the research study described by this form. I have answered the participant and/or parent/guardians’ questions and will answer any future questions to the best of my ability. I will tell the family and/or the person taking part in this research of any changes in the procedures or in the possible harms/possible benefits of the study that may affect their health or their willingness to stay in the study.

_________________________  ____________________________
Young Jin Joo                Amy Chan Hyung Kim
Printed Name of Research Team Member Obtaining Consent

_________________________
Signature of Research Team Member

_________________________
Date
APPENDIX B

QUESTIONNAIRE

Part 1-1; Physical activity before the outbreak of COVID-19

International Physical Activity Questionnaire – Short Form (modified)
Free to the public (IPAQ, 2002)

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active before the restrictions imposed because of COVID-19 (February of 2020). Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did before the restrictions imposed because of COVID-19. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During February 2020 before COVID-19, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ days per week

_____ No vigorous physical activities $\Rightarrow$ Skip to question 3

2. How much time did you spend doing vigorous physical activities on one of those days?

_____ hours per day

_____ minutes per day

_____ Don’t know/Not sure

Think about all the moderate activities that you did before the restrictions imposed because of COVID-19. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During February 2020, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.
4. How much time did you spend doing moderate physical activities on one of those days?

____ hours per day
____ minutes per day
____ Don’t know/Not sure

Think about the time you spent walking before the restrictions imposed because of COVID-19. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During February 2020 before COVID-19, on how many days did you walk for at least 10 minutes at a time?

____ days per week
____ No walking

6. How much time did you spend walking on one of those days?

____ hours per day
____ minutes per day
____ Don’t know/Not sure

The last question is about the time you spent sitting on weekdays before the restrictions imposed because of COVID-19. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or laying down to watch television.

7. During February 2020 before COVID-19, how much time did you spend sitting on a week day?

____ hours per day
____ minutes per day
____ Don’t know/Not sure
Part 1-2; Physical activity after the outbreak of COVID-19
International Physical Activity Questionnaire – Short Form
Free to the public (IPAQ, 2002)

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ days per week

_____ No vigorous physical activities ➔ Skip to question 3

2. How much time did you usually spend doing vigorous physical activities on one of those days?

_____ hours per day

_____ minutes per day

_____ Don’t know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ days per week

_____ No moderate physical activities ➔ Skip to question 5
4. How much time did you usually spend doing moderate physical activities on one of those days?

_____ hours per day
_____ minutes per day
_____ Don’t know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____ days per week
_____ No walking ➡️ Skip to question 7

6. How much time did you usually spend walking on one of those days?

_____ hours per day
_____ minutes per day
_____ Don’t know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a week day?

_____ hours per day
_____ minutes per day
_____ Don’t know/Not sure
## Part 2-1; Depression before the outbreak of COVID-19

The Patient Health Questionnaire-9 (PHQ-9) (modified)  
(Kronenke et al., 2002)

Over the **last 2 weeks in February 2020 before COVID-19**, how often had you been bothered by any of the following problems?

<table>
<thead>
<tr>
<th>PHQ-9</th>
<th>Not at all</th>
<th>Several days</th>
<th>More than half the days</th>
<th>Nearly every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Little interest or pleasure in doing things</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. Feeling down, depressed, or hopeless</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Trouble falling or staying asleep, or sleeping too much</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. Feeling tired or having little energy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Poor appetite or overeating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6. Feeling bad about yourself – or that you are a failure or have let yourself or your family down</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7. Trouble concentrating on things, such as reading the newspaper or watching television.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>8. Moving or speaking so slowly that other people could have noticed. Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>9. Thoughts that you would be better off dead, or of hurting yourself in some way</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

If you checked off any problems, how difficult had these made it for you to do your work, take care of things at home, or get along with other people (check one).

<table>
<thead>
<tr>
<th>Not difficult at all</th>
<th>Somewhat difficult</th>
<th>Very difficult</th>
<th>Extremely difficult</th>
</tr>
</thead>
</table>

## Part 2-2; Depression after the outbreak of COVID-19

The Patient Health Questionnaire-9 (PHQ-9)  
(Kronenke et al., 2002)

Over the **past 2 weeks**, how often have you been bothered by any of the following problems?

<table>
<thead>
<tr>
<th>PHQ-9</th>
<th>Not at all</th>
<th>Several days</th>
<th>More than half the days</th>
<th>Nearly every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Little interest or pleasure in doing things</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. Feeling down, depressed, or hopeless</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Trouble falling or staying asleep, or sleeping too much</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. Feeling tired or having little energy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Poor appetite or overeating</td>
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<td>3</td>
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<tr>
<td>6. Feeling bad about yourself – or that you are a failure or have let yourself or your family down</td>
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<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7. Trouble concentrating on things, such as reading the newspaper or watching television.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>8. Moving or speaking so slowly that other people could have noticed. Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>9. Thoughts that you would be better off dead, or of hurting yourself in some way</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

If you checked off any problems, how difficult have these made it for you to do your work, take care of things at home, or get along with other people (check one).

<table>
<thead>
<tr>
<th>Not difficult at all</th>
<th>Somewhat difficult</th>
<th>Very difficult</th>
<th>Extremely difficult</th>
</tr>
</thead>
</table>
Part 3-1; Anxiety before the outbreak of COVID-19
The General Anxiety Disorder-7 (GAD-7) (modified)
(Spitzer et al., 2006)

Over the last 2 weeks in February 2020 before COVID-19, how often had you been bothered by any of the following problems?

<table>
<thead>
<tr>
<th>GAD-7</th>
<th>Not at all</th>
<th>Several days</th>
<th>More than half the days</th>
<th>Nearly every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Feeling nervous, anxious, or on edge.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. Not being able to stop or control worrying.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Worrying too much about different things.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. Trouble relaxing.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Being so restless that it’s hard to sit still.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6. Becoming easily annoyed or irritable.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7. Feeling afraid as if something awful might happen.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

If you checked off any problems, how difficult had these made it for you to do your work, take care of things at home, or get along with other people (check one).

<table>
<thead>
<tr>
<th>Not difficult at all</th>
<th>Somewhat difficult</th>
<th>Very difficult</th>
<th>Extremely difficult</th>
</tr>
</thead>
</table>

Part 3-2; Anxiety after the outbreak of COVID-19
The General Anxiety Disorder-7 (GAD-7)
(Spitzer et al., 2006)

Over the past 2 weeks, how often have you been bothered by any of the following problems?

<table>
<thead>
<tr>
<th>GAD-7</th>
<th>Not at all</th>
<th>Several days</th>
<th>More than half the days</th>
<th>Nearly every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Feeling nervous, anxious, or on edge.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. Not being able to stop or control worrying.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Worrying too much about different things.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. Trouble relaxing.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Being so restless that it’s hard to sit still.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6. Becoming easily annoyed or irritable.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7. Feeling afraid as if something awful might happen.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

If you checked off any problems, how difficult have these made it for you to do your work, take care of things at home, or get along with other people (check one).

<table>
<thead>
<tr>
<th>Not difficult at all</th>
<th>Somewhat difficult</th>
<th>Very difficult</th>
<th>Extremely difficult</th>
</tr>
</thead>
</table>
**Part 4-1; Financial stress before the outbreak of COVID-19**

The Financial Stress Scale-College Version (FSS-CV) (modified)
(Northern et al., 2010)

Consider the **last six months before March 2020**. Please rate how often you thought about the following financial events.

<table>
<thead>
<tr>
<th>FSS-CV</th>
<th>Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Being behind on payments</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Having a low credit score</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Not having any emergency money</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Living paycheck to paycheck</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Being in a job where work isn’t steady/predictable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Barely making enough money to cover expenses</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Not making enough money to be able to cover unexpected expenses</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Knowing that you make less money than most of your peers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Having large debt</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Having loans with high interest rates</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Holiday/Special event expenses</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Having to borrow money from family/friends</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Paying taxes</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Part 4-2; Financial stress after the outbreak of COVID-19**

The Financial Stress Scale-College Version (FSS-CV)
(Northern et al., 2010)

Consider the past **six months**. Please rate how often you have thought about the following financial events.

<table>
<thead>
<tr>
<th>FSS-CV</th>
<th>Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>All the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Being behind on payments</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Having a low credit score</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Not having any emergency money</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Living paycheck to paycheck</td>
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<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Being in a job where work isn’t steady/predictable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Not making enough money to be able to cover unexpected expenses</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
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<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>Having large debt</td>
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<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Having loans with high interest rates</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Holiday expenses</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Having to borrow money from family/friends</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Paying taxes</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Part 5-1; Alcohol use before the outbreak of COVID-19
The Alcohol Use Disorder Identification Test (AUDIT) (modified)
(WHO, 2001)

Consider your alcohol consumption behavior in **February 2020 before COVID-19**. Please select one answer for each question that best describes your pre-pandemic behavior.

Note: One drink is typically: 12 ounces of beer, or 5 ounces of wine, or 1.5 ounces of liquor (one shot).

<table>
<thead>
<tr>
<th>AUDIT</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How often did you have a drink containing alcohol in February 2020 before COVID-19?</td>
<td>Never</td>
<td>Monthly or less</td>
<td>2-4 times a month</td>
<td>2-3 times a week</td>
<td>4 or more times a week</td>
</tr>
<tr>
<td>2. How many drinks containing alcohol did you have on a typical day when you were drinking in February 2020 before COVID-19?</td>
<td>1 or 2</td>
<td>3 or 4</td>
<td>5 or 6</td>
<td>7 to 9</td>
<td>10 or more</td>
</tr>
<tr>
<td>3. How often did you have six or more drinks on one occasion in February 2020 before COVID-19?</td>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
<tr>
<td>4. How often did you find that you were not able to stop drinking once you started during the year leading up to March 2020?</td>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
<tr>
<td>5. How often did you fail to do what was normally expected of you because of drinking during the year leading up to March 2020?</td>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
<tr>
<td>6. How often did you need a first drink in the morning to get yourself going after a heavy drinking session during the year leading up to March 2020?</td>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
<tr>
<td>7. How often did you have a feeling of guilt or remorse after drinking during the year leading up to March 2020?</td>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
<tr>
<td>8. How often were you unable to remember what happened the night before because of your</td>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
<tr>
<td>9. Had you or someone else been injured because of your drinking before March 2020?</td>
<td>No</td>
<td>Yes, but not in the last year</td>
<td>Yes, during the last year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Had a relative, friend, doctor, or other health care worker been concerned about your drinking or suggested you cut down before March 2020?</td>
<td>No</td>
<td>Yes, but not in the last year</td>
<td>Yes, during the last year</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Part 5-2; Alcohol use after the outbreak of COVID-19**

The Alcohol Use Disorder Identification Test (AUDIT) (WHO, 2001)

Consider your alcohol consumption behavior. Please select the one answer for each question that best describes behavior since the start of the pandemic.

Note: One drink is typically: 12 ounces of beer, or 5 ounces of wine, or 1.5 ounces of liquor (one shot).

<table>
<thead>
<tr>
<th>AUDIT</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How often do you have a drink containing alcohol?</td>
<td>Never</td>
<td>Monthly or less</td>
<td>2-4 times a month</td>
<td>2-3 times a week</td>
<td>4 or more times a week</td>
</tr>
<tr>
<td>2. How many drinks containing alcohol do you have on a typical day when you are drinking?</td>
<td>1 or 2</td>
<td>3 or 4</td>
<td>5 or 6</td>
<td>7 to 9</td>
<td>10 or more</td>
</tr>
<tr>
<td>3. How often do you have six or more drinks on one occasion?</td>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
<tr>
<td>4. How often during the last year have you found that you were not able to stop drinking once you had started?</td>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
<tr>
<td>5. How often during the last year have you failed to do what was normally expected of you because of drinking?</td>
<td>Never</td>
<td>Less than monthly</td>
<td>Monthly</td>
<td>Weekly</td>
<td>Daily or almost daily</td>
</tr>
</tbody>
</table>
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?  
   - Never  
   - Less than monthly  
   - Monthly  
   - Weekly  
   - Daily or almost daily

7. How often during the last year have you had a feeling of guilt or remorse after drinking?  
   - Never  
   - Less than monthly  
   - Monthly  
   - Weekly  
   - Daily or almost daily

8. How often during the last year have you been unable to remember what happened the night before because of your drinking?  
   - Never  
   - Less than monthly  
   - Monthly  
   - Weekly  
   - Daily or almost daily

9. Have you or someone else been injured because of your drinking?  
   - No  
   - Yes, but not in the last year  
   - Yes, during the last year

10. Has a relative, friend, doctor, or other health care worker been concerned about your drinking or suggested you cut down?  
    - No  
    - Yes, but not in the last year  
    - Yes, during the last year

---

**Part 6-1; Sleep quality before the outbreak of COVID-19**  
The Pittsburgh Sleep Quality Index (PSIQ) (modified)  
(Buysse et al., 1989)

**Instructions:**  
The following questions relate to your usual sleep habits during **February 2020 before COVID-19**. Your answers should indicate the most accurate reply for the majority of days and nights in February 2020.  
**Please answer all questions.**

1. During February 2020, what time did you usually go to bed at night?  
   **BED TIME _____**

2. During February 2020, how long (in minutes) did it usually take for you to fall asleep each night?  
   **NUMBER OF MINUTES _____**

3. During February 2020, what time did you usually get up in the morning?  
   **GETTING UP TIME _____**

4. During February 2020, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)  
   **HOURS OF SLEEP PER NIGHT _____**
For each of the remaining questions, please select the one response most representative of your sleep habits. **Please answer all questions.**

5. During February 2020, how often did you have trouble sleeping because you . . .
   
a) Could not get to sleep within 30 minutes

<table>
<thead>
<tr>
<th>Not during the month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
</table>

b) Woke up in the middle of the night or early morning

<table>
<thead>
<tr>
<th>Not during the month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
</table>

c) Had to get up to use the bathroom

<table>
<thead>
<tr>
<th>Not during the month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
</table>

d) Could not breathe comfortably

<table>
<thead>
<tr>
<th>Not during the month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
</table>

e) Coughed or snored loudly

<table>
<thead>
<tr>
<th>Not during the month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
</table>

f) Felt too cold

<table>
<thead>
<tr>
<th>Not during the month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
</table>

g) Felt too hot

<table>
<thead>
<tr>
<th>Not during the month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
</table>

h) Had bad dreams

<table>
<thead>
<tr>
<th>Not during the month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
</table>

i) Had pain

<table>
<thead>
<tr>
<th>Not during the month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
</table>

j) Other reason (s), please describe __________________________________________

How often during February 2020 did you have trouble sleeping because of this?
6. During February 2020, how would you rate your sleep quality overall?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not during the month</td>
<td>Very good</td>
</tr>
<tr>
<td>Less than once a week</td>
<td>Fairly good</td>
</tr>
<tr>
<td>Once or twice a week</td>
<td>Fairly bad</td>
</tr>
<tr>
<td>Three or more times a week</td>
<td>Very bad</td>
</tr>
</tbody>
</table>

7. During February 2020, how often did you take medicine to help you sleep (prescribed or “over the counter”)?

<table>
<thead>
<tr>
<th>Frequency</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not during the month</td>
<td></td>
</tr>
<tr>
<td>Less than once a week</td>
<td></td>
</tr>
<tr>
<td>Once or twice a week</td>
<td></td>
</tr>
<tr>
<td>Three or more times a week</td>
<td></td>
</tr>
</tbody>
</table>

8. During February 2020, how often did you have trouble staying awake while driving, eating meals, or engaging in social activity?

<table>
<thead>
<tr>
<th>Frequency</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not during the past month</td>
<td></td>
</tr>
<tr>
<td>Less than once a week</td>
<td></td>
</tr>
<tr>
<td>Once or twice a week</td>
<td></td>
</tr>
<tr>
<td>Three or more times a week</td>
<td></td>
</tr>
</tbody>
</table>

9. During February 2020, how much of a problem was it for you to keep up enough enthusiasm to get things done?

<table>
<thead>
<tr>
<th>Frequency</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not during the past month</td>
<td></td>
</tr>
<tr>
<td>Less than once a week</td>
<td></td>
</tr>
<tr>
<td>Once or twice a week</td>
<td></td>
</tr>
<tr>
<td>Three or more times a week</td>
<td></td>
</tr>
</tbody>
</table>

10. Did you have a bed partner or roommate in February 2020?

<table>
<thead>
<tr>
<th>Relationship</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No bed partner or roommate</td>
<td></td>
</tr>
<tr>
<td>Partner/roommate in other room</td>
<td></td>
</tr>
<tr>
<td>Partner in the same room, but not same bed</td>
<td></td>
</tr>
<tr>
<td>Partners in same bed</td>
<td></td>
</tr>
</tbody>
</table>

Part 6-2; Sleep quality after the outbreak of COVID-19
The Pittsburgh Sleep Quality Index (PSIQ)
(Buysse et al., 1989)

Instructions:
The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month.
Please answer all questions.

1. During the past month, what time have you usually gone to bed at night?

   BED TIME _____

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?

   NUMBER OF MINUTES _____

3. During the past month, what time have you usually gotten up in the morning?

   GETTING UP TIME _____
4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)

HOURS OF SLEEP PER NIGHT ______

For each of the remaining questions, answer the one best response. Please answer all questions.

5. During the past month, how often have you had trouble sleeping because you . . .

   a) Cannot get to sleep within 30 minutes

      | Not during the past month | Less than once a week | Once or twice a week | Three or more times a week |
      |--------------------------|----------------------|---------------------|---------------------------|

   b) Wake up in the middle of the night or early morning

      | Not during the past month | Less than once a week | Once or twice a week | Three or more times a week |
      |--------------------------|----------------------|---------------------|---------------------------|

   c) Have to get up to use the bathroom

      | Not during the past month | Less than once a week | Once or twice a week | Three or more times a week |
      |--------------------------|----------------------|---------------------|---------------------------|

   d) Cannot breathe comfortably

      | Not during the past month | Less than once a week | Once or twice a week | Three or more times a week |
      |--------------------------|----------------------|---------------------|---------------------------|

   e) Cough or snore loudly

      | Not during the past month | Less than once a week | Once or twice a week | Three or more times a week |
      |--------------------------|----------------------|---------------------|---------------------------|

   f) Feel too cold

      | Not during the past month | Less than once a week | Once or twice a week | Three or more times a week |
      |--------------------------|----------------------|---------------------|---------------------------|

   g) Feel too hot

      | Not during the past month | Less than once a week | Once or twice a week | Three or more times a week |
      |--------------------------|----------------------|---------------------|---------------------------|

   h) Had bad dreams

      | Not during the past month | Less than once a week | Once or twice a week | Three or more times a week |
      |--------------------------|----------------------|---------------------|---------------------------|

   i) Have pain

      | Not during the past month | Less than once a week | Once or twice a week | Three or more times a week |
      |--------------------------|----------------------|---------------------|---------------------------|
j) Other reason (s), please describe __________________________________________

How often during the past month have you had trouble sleeping because of this?

<table>
<thead>
<tr>
<th>Not during the past month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
</table>

6. During the past month, how would you rate your sleep quality overall?

<table>
<thead>
<tr>
<th>Very good</th>
<th>Fairly good</th>
<th>Fairly bad</th>
<th>Very bad</th>
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7. During the past month, how often have you taken medicine to help you sleep (prescribed or “over the counter”)?

<table>
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<tr>
<th>Not during the past month</th>
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</table>

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

<table>
<thead>
<tr>
<th>Not during the past month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
</table>

10. Do you have a bed partner or roommate?

<table>
<thead>
<tr>
<th>No bed partner or roommate</th>
<th>Partner/roommate in other room</th>
<th>Partner in the same room, but not same bed</th>
<th>Partners in same bed</th>
</tr>
</thead>
</table>
Part 7; Demographic Information
Directions: Please answer each question as accurately as possible by checking or filling in the blank provided.

1. What is your age in years? ______ years.

2. What is your ethnicity (or race)?
   - American Indian/Native American ______
   - Arab American/Middle Eastern. ______
   - Asian, Asian American, or Pacific Islander. ______
   - Black or African American ______
   - Hispanic or Latin American ______
   - White, Caucasian, Anglo (not Hispanic). ______
   - Other ______

3. What is your gender?
   - ______ Female  ______ Male

4. What was the academic program in a graduate school that you were engaged in February 2020?
   - ______ Master’s program  ______ Ph.D. program  ______ Other

5. What is the academic program in a graduate school that you are currently engaged in May 2021?
   - ______ Master’s program  ______ Ph.D. program  ______ Other

6. What is a zip code? ______

7. What is your major? ______
### Part 8; Screening Question 1

<table>
<thead>
<tr>
<th></th>
<th>Very Unsatisfied</th>
<th>Unsatisfied</th>
<th>Neutral</th>
<th>Satisfied</th>
<th>Very Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please check “Unsatisfied” for this question.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Part 9; Screening Question 2

<table>
<thead>
<tr>
<th></th>
<th>Very Unsatisfied</th>
<th>Unsatisfied</th>
<th>Neutral</th>
<th>Satisfied</th>
<th>Very Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please check “Satisfied” for this question.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C

IRB DOCUMENTATION

FLORIDA STATE UNIVERSITY
OFFICE of the VICE PRESIDENT for RESEARCH

EXEMPTION DETERMINATION

April 21, 2021

Young Jin Joo, 850-644-5260

Dear Young Jin Joo:

On 4/21/2021, the IRB staff reviewed the following submission:

<table>
<thead>
<tr>
<th>Type of Review:</th>
<th>Exempt (2)(i) Tests, surveys, interviews, or observation (non-identifiable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title:</td>
<td>Impact of the COVID-19 pandemic on physical activity, depression, and anxiety among graduate students in the United States</td>
</tr>
<tr>
<td>Investigator:</td>
<td>Young Jin Joo</td>
</tr>
<tr>
<td>Submission ID:</td>
<td>STUDY00002220</td>
</tr>
<tr>
<td>Study ID:</td>
<td>STUDY00002220</td>
</tr>
<tr>
<td>Funding:</td>
<td>None</td>
</tr>
<tr>
<td>Grant ID:</td>
<td>None</td>
</tr>
<tr>
<td>IND, IDE, or HDE:</td>
<td>None</td>
</tr>
</tbody>
</table>
| Documents Reviewed: | • Questionnaire_YJ_Joo.pdf, Category: Survey/Questionnaire;
  • Consent Form_Final_YJ_JOO.pdf, Category: Consent Form;
  • Protocol_Final_YJ_JOO.pdf, Category: IRB Protocol; |

The IRB staff determined the protocol qualifies for exemption, effective on 4/21/2021. Your study conforms to FSU policy on COVID-19-related requirements and restrictions related to research activities that involve in-person interventions or interactions with human research participants.

Note that once the COVID-19-related requirements and restrictions are lifted and IF you plan to substitute remote interactions or interventions with in-person alternatives, or IF you plan to include as human subjects persons who were previously excluded due to their high risk for
severe illness from COVID-19 or ages 65 or more years, please be sure to submit a modification to the IRB for its review of these substitutions. If however you only plan to discontinue other COVID19-specific risk mitigation (e.g., social distancing, screening, use of PPE), then no study modification request need to be submitted to the IRB for review before these changes may be implemented. For all other study modifications, see notes below.

You are advised that any modification(s) to the protocol for this project that may alter this exemption determination must be reviewed and approved prior to implementation of the proposed modification(s).

Modifications to the research may invalidate the exemption determination (because the research no longer meets the exemption criteria described in HRP-312 – WORKSHEET – Exemption Determination).

- Examples of minor changes to exempt research that would not alter the exemption determination and should therefore not be submitted to the IRB for further review include the following:
  - Making administrative (formatting, grammar, spelling) revisions to the protocol, consent or recruitment materials or other study documents
  - Adding or revising non-sensitive questions or non-identifiable response options to a survey, interview, focus group or other data collection instrument
  - Increasing or decreasing the number of study subjects—unless adding a new study sample such as children or prisoners or adding a new source of data or records
  - Making study team/personnel changes—except a change in Principal Investigator (PI)

Examples of changes to exempt research that do require prospectively submitting a modification to the IRB before implementing changes include the following:

- Making substantive revisions or additions (e.g., change in PI; funding source; sample; source of study subjects or their data; study sites or settings; procedures, interventions or interactions with study subjects; use of any drug, device, supplement or biologic; study subjects’ time or duration spent performing or participating in study activities) to the protocol, consent or recruitment materials or other study documents
- Adding or revising sensitive questions or identifiable response options to a survey, interview, focus group or other data collection instrument
- Adding a new study sample such as children or prisoners or adding a new source of data or records
- Obtaining, using, studying, analyzing, generating, storing or maintaining identifiable information or identifiable biospecimens in addition to or in lieu of de-identified or anonymous information or specimens
- Change in study risks (e.g., impact upon study subjects; impact upon students’ opportunity to learn educational content or assessment of educators who provide instruction; any disclosure of study subjects’ responses outside of the research may place study subjects at risk of criminal or civil liability or be damaging to subjects’ financial standing, employability, educational advancement or reputation)
- Change in Principal Investigator (PI) or (for students) faculty advisor
• New or change in financial interest

In conducting this protocol, you are required to follow the applicable requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the Library within the RAMP IRB system.

Sincerely,

Office for Human Subjects Protection (OHSP)
Florida State University Office of Research
2010 Levy Avenue, Building B Suite 276
Tallahassee, FL 32306-2742
Phone: 850-644-7900
OHSP Group Email: humansubjects@fsu.edu
OHSP Web: https://www.research.fsu.edu/hs
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BIOGRAPHICAL SKETCH

Young Jin Joo was born in Incheon, South Korea. He received his bachelor’s degree in Physical Education from Yonsei University in February 2019. Young Jin started his master's degree in Sport Management at Florida State University in 2019. His research abstract, "Psychological and Social Outcomes of Sport Participation among College Students: A Systematic Review," was accepted to be presented at the North American Society for Sport Management (NASSM) conference in 2020.