

Health Behaviors and Wellbeing of University Students During the Early COVID-19 Pandemic: A Systematic Review

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Abstract

This study evaluates the impact of the COVID-19 pandemic on university students' health outcomes and health behaviors through a systematic literature review of English and Spanish publications dated between March 2020 and November 2021. Synthesizing the findings from research identified using multiple databases and analyzed following PRISMA guidelines, the review establishes that mental health was the predominant area of focus during the early phase of the pandemic, representing 72% of all health outcomes studied. In addition, 22% of outcomes were related to health behaviors and 6% to physical health. Tools used to measure these outcomes varied in their validity: 79% of studies relied on validated measurement instruments to assess anxiety (94%) and depression (82%), while 21% employed non-validated tools, mostly to measure constructs such as worry and lifestyle changes. These trends highlight a strong emphasis on capturing prevalence and severity of mental health concerns among university students during a critical period of uncertainty. Moving forward, it is essential that researchers and practitioners employ a coordinate, global approach that measures university student health in a more holistic and standardized approach in future public health crises. Specifically, using validated measurement tools to assess health outcomes – including physical health, mental health, and health behaviors – while also considering related risk factors, provides more comprehensive surveillance data that allows for quicker and more targeted interventions and policies for the next major public health crisis.

Keywords: COVID-19, university students, systematic review, health outcomes, health behaviors

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Introduction

COVID-19 and University Students

University students represent a unique and important population for mapping and preventing the transmission of contagious diseases. While 87% of undergraduate students in the United States self-report their health to be “excellent,” “very good,” or “good,” (Association ACH, 2022) 25% of students face inadequate healthcare access

and utilization (Kenyon, 2020). College-aged adults, or undergraduate and graduate students that are 18 years or older, are disproportionately uninsured, especially those with traditionally underserved minority backgrounds (Liang, 2009). This reality is in stark contrast to pediatric populations that frequently access the healthcare system for school requirements, vaccinations, and common health issues (e.g., ear infection and fever), as well as complex geriatric populations that regularly access the

healthcare system for a range of health concerns. Additionally, universities serve as a focal point for the community (El-Jardali et al., 2018; Migliore et al., 2024) with university students having regular interaction with diverse sectors of society. From attending multiple campuses to engaging in volunteer work and internships, university students are often exposed to diverse environments, making them at high risk for communicable diseases and a strategic priority for preventive efforts.

It is essential to explore university students' relationship with their health and the healthcare system, especially in the context of a new disease or pandemic. The COVID-19 pandemic introduced new health challenges for university students, which afforded the field a unique opportunity to examine these relationships in real time. Although college students were generally at lower clinical risk for severe COVID-19 morbidity and mortality compared to older adults and individuals with underlying medical conditions, they were uniquely vulnerable to the secondary consequences of pandemic mitigation measures. Framing students as a "low-risk" population from a virologic standpoint may have inadvertently deprioritized their social, developmental, and behavioral health needs in public health planning. This relative neglect contributed to a secondary public health crisis characterized by social isolation, disrupted routines, reduced access to supportive resources, and worsening mental and behavioral health outcomes (Li et al. 2021; Son et al., 2020; Huckins et al., 2020).

A retrospective review of pandemics over the past century shows that many universities remained open during the 2009 H1N1 swine flu (Cauchemez et al. 2014), the peak of the U.S. HIV/AIDS pandemic in the 1980s and 1990s, (Elbe, 2005) and the Russian (1977), Hong Kong (1968), and Asian (1957) flu pandemics (Henderson et al., 2009;

Honigsbaum, 2019). Although some U.S. cities temporarily closed universities during the 1918 Spanish flu, there were no coordinated global closures comparable to those implemented during COVID-19 (Markel et al., 2007; Stern et al., 2009; Hale et al., 2021; Marinoni et al., 2020). Thus, studies conducted during the first uncertain year of COVID-19 offer the clearest perspective on how university students and researchers made sense of the disease as it unfolded in real time.

Public health issues that emerged and/or worsened as a result of the pandemic include housing and food insecurity, financial hardships, a lack of social connectedness and belonging, and limited access to resources (e.g., gyms, clinics, community spaces, study groups, professor office hours) (Wolfson & Leung, 2020; Kim & Murphy, 2023; Gjestvang et al., 2022; Kopels et al., 2025). These factors impacted students' academic performance and overall well-being, which contributed to a general sense of uncertainty about their future (Haddad et al., 2021; Copeland et al., 2021; Davitt et al., 2021). In fact, in the early stage of the COVID-19 pandemic, much of the research on university students focused on how it affected mental health, learning styles, and financial insecurity (Haddad et al., 2021). However, during this critical time period, few studies explored how the COVID-19 pandemic holistically affected the overall health and wellness (including the health behaviors such as sleep, nutrition, exercise, and substance use, that affect mental health in the global university student population) of university students as schools reopened (Gallè et al., 2020; Allen et al., 2021; Tavolacci et al., 2021; Di Consiglio et al., 2021; Sazakli et al., 2021; Alyoubi et al., 2021; Saravanan & Mahmoud, 2020; Boolani et al., 2023; Stamatis et al., 2022). Given the restricted living spaces and the closure of many facilities during the early stage of the

pandemic, it is likely that pandemic-related disruptions and restrictions affected the health and health behaviors of students, as seen in other populations (Laron & Hartal, 2020; LaCaille et al., 2021).

Research Context and Questions

Only one week after the WHO declared COVID-19 a pandemic on March 11th, 2020, at least 107 countries implemented national school closures, making it the most widely adopted policy to fight against COVID-19 (Alfano, 2022). Consequently, most schools initiated shutdown protocols in March 2020, and did not reopen to in-person interactions until November 2021, albeit gradually with hybrid (i.e., online and in-person) options that required strict social distancing and mask requirements (Jack & Oster, 2023; Chang et al., 2022). With schools largely reopened in the United States and worldwide by November 2021 (UNICEF, 2021), this provided a defined time period to evaluate the impact of the COVID-19 pandemic's shutdown period by region on university students around the world.

Guidelines for responding to any health condition—whether USPSTF recommendations for weight management or WHO guidance during a pandemic—can only be developed based on the evidence available that meets their review criteria. Therefore, it is essential to examine the types of research being produced, including study designs, populations, and key findings, to understand how they shaped the evolving guidance for and governance regarding the disease. In the case of the rapidly evolving understanding of the COVID-19 pandemic, early research and white papers centered on working adults and distinctions between essential and non-essential workers and/or schoolchildren. University students occupied a hybrid position: as students, they were still studying and working, yet simultaneously confined to their homes (Mody et al., 2022).

While they may have been included as part of the population in these larger studies, there was limited published literature about how the COVID-19 pandemic specifically affected health conditions and outcomes within the university student population. Therefore, we conducted a systematic review to assess and summarize the prevalence and impacts of mental health issues, pre-existing conditions, and associated behaviors such as sleep and alcohol use on university students worldwide during the earliest stages of the COVID-19 pandemic's shutdown period. We investigated which health domains were widely captured in research, and which domains were lacking.

Methodology

To adhere to best practices, this systematic literature review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The study was conducted in fulfillment of a Fulbright project (author M.B.) and was registered with PROSPERO (CRD42022335411).

Search strategy

We conducted a literature search in PubMed and ScienceDirect from March 1st, 2020 to November 9th, 2021. The search strategy was developed and executed by a library scientist from Universidad El Bosque. Keyword searches used Boolean operators “AND” and “OR” to refine or broaden the search. The English search terms for both databases followed the same strategy: (“university student” OR “college student”) AND (“wellbeing study” OR “mental health” OR “health needs” OR “health conditions” OR “health preferences”) AND (Covid-19 OR coronavirus OR “sars-cov2”). The same strategy was applied to Spanish search terms in both databases: (Covid-19 OR Sars-Cov-2 OR coronavirus) AND (salud OR bienestar

OR “calidad de vida”) AND (“estudiante universitario”). Spanish was selected as a second language to bolster the global approach to the topic, while remaining within the scope of the authorship team. Additionally, articles from an exploratory analysis in SCOPUS, a third database, were included in this review (see Supplemental Material).

Key words were searched throughout the entire text of identified manuscripts to ensure that all relevant terms were included. The librarian conducted the main search in PubMed using the MeSH Headings, along with equivalent key words and phrases. These terms were then tested for relevance, and the final search was completed in Medline on November 9th, 2021. The search terms from PubMed were then translated for use in ScienceDirect on the same date. Additionally, reference lists from included systematic reviews were screened for further studies, and relevant references were incorporated into the review. Eligible articles were published between March 2020 and November 2021 in English or Spanish. Study protocols, commentaries, editorials, and non-peer-reviewed articles were excluded with a list of excluded articles and their reasons provided in Supplemental Materials.

Article Screening

Abstracts and full-text articles were independently reviewed for eligibility by at least two investigators using prespecified inclusion criteria in separate Microsoft Excel worksheets. Kappa statistics reporting the level of inter-rater reliability or agreement for article inclusion were calculated for each reviewer. An overall score was then determined for the entire sample. In the first round, the inter-rater reliability (kappa coefficient) was 0.70. All discrepancies were resolved by jointly reviewing the article and reaching a consensus. If consensus could not

be reached, a third reviewer was brought in for a final determination. Detailed exclusion criteria are provided in the PRISMA flow diagram (Figure 1).

To ensure accuracy, all excluded abstracts were reviewed independently by two investigators. There were very few discrepancies, which primarily concern the target population and the presence of reported results.

Guided by the PRISMA guidelines (Takkouche & Norman, 2011; Page et al., 2021) and the Population, Intervention, Comparators, Outcomes, Timing, and Settings (PICOTS) framework (FDA U), eligibility criteria were established *a priori* to determine which abstracts would be included or excluded. Our review included studies involving university populations (student learners of any age enrolled in university courses) during the COVID-19 shutdown, with no exclusions based on intervention or comparator. Eligible studies reported on the effect of COVID-19 shutdown period on university students' mental health, health behaviors, physical health, and/or overall wellbeing.

With respect to mental health, specific outcomes included anxiety, depression, stress, mood and wellness behaviors (e.g., mood, fear, happiness, gratitude, optimism, self-esteem), general mental health, concerns related to COVID-19 (e.g., worry, fear, guilt, and distress), loneliness, suicidal thoughts, psychiatric symptoms, PTSD, self-harm, and life satisfaction. With respect to health behaviors, specific outcomes included physical activity, alcohol consumption, substance use, eating and sleeping habits, access to medical treatment, marijuana use, sexual activity, and tobacco habits. Additional outcomes included physiological effects and other factors like lifestyle changes, general health, abuse or victimization, concentration, and loss. With respect to physical health, specific outcomes

included body mass index and cardiometabolic conditions such as hypertension and diabetes mellitus, and respiratory conditions like asthma.

Data Extraction Protocol

Reviewers (JY and MB) created a unique data extraction form for this systematic literature review using Microsoft Excel. Reviewer MB extracted the data, while JY reviewed the data extracted. The data collected included publication details (authors, publication date, and title), study design, sample size, gender distribution, and some demographic information of the participants such as race, socioeconomic background, and age, the number of universities involved, the country and/or city of the study, reported study aims, measures of association (Supplemental Tables 1 and 2), outcomes of interest, key findings relevant to our research question, potential bias, limitations identified by the research team, and whether the study accounted for previous physical or mental health conditions prior to the COVID-19 pandemic. Additionally, the reviewers noted whether the study was descriptive or interventional and whether it was based on a theoretical framework.

Analysis and Quality Assessment

We weighted reported gender percentages, mean age, and selected health outcomes based on sample size to create a pooled analysis. Due to variations in how these statistics were reported across studies, not all studies were included in the pooled analysis (e.g., studies reporting age as a range or studies with multiple sample sizes). To calculate the pooled gender percentage, we multiplied the reported percent female value by the study size to obtain a weighted value. The same was done for the reported percent male value. Means were then calculated by summing all the weighted numbers and dividing by the total sample size. A similar

approach was used to calculate the pooled age percentage.

While the initial planned analysis included mean prevalence of all health outcomes reported across studies, the variable nature of how studies reported a specific health outcome meant that not all studies could be included in the pooled analysis, even if they included quantitative data. For example, findings stated as “20.6% of the study population reported symptoms of anxiety” (Zhan et al., 2021) and “the prevalence of pooled anxiety symptoms in the study population was 31%” (Chang et al., 2021) would be included in the pooled analysis because the reporting was in a similar format. However, a finding stated as “69.62% of the study population reported a moderate to exaggerated increase in anxiety state prior to the start of the pandemic” (García-Espinosa et al., 2021) was excluded due to its different reporting format. The pooled analysis for consistently measured health outcomes was calculated similarly to the analysis for gender and age. The reported percentages for mild, moderate, severe, and overall outcomes were multiplied by the sample size to obtain a weighted value. The sum of these weighted values was then divided by the total sample size to calculate a weighted mean. Data were also analyzed by geographic region, with North America and Australia combined given the scarce number of studies on Australia (n=1).

Predefined criteria were used to assess the risk of bias (also referred to as quality or internal validity) for each individual study, using criteria that are appropriate to the study design. To ensure accuracy, all excluded abstracts were reviewed independently by two investigators. However, due to the overall poor quality of the cross-sectional studies—characterized by limitations such as recruitment issues, reporting inconsistencies, and a mix of validated and unvalidated assessment tools—only cohort studies were

evaluated using criteria set by the Agency for Healthcare Research and Quality (AHRQ) (Viswanathan et al., 2018). Cohort studies were independently rated by two investigators, with no disagreements (Supplemental Table 3).

Results

A total of 94 studies from electronic database searches and reference lists were reviewed. After a dual review of titles and abstracts, 64 papers were selected for full-text review, of which 62 articles were included for final data analysis (Figure 1).

The results were organized into an overview of study populations, followed by a discussion of measurement tools, the prevalence of reported health outcomes, and associated health behaviors. Tables 1 and 2 summarize the characteristics of all studies included in this review, including details such as authors, study design, research context, sample size, and population demographics, study objectives, and outcomes. Tables 3 and 4 presented pooled data on gender and age, stratified by region, along with health outcomes and behaviors.

Study Populations

Of the 62 studies included, 10 were cohort studies, 51 were cross-sectional, and one was a case study. Most studies were conducted in Asia (42%, 26/62) and North America (29%, 18/62), with the majority from China (26%, 16/62) and the United States (26%, 16/62) (Tables 1-3). Females accounted for 53% to 72% of the study populations, and the participants' mean age ranged from 20.6 to 22.8 years (Tables 1-3). Fifteen studies (24%) reported race or ethnicity, eight (13%) reported socioeconomic background, and only 14 studies (23%) reported baseline health status. Of the 10 cohort studies assessed for risk of bias (ROB), two were rated high risk, seven moderate risk, and one

low risk (Supplemental Table 3). The two high-risk studies were rated as such due to unclear blinding, high loss to follow-up, and baseline differences between groups. An additional seven studies were rated moderate-risk generally due to unclear blinding and limited reporting of attrition and loss to follow-up.

Reported Outcomes

When aggregating all reported outcomes (n=209) across the studies included in this review, 150 (72%) were mental health outcomes, 46 (22%) were health behavior outcomes, and 13 (6%) were physical health outcomes (Tables 1 and 2). Within the mental health outcomes, anxiety, depression, and stress accounted for 59% of the total outcomes measured. Health behavior outcomes were less commonly assessed; physical activity, general lifestyle changes, alcohol consumption, and sleep were the most frequently assessed, accounting for 67% of the health behavior outcomes measured. Physical health outcomes were the least commonly measured, with "general health" being the most frequently reported outcome (62%) (Tables 1 and 2).

Measurement Tools

Across 62 studies, 82 different tools were used to measure outcomes of interest, of which 17 were unvalidated. Most tools (79%, 65/82) were employed to assess mental health outcomes (Supplemental Tables 1 and 2). Of the validated mental health tools, most were used to measure anxiety and depression, while unvalidated tools were primarily used in studies evaluating worry and lifestyle changes. The most used tools included the General Anxiety Disorder-7 (GAD-7) for anxiety, the Patient Health Questionnaire-9 (PHQ-9) for depression, and the Perceived Stress Scale-10 (PSS-10) for stress (Supplemental Table 1). Notably, 44 (71%) studies used multiple measurement tools in

their research, with eight of these combining both validated and non-validated tools (Tables 1 and 2).

Across all included studies, 97% (60/62) assessed at least one mental health outcome, 34% (21/62) measured health behavior outcomes, and only 2% (1/62) included data on physiological outcomes (Tables 1 and 2). With respect to mixed outcomes, 21 studies reported both mental health and health behaviors (e.g., alcohol consumption, physical activity), 19 studies presented both mental health and other health outcomes (e.g., loss/death, abuse/victimization), and one study presented both physiological and mental health outcomes (Tables 1 and 2). The most measured outcomes were anxiety, depression, and stress, as indicated by the frequently used assessment tools (Tables 1 and 2). Anxiety was measured in 54.8% (34/62) of studies, depression in 50% (31/62), and stress in 33.9% (21/62) (Tables 1 and 2). Of the studies that measured anxiety, 94% (32/34) used a validated tool, while 81% (25/31) of studies measuring depression, and 86% (18/21) of studies measuring stress used a validated tool.

Pooled Analysis

In the weighted pooled analysis, university students reported experiencing anxiety (26%), depression (26%), and stress (24%) during the COVID-19 pandemic shutdown period (Table 4). In cohort studies, the use of differing assessment tools, varying timing during the lockdown, and differences in follow-up duration prevented meta-analysis or meaningful statistical comparisons. However, in general, anxiety and depression worsened during the early months of the pandemic, with students having “mild” anxiety and/or depression before the pandemic experiencing “moderate” or “severe” symptoms during the shutdown (Wattick et al., 2021). However, symptoms of anxiety and depression tended

to decrease from the early months of the shutdown to the summer months as students adapted to their ‘new normal.’ Further, a past medical history of mental health conditions (e.g., depression) was associated with the development of new mental health conditions (e.g., anxiety) during the pandemic (García-Espinosa et al., 2021; Husky et al., 2021; Saraswathi et al., 2019; Li et al., 2021; Ji et al., 2020). Other reported predictors of higher risk for adverse effects included female gender (Copeland et al., 2021; García-Espinosa et al., 2021; Hoyt et al., 2021), identification as a gender or racial/ethnic minority (García-Espinosa et al., 2021; Hoyt et al., 2021), and younger age (Copeland et al., 2021; García-Espinosa et al., 2021; Saraswathi et al., 2020; Prokes & Housel, 2021).

Discussion

In this study, we reviewed and synthesized the existing literature to evaluate the prevalence and impacts of health and health behaviors on university students worldwide during the COVID-19 pandemic. We identified a significant amount of data on the prevalence of mental health conditions, and moderate data reporting on associated health behaviors. We also found an overrepresentation of data from China and the United States, as well as data focusing on females. Overall, our findings suggest that the current data on this topic may not adequately or equitably represent the global university student population. Additionally, the study designs often preclude drawing causal inferences about the relationship between health behaviors and health outcomes.

Regional Findings

Over half of the studies (52%, 32/62) were conducted in either China or the United States, making these high-income and upper-

Figure 1.

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources

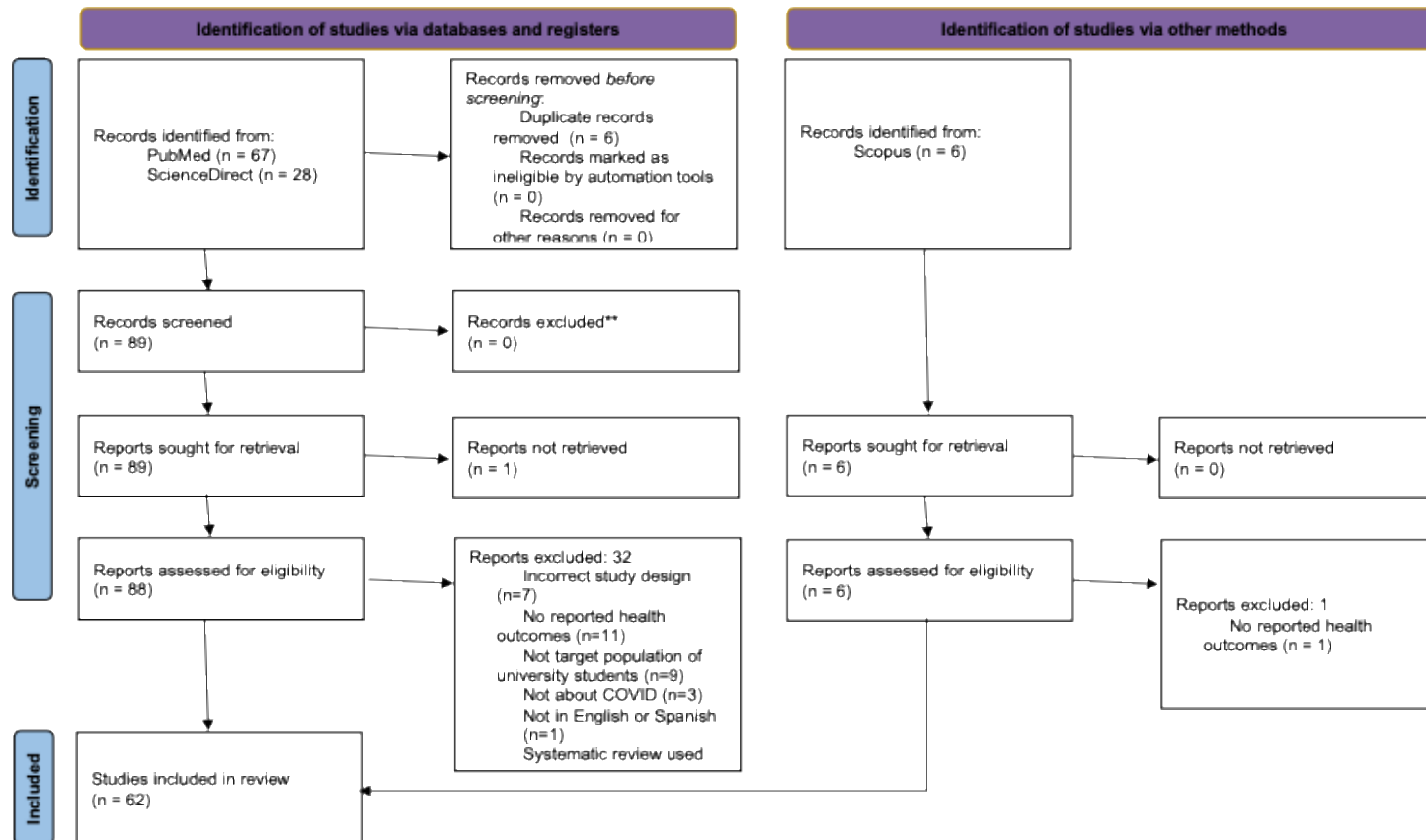


Table 1.*Study Information - Case Study and Cross-Sectional*

Authors (Month Year)	Study Location (Country); Number of Sites (One or Multiple)	Outcome(s) of Interest	Comparison Group	Sample characteristics (N, sex, age, race, SES, baseline health conditions)	Assessment Tools Used in Study
Case Study					
Lai et al. (May 2021)	United States; One	Depression; Anxiety; Loneliness; Physiology; Sleep	NA	1 participant; 0% female; 100% male; age demographics NR; race NR; SES NR; health NR	BDI-II, BSI, UCLA-LS-3, Oura ring, Samsung Gear Sport smartwatch, PANAS
Cross-Sectional					
Aker et al. (May 2020)	Turkey; One	Physical and mental state		1,375 participants; 53.5% female; 46.5% male; mean age 21.4; race NR; SES NR; health NR	Non-validated tool: author-designed, 40 open- and close-ended questions
Al-Tammemi et al. (November 2020)	Jordan; Multiple	Worry / fear / guilt / distress about COVID; Tobacco smoking; Physical activity	NA	381 participants; 52.2% female; 47.8% male; mean age 22.6; race NR; SES NR; 4% pre-existing psychiatric condition	KPDS-10

Arsандаux et al. (August 2021)	France; Multiple	Depression; Anxiety; Suicidal thoughts; Stress	NA	1,335 participants; 79.8% female; male sex demographics NR; mean age 23.3; race NR; SES NR; 23% history of psychiatric disease, 28% history of other disease at risk for COVID-19	PHQ-9, GAD-7
Biber et al. (November 2020)	United States; One	Anxiety; Mood and wellness behaviors	NA	1,640 participants; 60.3% female; 38.6% male; age demographics NR; race breakdown of 61.4% White, 24.7% Black, 12.9% other; SES NR; health NR	GAD-7, GQ-6
Bourion Bedes et al. (January 2021)	France; Multiple	Anxiety		3,936 participants; 70.6% female; 29.4% male; mean age 21.7; race NR; SES NR; health NR	GAD-7
Cadena-Duarte et al. (May 2021)	Colombia; Multiple	Mood and wellness behaviors; Physical activity	NA	499 participants; 52.9% female; 47.1% male; mean age 23.5; race NR; SES 43.6- 52.3% lower class, 30.6-42.4% low- middle class, 9.1% middle class, 4.9- 7.2% below poverty level; health NR	PSQ

Cao et al. (March 2020)	China; One	Anxiety		7,143 participants; 69.7% female; 30.4% male; age demographics NR; race NR; SES NR; health NR	GAD-7
Caycho-Rodríguez et al. (September 2020)	Peru; Multiple	Worry / fear / guilt / distress about COVID; General mental health; Depression	NA	704 participants; 57.5% female; 42.5% male; mean age 23.4; race NR; SES NR; 9% current anxiety treatment	MHI-5, PHQ-2, CAS
Chen et al. (May 2021)	South Korea, Taiwan; Multiple	Mood and wellness behaviors	NA	889 participants; 42.2-49.6% female; 50.4-58.8% male; age range 19-29; race NR; SES NR; health NR	Non-validated tool: author-designed, measured 3 aspects of mental health and 7 of lifestyle change
Conrad et al. (April 2021)	United States; Multiple	Worry / fear / guilt / distress about COVID; Depression; Loneliness; Anxiety; PTSD	NA	791 participants; 82.2% female; 14.3% male; age range 18-31; race breakdown of 59.7% White, 21.0% Asian, 5.8% Hispanic, 4.8% Black, 7.0% multi-racial, 1.8% other; 7% received financial aid; 43% pre-existing psychiatric diagnosis	PHQ-8, GAD-7, UCLA-LS-3, PCL-C, plus non-validated tools: 6 item COVID-19-related worry and 6-item COVID-19-related grief scales from prior studies
Daigle et al. (August 2021)	United States; Multiple	Abuse/victimization; Stress; Medical treatment; Alcohol consumption; Marijuana use;	NA	13,373 participants; 72% birth sex female; 28% birth sex male; mean age 23; race	Non-validated tool: author-designed, measured victimization, substance abuse, and

		Substance use		breakdown of 64% White, 12% Asian, 7% Black, 7% Hispanic, 4% multi-racial, 6% other; SES NR; health NR	COVID-19 impact on stress, finances, counseling services
Fanari et al. (April 2021)	United States; Multiple	Stress; Alcohol consumption; Depression; Loneliness; Life satisfaction	NA	133 participants, 78.2% female; 21.1% male; mean age 20.6; Race breakdown of 68.4% White; 9% Black; 12.8% Hispanic; 9% Asian; SES NR; health NR	ASSIS, PSS, COVID-19-SS, NIAAA-RAQ, CES-D
Fila-Witecka et al. (September 2021)	Poland; Multiple	General health; Sleep; Lifestyle changes; Mood and wellness behaviors; Eating habits; Physical activity; Sex; Psychiatric symptoms; Self harm; Substance use; Depression	NA	980 participants; 75% female; 25% male; mean age 22.2; race NR; SES NR; health NR	GHQ-28, IES-R, ISI
Ganjoo et al. (October 2021)	Iran; One	General health; Stress	NA	255 participants; 58.4% female; 41.6% male; mean age 22.2; race NR; SES NR; excluded history of treatment for mental disorder	MHLCS, PSS
García-Espinosa et al. (June 2021)	Mexico; One	Anxiety; Depression	Health vs. Non-health students	1,149 participants; 64.8% female; 35.2% male; mean age 20.6; 9.1% stated minority	GAD-7, PHQ-9

				status; 67.1% “consider having a sufficient income”; 56% major depressive disorder; 81% generalized anxiety disorder; 6% bipolar or other	
Garver et al. (July 2021)	United States; One	Depression; Anxiety; Stress	NA	249 participants; 49.8% female; 50.2% male; age demographics NR; race NR; SES NR; health NR	DASS-21, MHLCS
Giusti et al. (September 2021)	Italy; One	Depression	NA	203 participants; 76.4% female; 23.6% male; mean age 24.3; race NR; SES NR; health NR	BDI-II, Eyes Task (Italian validation)
Hernández-García et al. (July 2021)	Cuba; Multiple	Stress	NA	200 participants; 39% female; 61% male; mean age 22.3; race NR; SES NR; health NR	PSS-10 (EEP-10-C, in Spanish)
Hong et al. (April 2021)	China; Multiple	Mood and wellness behaviors; General mental health	NA	439 participants; 58.1% female; 41.9% male; mean age 20.4; race NR; SES NR; health NR	CAMM, E-RRI, KPDS
Husky et al. (May 2021)	France; One	Anxiety; Alcohol consumption; Stress; Depression; Substance use	NA	291 participants; 73.5% female; male sex demographics NR; mean age 19.1; race	CIDI, AUDIT, WMH-CIDI

				NR; SES NR; 66% prior depression	
Islam et al. (August 2020)	Bangladesh; Multiple	Depression; Anxiety; Physical activity	NA	476 participants; 32.8% female; 67.2% male; 91% of population in age range 17-24; race NR; SES NR; health NR	PHQ-9, GAD-7
Jojoa et al. (May 2021)	Colombia, Chile, Nicaragua, Spain; Multiple	Lifestyle changes; Anxiety; Stress; Physical activity; Abuse/victimization	NA	1,084 participants; 33% female; 65% male; age demographics NR; race NR; SES NR; 12% current chronic disease	Non-validated tool: 82-item LockedDown survey
Kamaludin et al. (November 2020)	Malaysia; Multiple	Anxiety; Mood and wellness behaviors	NA	983 participants; 66.4% female; 33.6% male; 85% of population in age range 19-25; race NR; SES NR; health NR	SAS
Konstantinov et al. (November 2020)	Republic of Kazakhstan; One	General mental health; Substance use	NA	466 participants; 67% female; 33% male; mean age 19.0; race NR; SES NR; health NR	FCV-19S-7
Li et al. (January 2021)	China; Multiple	PTSD	NA	4,355 participants; 49.3% female; 50.7% male; 55.9% of the population at least of age 20; race NR; SES NR; health NR	IES-R

Li et al. (November 2020)	China; Multiple	Mental health; Mood and wellness behaviors	NA	1,676 participants; 64.9% female; 35.1% male; mean age 20.2; race NR; monthly disposable income yuan ≤ 1000 22%; 1001-2000 62%; 2000 16.2%; health NR	SCL-90, HAI
Lopez-Castro et al. (April 2021)	United States; One	Depression; Anxiety; Stress; Lifestyle changes; General mental health; Medical treatment; Sleep	NA	909 participants; 69.2% female; 30.8% male; age demographics NR; race NR; SES NR; health NR	PHQ-9, GAD-7, DAAS, PC-PTSD
Martínez et al. (October 2020)	Colombia; One	General health; Mood and wellness behaviors; Worry / fear / guilt / distress about COVID	NA	634 participants; 56% female; male sex demographics NR; mean age 20; race NR; SES NR; health NR	Non-validated tool: annual CaliBRANDO survey in Cali, Colombia
Misirlis et al. (November 2020)	The Netherlands; One	Loneliness; Anxiety; Depression; General mental health	NA	248 participants; 69.0% female; 31.0% male; age demographics NR; race NR; SES NR; health NR	UCLA-LS-3, 3-PSCS, HAD
Ochnik et al. (June 2021)	Poland, Slovenia, Czechia, Ukraine, Russia, Germany, Turkey, Israel, Colombia; Multiple	Depression; Anxiety; Worry / fear / guilt / distress about COVID; Physical activity; General health	NA	2,349 participants; 69% female; male sex demographics NR; mean age 23; race NR; SES NR; health NR	PHQ-8, GAD-7, PIC, GSRH, non-validated tools: author-designed, questions on physical health and exposure to COVID-19

Ochnik et al. (September 2021)	Poland, Slovenia, Czechia, Ukraine, Russia, Germany, Turkey, Israel, Colombia; Multiple	Anxiety; Depression; Stress	NA	2,349 participants; 69.3% female; 30.2% male; age demographics NR; race NR; SES NR; health NR	GAD-7, PHQ-8, PSS- 10
Olson et al. (March 2021)	United States; One	Lifestyle changes	NA	116 participants; 71.6% female; male sex demographics NR; 82.8% of the population between 18-24; race breakdown of 73.3% White; 11.2% Asian; 9.5% Black; 0.7% Native Hawaiian or Pacific Islander, 6% other; SES NR; health NR	Non-validated tool: photo-survey and free- form response on life and health behavior changes during COVID-19 pandemic
Ren et al. (April 2021)	China; Multiple	Anxiety; Depression	NA	478 participants; 57.1% female; 42.9% male; age demographics NR; race NR; SES NR; 45% history of counseling	SAS, PHQ-9
Rogowska et al. (September 2020)	Poland; One	Anxiety; Stress; General Health; Life satisfaction	NA	914 participants; 43.1% female; 56.9% male; mean age 23; race NR; SES NR; health NR	GAD-7, PSS, GSRH, SWLS, CISS
Sandoval et al. (December 2021)	Peru; One	Depression; Anxiety; Stress; General health	NA	284 participants; 48.2% female; 51.8%	DASS-21

				male; age range 22-42; race NR; SES NR; health NR	
Schepis et al. (Oct 2021)	United States; Multiple	Alcohol consumption; Marijuana use; Psychiatric symptoms	NA	1795 participants, 68% female; male sex demographics NR; mean age 19.9; race breakdown of 5.3% White, 16.4% Black, 5.9% Hispanic, 7.0% Asian, 0.2% Native Hawaiian or Pacific Islander, 0.3% American Indian or Alaskan Native, 0.8% other, 24.1% multi-racial; 46.8% middle class, 24.5% upper-middle class, 21.3% working class, 4.4% poor, 3.0% wealthy; health NR	DDQ, B-YAACQ, MUG, B-MACQ, DSM-5 CCSM
Sirrine et. al (June 2021)	United States; Multiple	Lifestyle changes; Loss	NA	162 participants; 81.5% female; 17.2% male; mean age 27; race breakdown of 82.71% White; 7.40% Black; 1.85% Asian; 1.85% American Indian/Alaskan Native; SES NR; health NR	RLS, BMMRS
Son et al. (September 2020)	United States; One	Stress; Anxiety; Sleep; Eating habits;	NA	195 participants; 57% female; mean age	PSS-10

		Lifestyle changes; Depression; Medical treatment; Suicidal thoughts		20.7; race NR; SES NR; health NR	
Tang et al. (September 2020)	China; Multiple	PTSD; Depression; Sleep	NA	2,485 participants; 60.8% female; 39.2% male; mean age 19.8; race NR; SES NR; health NR	PCL-C, PHQ-9
Verma et al. (June 2021)	India; Multiple	Stress; Anxiety	NA	550 participants; 76% female; male sex demographics NR; mean age 20.8; race NR; SES NR; health NR	Non-validated tool: author-designed, 16 questions on COVID- 19
Wang et al. (September 2020)	United States; One	Depression; Anxiety; Worry / fear / guilt / distress about COVID	NA	2,031 participants; 61.6% female; 37.3% male; mean age 22.9; race NR; SES NR; health NR	PHQ-9, GAD-7, non- validated tool: author- designed, questions regarding COVID-19 related stress and coping mechanisms and barriers
Wang et al. (October 2020)	China; Multiple	Depression; Anxiety	NA	44,447 participants; 54.5% female; 45.5% male; mean age 21; 2.8% considered “minority”; SES NR; health NR	SAS, CES-D
Wathelet et al. (October 2020)	France; Multiple	Depression; Anxiety; Suicidal thoughts; Stress; Mood and wellness behaviors; Physical activity	NA	69,054 participants; 72.8% female; 26.1% male; median age 20; race NR; SES NR; health NR	IES-R, PSS-10, STAI- S20, BDI-II

Wattick et al. (August 2021)	United States; One	Mood and wellness behaviors; Stress; Depression; Anxiety; Alcohol consumption	NA	2,018 participants; 70.7% female; 27.6% male; mean age 24.9; race breakdown of 83.1% White; 2.6% Black; 4.2% other; SES NR; self-reported health very good 29%; good 43%; fair 22%; poor 5%; very poor 1%; 55% mild to severe anxiety; 54% mild to severe depression; 60% moderate or high stress; 77% at high risk for alcohol use	BRS, PSS-10, PHQ-9, GAD-7, AUDIT-C
Xiao et al. (July 2020)	China; Multiple	Anxiety; Depression	NA	933 participants; 70.1% female; 29.9% male; 81% of population in age range 17-24; race NR; SES NR; health NR	GAD-7, PHQ-9
Xin et al. (July 2020)	China; Multiple	Worry / fear / guilt / distress about COVID; Depression; Suicidal thoughts; General mental health; Self harm	NA	24,378 participants; 67.7% female; 32.3% male; mean age 19.9; race NR; SES NR; health NR	PHQ-9 (Chinese version), SH-SI, non-validated tools: author-designed, questions on quarantine status, emotional distress, and perceived risk of and discrimination because of COVID-19
Xu et al. (March 2021)	China; NR	Physical activity; General mental health;	NA	2,233 participants; sex demographics NR;	PAQ, RES, SCL-90

		Mood and wellness behaviors		mean age 19.3; race NR; SES NR; health NR	
Yang et al. (September 2021)	China; NR	Anxiety	NA	1,039 participants; 66.9% female; 33.1% male; 52.7% of the population above the age of 22; race NR; SES NR; excluded participants with history of anxiety	STAI, GAD-7
Yu et al. (August 2021)	China; NR	Sleep; General mental health; Stress	NA	1,086 participants; 67.8% female; 32.2% male; age range 20-40; race NR; SES NR; health NR	AIS, SRQ-20, CPSS
Zhan et al. (June 2021)	China; NR	Stress; Depression; Anxiety	NA	1,586 participants; 63.7% female; 36.3% male; age demographics NR; race NR; SES NR; health NR	PSS, PHQ-9, SAS, non-validated tool: author-designed, general situation questionnaire
Zhao et al. (December 2020)	China; Multiple	Mood and wellness behaviors; General mental health; Depression; Anxiety	NA	512 participants; 62.5% female; 37.5% male; mean age 22.1; ethnic Han 94%; average monthly income people's renminbi (RMB) 23% 0-4,999; 40% 5,000-9,999; 16% 10K-14.9K; 22% >15K; 6% diagnosed mental	PANAS, STSS-SM-17, PHQ-9, GAD-7

				disorder; 10% prior collective trauma exposure	
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Abbreviations: 3-PSCS, Three-Factor Psychological Sense of Community Scale; ASSIS, Acculturative Stress Scale for International Students; AIS, Athens Insomnia Scale; AUDIT(-C), Alcohol Use Disorders Identification Test (-Concise); BMMRS, Brief Multidimensional Measurement of Religiousness and Spirituality; BDI-II, Beck Depression Inventory-II; BRS, Brief Resilience Scale; B-MACQ, Brief Marijuana Consequences Questionnaire; B-YAACQ, Brief Young Adult Alcohol Consequences Questionnaire; BSI, Brief Symptom Inventory; CPSS, Chinese perceived stress scale; CES-D, Center for the Epidemiological Studies-Depression; CISS, Coping Inventory for Stressful Situations; CAS, Coronavirus Anxiety Scale; CSS, COVID-19 Stress Scale; CAMM, Child and Adolescent Mindfulness Measure; CIDI, Composite International Diagnostic Interview Screening Scales; DDQ, Daily Drinking Questionnaire; DASS-21, Depression Anxiety Stress Scale-21; DSM-5 CCSM, DSM-5 Level 1 Cross-Cutting Symptom Measure; E-RRI, Event-Related Rumination Inventory; FCV-19S, Seven-item Fear of COVID-19 Scale; GAD-7, General Anxiety Disorder-7; GHQ-12, General Health Questionnaire; GHQ-28, General Health Questionnaire; GSRH, General Self-Rated Health; GQ-6, Gratitude questionnaire-6; HAD, Hospital Anxiety and Depression; HAI, Health Anxiety Inventory; IES-6, Impact of Event Scale-6; IES-R, Impact of Event-Scale-Revised; ISI, Insomnia Severity Index; KPDS-10, 10-item Kessler Psychological Distress Scale; MUG, Marijuana Use Grid; MHLCS, Multidimensional Health Locus of Control Scale; MHI-5, Mental Health Inventory-5; NA, not applicable; NIAAA-RAQ, National Institute on Alcohol Abuse and Alcoholism's Task Force on Recommended Alcohol Questions; NR, not reported; PANAS, Positive and Negative Affect Schedule; PSS-10, 10-item Perceived Stress Scale; PHQ, Patient Health Questionnaire; PIC, Perceived Impact of Coronavirus; PAQ, Physical Activity Questionnaire; PSQ, Physical Self Questionnaire; PTSD, posttraumatic stress disorder; PC-PTSD, Primary Care PTSD; PCL-C, PTSD Checklist - Civilian Version; RLS, Reactions to Loss Scale; RES, Regulatory Emotional Self-efficacy scale; SWLS, Satisfaction With Life Scale; STSS-SM, 17-item Secondary Traumatic Stress Scale for Social Media Users; SH-SI, Self-Harm or Suicidal Ideation; SAS, Self-rating Anxiety Scale; SRQ-20, Self-Reporting Questionnaire-20; SES, socioeconomic status; STAI-S-20, 20-item State-Trait Anxiety Inventory (State subscale); SCL-90, Symptom Checklist; UCLA-LS-3, University of California, Los Angeles 3-item Loneliness Scale; WMH-CIDI, World Mental Health-CIDI

^a Mixed-methods study; eligible abstracted data were qualitative.

Table 2.*Study Information - Cohort Studies*

Authors (Month Year)	Study Location (Country); Number of Sites (One or Multiple)	Outcome(s) of Interest	Comparison Group	Sample characteristics (N, sex, age, race, SES, baseline health conditions)	Assessment Tools Used in Study
Cohort					
Copeland et al. (January 2021)	United States; One	Mood and wellness behaviors	Beginning vs. end of Spring semester, first-year students	675 participants; 74% female; 25.5% male; age range 18-25; race breakdown of 89.5% White, 4.2% Asian, 3.0% Hispanic; 0.7% African-American; 2.2% other; 66.3% middle class, 26.8% upper-middle class or wealthy, 6.9% lower class; health NR	BPM, non-validated tools: author-designed, questions on wellness behaviors, mood, and stress
Giusti et al. (December 2021)	Italy; One	Stress; Anxiety; Depression; Concentration	NA	103 participants; 81.6% female; 18.4% male; mean age 22.5; race NR; SES NR; 22% prior mental health service experience; 8% current antidepressant treatment	SAS, IES-R, GHQ-12, BDI-II
Hood et al. (March 2021)	United Kingdom; One	General mental health; Loneliness; Mood and wellness behaviors	Study 2, February vs. May 2020	396 participants; 73-79% female; male sex demographics NR; age range of 18-25;	SWEMWBS, UCLA-LS-3

				race reported 78-82% White; SES NR; health NR	
Horita et al. (January 2021)	Japan; One	Worry / fear / guilt / distress about COVID; Depression; Anxiety; Eating habits; Substance use	2020 vs. 2019, first-year students	766 participants; 45% female; 55% male; age demographics NR; race NR; SES NR; health NR	KPDS-10, CCAPS-J
Hoyt et al. (February 2021)	United States; Multiple	Stress; Anxiety; Lifestyle changes	April vs. July 2020	707 participants; 61.0% female; 34.4% male; mean age 20.0; race breakdown of 54.3% White, 20.4% Asian or Pacific Islander, 8.9% Hispanic, 5.2% Black or African American, 1.1% Middle Eastern or North African, 10.1% multi-racial; annual household income 6% >250K; 32% \$100K-\$250K; 29% \$54K-\$100K; 21% \$26K-\$54K; 13% <\$26K; health NR	PSS-10, GAD-7, non-validated tools: author-designed, questions on COVID-19 emotional distress and mental health
Ji et al. (September 2020)	China; One	Worry / fear / guilt / distress about COVID	February vs. March vs. April 2020	4,006 participants; 65% female; 35% male; age range 17-50; race NR; SES NR; health NR	Y-BOCS, SAS, Non-validated tools: author-designed, questions on COVID-19 distress

Li et al. (February 2021)	China; Multiple	Stress; Anxiety; Depression; Physical activity; Alcohol consumption; Tobacco smoking; Worry / fear / guilt / distress about COVID	February vs. March/April 2020	148,343 participants; 62.6% female; 37.4% male; age demographics NR; race NR; SES NR; health NR	IES-6, PHQ-9, GAD-7 (Chinese version), SPSS
Post et al. (September 2021)	Australia; One	General health; Physical activity; Tobacco smoking; Eating habits; Medical treatment; General mental health	March vs. May 2020, first-year students	126 participants; 70.3% female; male sex demographics NR; median age 18; race NR; SES NR; health NR	Non-validated tools: author-designed, questions on self-rated health, physical activity, smoking, health service use, medication use, diet, and mental health
Prokes et al. (February 2021) ^a	United States; One	Lifestyle changes; General mental health; Concentration	April vs. May 2020	356 participants; 66.4% female; 25.7% male; 67% of the population between 18-21; race breakdown of 69.4% White, 20.2% African American, 10.4% other/prefer not to answer; SES NR; health NR	Non-validated tool: author-designed, open-ended questions on the impact of life changes from COVID-19
Saraswathi et al. (October 2020)	India; One	Depression; Anxiety; Stress	December 2019 vs. June 2020	217 participants; 64.0% female; 36.0% male; mean age 20; race NR; SES NR; 33% mild to extremely severe depression; 21% mild to extremely severe anxiety; 21% mild to severe stress	DASS-21, PSQI

Abbreviations: BDI-II, Beck Depression Inventory-II; BPM, Brief Problem Monitor; CCAPS-J, Counseling Center Assessment of Psychological Symptoms-Japanese; DASS-21, Depression Anxiety Stress Scale-21; GAD-7, General Anxiety Disorder-7; GHQ-12, General Health Questionnaire; IES-6, Impact of Event Scale-6; IES-R, Impact of Event-Scale-Revised; NA, not applicable; NR, not reported; PSS-10, 10-item Perceived Stress Scale; PHQ, Patient Health Questionnaire; PSQI, Pittsburgh Sleep Quality Index; SWEMWBS, Short-Warwick Edinburgh Mental Well-Being Scale; SPSS, Scale of Perceived Social Support; SAS, Self-rating Anxiety Scale; SES, socioeconomic status, UCLA-LS-3, University of California, Los Angeles 3-item Loneliness Scale; Y-BOCS, Yale-Brown Obsessive Compulsive Disorder

^a Mixed-methods study; eligible abstracted data were qualitative.

Table 3.*Gender and Age Demographics of Study Populations by Region*

	North America / Australia (k=18)	Asia (k=26)	Europe (k=10)	Latin/South America (k=5)	Multi-country (k=3)
% Female (Weighted Average)	69.6	61.6	71.7	53.4	68.3
% Female (Study Range)	49.8 to 82.2	32.8 to 76	53.5 to 81.5	39 to 57.5	64.8 to 69.3
% Male (Weighted Average)	28.2	38.4	27.5	47.6	31.8
% Male (Study Range)	14.3 to 100	29.9 to 67.2	18.4 to 56.9	42.5 to 61	30.2 to 35.2
	North America / Australia (k=8)	Asia (k=12)	Europe (k=10)	Latin/South America (k=5)	Multi-country (k=2)
Mean Age, Years (Weighted)	22.8	20.6	21.9	22.3	22.2
Lowest Mean Age, Years	19.9	19	19.1	20	20.6
Highest Mean Age, Years	27	22.6	24.3	23.5	23

Table 4.*Pooled Analysis of Prevalence*

	Prevalence of Outcome
<i>Anxiety</i>	
Mild Anxiety (k=12)	27.1%
Moderate Anxiety (k=11)	11.4%
Severe-Extremely Severe Anxiety (k=15)	12.0%
Overall Anxiety (k=23)	25.6%
<i>Depression</i>	
Mild Depression (k=7)	22.0%
Moderate Depression (k=7)	18.1%
Moderately Severe-Severe Depression (k=12)	14.5%
Overall Depression (k=19)	26.1%
<i>Stress</i>	
Light (k=5)	16.2%
Moderate (k=5)	46.0%
High (k=7)	21.5%
Overall (k=12)	23.5%
<i>Other</i>	
Increased Stress and Anxiety (k=3)	71.2%
Lifestyle Changes (k=3)	85.4%
Suicidal Thoughts (k=3)	17.9%
Decreased Concentration (k=2)	49.0%
Decreased Physical Activity (k=2)	55.8%
Sleep Habit Changes (k=2)	80.1%

middle countries significantly represented in the literature compared to the rest of the world. There was a notable lack of data from Latin and South American countries, despite gross enrollment in tertiary education in South American nations being comparable to that in European countries (Roser & Ortiz-Ospina, 2013). Data from European countries were also surprisingly low, although many “multi-continent” studies were predominantly across European countries (Chang et al., 2021; Ochnik et al., 2021a; Ochnik et al., 2021b). The relative scarcity of independent European studies may stem from a documented shift in academic labor during the initial pandemic waves. European faculty often faced a dual burden: (1) a rapid, resource-intensive transition to digital-only curricula; and (2) the redirection of public health and medical professors toward frontline clinical duties or national advisory roles (Bartkowiak et al., 2022; Becker et al., 2021). Furthermore, while European research productivity remained high in clinical epidemiology, social and behavioral research in higher education settings may have been hampered by strict lockdowns that prevented the face-to-face fieldwork common in European qualitative traditions (Bratan et al., 2021). This may have been further exacerbated by a temporary dip in female academic output due to disproportionate domestic labor during school closures (Myers et al., 2020; Gao et al., 2021). The lack of data from low- and middle-income countries, as well as the absence of studies addressing different cultural norms that may contribute to risk or resilience during times of trauma, limits our ability to draw conclusions about how the earliest stages of the COVID-19 pandemic impacted the health outcomes for this demographic globally.

Gender Skew

The data collected were predominantly from the female population. Existing data in the United States suggest that in 2020, females made up the majority of college students (58%) (Roser & Ortiz-Ospina, 2013). However, in the university populations in our findings from North America, females constituted 70% of the samples, which is significantly higher than the national average (Hanson, 2023). This skew likely impacted our findings, as many studies have documented depression and anxiety to be twice as common in females as in males (Shi et al., 2021). If this is true, the overrepresentation of females in these studies may lead to an overestimation of the prevalence and impact of mental health outcomes on university students during the earliest stages of the COVID-19 pandemic. This overestimation highlights the need for universities to consider the gender demographics of their student populations when implementing health interventions, as female-identifying students may require more resources and support than their male counterparts, or may be more likely to seek help for psychological concerns.

Health Outcomes

Mental health outcomes have often been the primary focus of research, with less emphasis on the health conditions and wellbeing factors that influence an individual's mental health. The increasing attention to mental health among university students is important, and research should continue to focus on the prevalence of mental health challenges in this demographic. However, future studies should take a more holistic approach to evaluating mental health, which considers the health conditions and wellbeing strategies that impact students' mental wellbeing. Few studies have examined health conditions or wellbeing

practices (Yudkin, 2022) alongside mental health evaluations. Notably, no study in our review explicitly explored how preexisting physical health conditions, such as cardiometabolic (Ditmars et al., 2022) or autoimmune conditions (Bingham et al., 2021), impacted the mental and emotional health of this age group (Allemang et al., 2023; Gui et al., 2022; Sharkey et al., 2018; Dosil-Santamaria et al., 2022) during the earliest stages of the pandemic. Additionally, only one study (Post et al., 2021) discussed how the health needs of the university students, such as access to medical care, evolved during this period. Data on traditional wellbeing practices, including sleep, alcohol consumption, and physical activity, was limited. While the prevalence of health conditions might be lower among university students compared to the general population, understanding these factors is still valuable for identifying potential interventions and contributing to a more comprehensive approach to health—mental, emotional, and physical, as defined by the World Health Organization (WHO, 2023).

Simultaneously, our results provide valuable insights into the mental health conditions of university students during a period of acute stress. The overall rates of anxiety and depression across all studies were 26%, which is much higher than the global prevalence of 4% for these diseases (Santomauro et al., 2021). Other health institutions suggest that this rate increased in the aftermath of the COVID-19 pandemic (WHO, 2022). It is evident that further research is needed to determine how we can better support the university student population during grand-scale times of crisis, which is increasingly burdened by these mental health challenges.

Lastly, given the cross-sectional design of most studies, only a few were able to evaluate how mental health conditions changed before and after the pandemic. These findings

underscore the need for greater attention to students with preexisting mental health conditions during times of crisis.

Tool and Outcome Heterogeneity

The tools used to measure common mental health outcomes, such as anxiety and depression, varied significantly across studies. The lack of consistency in measurement tools makes it difficult to generalize findings and inhibits the development of comprehensive and effective health interventions. A standardization of measurement tools could benefit the research community by enabling clearer synthesis of data. In this study, the heterogeneity of outcomes and measurement tools limited our ability to perform robust statistical analysis.

Implications for Pandemic Health Policy

Universities represent unique, high-density community hubs that function as distinct ‘micro-cities,’ yet this review highlights that pandemic health policy for this population has been largely reactive rather than proactive. The lack of coordinated global closures during the 1918 influenza pandemic versus the synchronized shutdowns of COVID-19 illustrates a shift toward global policy alignment; however, the *data* informing these policies remains fragmented.

From Ad-Hoc Response to Standardized Surveillance.

Our review identified the use of 82 different measurement tools across 62 studies, with significant reliance on unvalidated instruments and cross-sectional snapshots. From a policy perspective, this heterogeneity renders the data ‘noisy’ and prevents the creation of evidence-based global guidelines. Decision-makers (university administrators and public health officials) currently lack a standardized

dashboard to monitor student health in real-time. Thus, our policy recommendation would be that *universities and governing health bodies must establish standardized health surveillance infrastructures that collect longitudinal baseline data prior to a crisis*. Just as universities track academic metrics, they must institutionalize the tracking of validated health metrics (physical, mental, and behavioral). Without pre-pandemic baselines, policymakers cannot accurately determine if a specific intervention (e.g., closing gyms or dorms) is causing more harm than good.

Integrating Physical and Mental Health Policy.

Current policies often treat mental health in isolation. Our results showed that 72% of outcomes measured in the early pandemic were mental health-related, while only 6% addressed physical health and 2% physiological outcomes. This "blind spot" implies that policies addressed the *symptoms* of the crisis (anxiety/depression) while ignoring the *determinants* (sleep, diet, physical activity, and management of pre-existing conditions). Thus, our policy recommendation would be that *health policies in higher education must shift from a crisis-response model to a 'Whole-of-University' approach*. Policies regarding campus closures must weigh infection control against the loss of health-promoting resources (e.g., gyms, food security, clinics). Future pandemic planning should explicitly mandate the maintenance of student access to physical health resources, as these are inextricably linked to mental well-being.

Addressing the Representation Gap

Finally, the over-representation of female participants and high-income nations (specifically China and the U.S.) in the

literature creates a policy bias. Protocols developed based on this data may not be culturally or structurally appropriate for male students or those in the Global South. Thus, our policy recommendation would be for *funding bodies and university consortia to prioritize and incentivize data collection from underrepresented demographics and regions to ensure that global health guidelines are truly equitable and globally applicable*.

Implications for Health Behavior Research

The findings of this review highlight a critical disconnect between the identification of mental health symptoms and the clinical monitoring of their underlying behavioral determinants. While the literature extensively documents high rates of anxiety and depression in the early pandemic period, the scarcity of data on physical health and lifestyle behaviors (e.g., sleep, physical activity, nutrition) suggests that university health systems may be treating symptoms in isolation.

A primary implication is the need to expand standard intake protocols. Since physical activity and sleep quality are strong predictors of mental well-being (and were likely the first behaviors to deteriorate during the shutdown) clinicians should routinely assess these physical determinants alongside standard mental health screenings (e.g., PHQ-9, GAD-7). Interventions that solely target psychological symptoms (e.g., telehealth) may have limited efficacy if the student's physiological baseline remains compromised by confinement or disrupted routines.

Second, the data reveal that mental health and physical health are often studied, and likely treated, in silos. On university campuses, this fragmentation often mirrors the administrative separation between

Counseling and Psychological Services (CAPS) and Recreation/Wellness departments. Our findings support an integrated care where mental health support is formally integrated with physical wellness programming. For instance, clinical "prescriptions" for physical activity or sleep hygiene education should be considered standard adjuncts to psychotherapy for students facing pandemic-related distress.

Third, the significant underrepresentation of male students in the literature (constituting roughly 30% of participants) has immediate clinical implications. Men often manifest distress through externalizing behaviors (i.e., substance use, irritability, or social withdrawal) rather than the internalizing symptoms captured by standard anxiety/depression inventories (Addis, 2008). Consequently, university health promotion efforts must diversify their outreach strategies. Reliance on self-referral to counseling services may miss a large cohort of male students who are struggling but do not identify with the traditional language of "anxiety" or "depression." Proactive outreach that focuses on performance, physical fitness, and stress management may be more effective entry points for engaging this demographic.

Finally, as universities transition away from emergency remote operations, clinical practice must account for the specific challenges of the "re-entry" phase. Students returning to campus may not simply "bounce back" to pre-pandemic baselines. Health promotion teams should anticipate a period of re-adjustment where students require scaffolding to rebuild healthy daily routines—re-establishing sleep schedules, socializing in person, and engaging in organized physical activity—skills that may have atrophied during prolonged lockdowns.

We found that the existing data shed light on the prevalence of disease within this population but were less useful for

understanding incidence. Very few conclusions can be drawn about how the earliest stages of the COVID-19 pandemic affected health outcomes and behaviors. The urgent need for a rapid response to the pandemic, along with the use of numerous unvalidated tools that prevented standard comparisons, likely explains this gap in the data. However, given the likelihood of future disease outbreaks, there is a clear need for measurement tool(s) that can effectively assess rapid changes in health outcomes.

Limitations

This study has some limitations. First, although we examined peer-reviewed literature in multiple languages (English and Spanish), we did not include literature from all languages. Given that between 75-90% of scientific literature is published in English (Montgomery, 2023), the inclusion of both English and Spanish articles allowed us to capture the majority of relevant research on this topic. However, our search also identified articles in other languages, such as Mandarin (Chang et al., 2020). These articles were not included in our review, but considering the significant COVID-19 outbreaks in Asian countries (Alyoubi et al., 2021), they could offer valuable insights that were not captured in our study. Second, there is a documented delay in research (Neta et al., 2018), and it is likely that these preliminary studies may not fully capture the impact of the pandemic during the earliest stages. Third, due to the heterogeneity of populations, outcomes, and measurement tools across studies, a meta-analysis could not be conducted. Fourth, the lack of longitudinal studies with pre-post measurements and comparative studies across different populations limited the potential for a deeper, more quantitative analysis. Fifth, many of the measurement tools used in these studies were not validated. Sixth, few studies reported baseline data,

creating challenges in interpreting their findings. Without baseline information on existing mental health conditions and health behaviors, the value of these findings is constrained. Finally, new data from studies with sample sizes over 8,000 participants were published in non-traditional formats (e.g., letters to the editors) and yielded similar findings. Although these studies fell outside the scope of this review, future research should consider including such data from non-traditional sources to ensure a more comprehensive analysis (Essadek & Rabeyron, 2020; Kaparounaki et al., 2020).

Strengths

This study has several strengths. First, it was reported in accordance with best practices and PRISMA guidelines. Second, the search was conducted using multiple databases and in two languages, with a search strategy that was developed and executed by a librarian scientist at Universidad El Bosque. Third, this study responsively assessed research published during the earliest stages of the pandemic, an uncertain time of crisis. Examining research from this stage provides valuable information to researchers, practitioners, and policymakers, with the ultimate goals of reducing the lag in translating research into practice and improving health outcomes and elevating research during future grand-scale health crises.

Future Research

Future research should focus on identifying the health behaviors that contribute to the mental health conditions of university students. This includes examining the physiological health conditions and traditional health behaviors of university students that influence their mental wellbeing. Understanding these factors will help identify which aspects of university life serve as protective or risk factors for mental

health conditions. Additionally, research should emphasize ongoing surveillance and longer follow-up periods to enhance the internal validity of study designs and improve our ability to measure incidence. For example, cross-sectional studies comprised most of the studies reviewed (79%, 49/62). It is crucial that future research tracks participants over time, examining the impacts of changing environments on health and health outcomes, and transitions cross-sectional studies into cohort designs. Ideally, future research would also delineate between undergraduate students and graduate studies, two populations that although share similar spaces, are distinct in terms of their health behaviors and needs. With this approach, we would gain a clearer understanding of the long-term effects of the pandemic on this vulnerable population.

Additionally, measuring self-reported changes without baseline data does not provide a clear indication of whether the change is healthy. Baseline data is essential for contextualizing and explaining reported change in health behaviors and outcomes. With sufficient data and standardized measurements, meta-analyses will become possible and are necessary to determine if the effects were consistent or varied across different populations and settings, allowing for subgroup analysis to tailor interventions appropriately based on unique needs. Finally, now that COVID-19 is no longer classified as a global health emergency (WHO, 2023), a follow-up review focusing on mental health outcomes, physical health outcomes, and both proximal and distal risk factors across all languages would offer a more comprehensive understanding of the COVID-19 pandemic, beyond the scope of our review, which focused primarily on the initial wave.

Conclusion

In conclusion, this global review, conducted in both English and Spanish, demonstrated that early COVID-19 research primarily focused on mental health outcomes such as anxiety, depression, and stress, using validated tools, with a particular emphasis on females in North America and Asia. Limited research also explored health behaviors such as alcohol consumption, physical activity, and other lifestyle changes, although these were not assessed using validated instruments.

Declarations of Interest: The authors declare no conflicts of interest.

Funding and Acknowledgment of Agency Support: No funding was received for this study.

Disclosure Statement: The authors declare no conflicts of interest.

Ethical Approval: N/A

Authorship contribution statement: Authors Mckenna Brownell and Joshua Yudkin contributed to project ideation, analysis, writing, and editing, while author Rebecca Jungbauer was responsible for analyzing, writing, and editing. Matthew Smith provided significant edits to the manuscript.

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COVID-19. *Frontiers in psychiatry*. 915.

Appendix 1: Supplemental Material

Search Strategies

PubMed: ("University Student" OR "College student") AND ("Wellbeing Study" OR "mental health" OR "health needs" OR "health conditions" OR "health preferences") AND (Covid-19 OR coronavirus OR "sars-cov2")

Scopus: ("University Student" OR "College student") AND ("Wellbeing Study" OR "mental health" OR "health needs" OR "health conditions" OR "health preferences") AND (Covid-19 OR coronavirus OR "sars-cov2")

ScienceDirect: ("University Student" OR "College student") AND ("Wellbeing Study" OR "mental health" OR "health needs" OR "health conditions" OR "health preferences") AND (Covid-19 OR coronavirus OR "sars-cov2")

Spanish terms: (Covid-19 OR Sars-Cov-2 OR coronavirus) AND (salud OR bienestar OR "calidad de vida") AND ("estudiante universitario")

Excluded Studies List

Article	Exclusion Reason
Morote-Jayacc PV, Sandoval KD, Moreno-Molina M, Taype-Rondan Á. Mental Health Studies in Medical Students in the Context of COVID-19. <i>Rev Colomb Psiquiatr (Engl Ed)</i> . 2020 Oct-Dec;49(4):223-224. English, Spanish. doi: 10.1016/j.rcp.2020.07.005. Epub 2020 Oct 3. PMID: 33328011; PMCID: PMC7532760.	Not specific health outcomes
Yumeng Shi, Alyse Davies, Margaret Allman-Farinelli, The Association Between Food Insecurity and Dietary Outcomes in University Students: A Systematic Review, <i>Journal of the Academy of Nutrition and Dietetics</i> , 2021, ISSN 2212-2672, https://doi.org/10.1016/j.jand.2021.07.015 .	Not about COVID-19
Karaşar B, Canli D. Psychological Resilience and Depression during the Covid-19 Pandemic in Turkey. <i>Psychiatr Danub</i> . 2020 Summer;32(2):273-279. doi: 10.24869/psyd.2020.273. PMID: 32796798.	Not about university students

Chang J, Yuan Y, Wang D. [Mental health status and its influencing factors among college students during the epidemic of COVID-19]. <i>Nan Fang Yi Ke Da Xue Xue Bao</i> . 2020 Feb 29;40(2):171-176. Chinese. doi: 10.12122/j.issn.1673-4254.2020.02.06. PMID: 32376528; PMCID: PMC7086131.	Article not available in English
Liu CH, Pinder-Amaker S, Hahm HC, Chen JA. Priorities for addressing the impact of the COVID-19 pandemic on college student mental health. <i>J Am Coll Health</i> . 2022 Jul;70(5):1356-1358. doi: 10.1080/07448481.2020.1803882. Epub 2020 Oct 13. PMID: 33048654; PMCID: PMC8041897.	Not study design
Adrián García Ron, Isabel Cuéllar-Flores, Impacto psicológico del confinamiento en la población infantil y como mitigar sus efectos: revisión rápida de la evidencia, <i>Anales de Pediatría</i> , Volume 93, Issue 1, 2020, Pages 57-58, ISSN 1695-4033, https://doi.org/10.1016/j.anpedi.2020.04.015 .	Not university setting
Alexopoulos AR, Hudson JG, Otenigbagbe O. The Use of Digital Applications and COVID-19. <i>Community Ment Health J</i> . 2020 Oct;56(7):1202-1203. doi: 10.1007/s10597-020-00689-2. Epub 2020 Jul 30. PMID: 32734311; PMCID: PMC7391475.	Not study design
Cislo C, Clingan C, Gilley K, Rozwadowski M, Gainsburg I, Bradley C, Barabas J, Sandford E, Olesnavich M, Tyler J, Mayer C, DeMoss M, Flora C, Forger DB, Cunningham JL, Tewari M, Choi SW. Monitoring beliefs and physiological measures in students at risk for COVID-19 using wearable sensors and smartphone technology: Protocol for a mobile health study. <i>JMIR Res Protoc</i> . 2021 Jun 4;10(6):e29561. doi: 10.2196/29561. Epub ahead of print. PMID: 34115607; PMCID: PMC8386373.	Not study design
Cristian Ramos-Vera, Las relaciones dinámicas de red de la obsesión y la ansiedad ante la muerte por COVID-19 durante la segunda cuarentena en universitarios peruanos, <i>Revista Colombiana de Psiquiatría</i> , Volume 50, Issue 3, 2021, Pages 160-163, ISSN 0034-7450, https://doi.org/10.1016/j.rcp.2021.03.004 .	Not study design
D. Fernandez-Villacorta, A.N. Soriano-Moreno, T. Galvez-Olortegui, N. Agui-Santivañez, D.R. Soriano-Moreno, V.A. Benites-Zapata, Síndrome visual informático en estudiantes universitarios de posgrado de una universidad privada de Lima, Perú, <i>Archivos de la Sociedad Española de Oftalmología</i> , Volume 96, Issue 10, 2021, Pages 515-520, https://doi.org/10.1016/j.ofal.2020.12.003 .	Not about COVID-19
Durán Acevedo CM, Carrillo Gómez JK, Albarracín Rojas CA. Academic stress detection on university students during COVID-19 outbreak by using an electronic nose and the galvanic skin response. <i>Biomed Signal Process Control</i> . 2021 Jul;68:102756. doi: 10.1016/j.bspc.2021.102756. Epub 2021 May 11. PMID: 36570516; PMCID: PMC9760229.	Not about health outcomes
E. Paz-Maldonado, Honduras: estudiantes universitarios en situación de discapacidad durante la COVID-19, <i>Fisioterapia</i> , 2021, ISSN 0211-5638, https://doi.org/10.1016/j.ft.2021.05.002 .	Not study design
Elena Bermejo-Martins, Elkin O. Luis, Pablo Fernández-Berrocal, Martín Martínez, Ainize Sarrionandia, The role of emotional intelligence and self-care in the stress perception during COVID-19 outbreak: An intercultural moderated mediation analysis, <i>Personality and Individual Differences</i> , Volume 177, 2021, 110679, ISSN 0191-8869, https://doi.org/10.1016/j.paid.2021.110679 .	Not about university students

Khademian F, Aslani A, Ravangard R, Bastani P, Nami M, Jafari P. Efficacy of a web application for stress management among Iranian college students during COVID-19 outbreak: a study protocol for randomized controlled trials. <i>Trials</i> . 2020 Dec 14;21(1):1023. doi: 10.1186/s13063-020-04949-0. PMID: 33317615; PMCID: PMC7734615.	Not about health outcomes
Konstantinos N Fountoulakis, Maria K. Apostolidou, Marina B. Atsiova, Anna K. Filippidou, Angeliki K. Florou, Dimitra S. Gousiou, Aikaterini R. Katsara, Sofia N. Mantzari, Marina Padouva-Markoulaki, Evangelia I. Papatriantafyllou, Panagiota I. Sacharidi, Aikaterini I. Tonia, Eleni G. Tsagalidou, Vasiliki P. Zymara, Panagiotis E Prezerakos, Sotirios A. Koupidis, Nikolaos K. Fountoulakis, George P. Chrousos, Self-reported changes in anxiety, depression and suicidality during the COVID-19 lockdown in Greece, <i>Journal of Affective Disorders</i> , Volume 279, 2021, Pages 624-629, ISSN 0165-0327, https://doi.org/10.1016/j.jad.2020.10.061 .	Not about university students
Mazzucchelli R, Agudo Dieguez A, Dieguez Costa EM, Crespi Villarias N. Democracia y mortalidad por Covid-19 en Europa [Democracy and Covid-19 mortality in Europe.]. <i>Rev Esp Salud Publica</i> . 2020 Jun 24;94:e202006073. Spanish. PMID: 32576811.	Not about health outcomes
Md. Estiar Rahman, Abdullah Al Zubayer, Md. Rifat Al Mazid Bhuiyan, Mary C. Jobe, Md. Kamrul Ahsan Khan, Suicidal behaviors and suicide risk among Bangladeshi people during the COVID-19 pandemic: An online cross-sectional survey, <i>Heliyon</i> , Volume 7, Issue 2, 2021, e05937, ISSN 2405-8440, https://doi.org/10.1016/j.heliyon.2021.e05937 .	Not about university students
Mervin Joe Thomas, Vishnu Lal, Ajith Kurian Baby, Muhammad Rabeeh VP, Alos James, Arun K. Raj, Can technological advancements help to alleviate COVID-19 pandemic? a review, <i>Journal of Biomedical Informatics</i> , Volume 117, 2021, 103787, ISSN 1532-0464, https://doi.org/10.1016/j.jbi.2021.103787 .	Review; not about health outcomes
Patricio Burdiles, Armando Ortiz Pommier, EL TRIAJE EN PANDEMIA: FUNDAMENTOS ÉTICOS PARA LA ASIGNACIÓN DE RECURSOS DE SOPORTE VITAL AVANZADO EN ESCENARIOS DE ESCASEZ, <i>Revista Médica Clínica Las Condes</i> , Volume 32, Issue 1, 2021, Pages 61-74, ISSN 0716-8640, https://doi.org/10.1016/j.rmcl.2020.12.004 .	Not about university students
Pedro J. Alcalá Minagorre, Enrique Villalobos Pinto, José Miguel Ramos Fernández, Rosa Rodríguez-Fernández, Miguel Vázquez Ronco, Luis Escosa-García, Juan Ignacio Montiano Jorge, Juan José García García, Cambios a partir de la COVID-19. Una perspectiva desde la pediatría interna hospitalaria, <i>Anales de Pediatría</i> , Volume 93, Issue 5, 2020, Pages 343.e1-343.e8, ISSN 1695-4033, https://doi.org/10.1016/j.anpedi.2020.06.004 .	Not about university students
Perz CA, Lang BA, Harrington R. Validation of the Fear of COVID-19 Scale in a US College Sample. <i>Int J Ment Health Addict</i> . 2020 Jun 25;1-11. doi: 10.1007/s11469-020-00356-3. Epub ahead of print. PMID: 32837435; PMCID: PMC7315905.	Not about health outcomes (validation study)
Ritvo P, Ahmad F, El Morr C, Pirbaglou M, Moineddin R; MVC Team. A Mindfulness-Based Intervention for Student Depression, Anxiety, and Stress: Randomized Controlled Trial. <i>JMIR Ment Health</i> . 2021 Jan 11;8(1):e23491. doi: 10.2196/23491. Erratum in: <i>JMIR Ment Health</i> . 2021 Jan 25;8(1):e27160. PMID: 33264098; PMCID: PMC7833974.	Wrong time period (pre-COVID)
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Supplemental Table 1.*List of validated instrument tools that were used more than once across studies*

Tool	Frequency Used
GAD-7, General Anxiety Disorder-7	18
PHQ-9, Patient Health Questionnaire 9-question	14
PSS-10, 10-item Perceived Stress Scale	10
SAS, Self-rating Anxiety Scale	6
IES-R, Impact of Event-Scale-Revised	4
BDI-II, Beck Depression Inventory-II	4
DASS-21, Depression Anxiety Stress Scale-21	4
UCLA-LS-3, University of California, Los Angeles 3-item Loneliness Scale	4
PHQ-8, Patient Health Questionnaire 8-question	3
KPDS-10, 10-item Kessler Psychological Distress Scale	3
STAI-S-20, 20-item State-Trait Anxiety Inventory (State subscale)	3
AUDIT(-C), Alcohol Use Disorders Identification Test (-Concise)	2
PCL-C, PTSD Checklist - Civilian Version	2
PANAS, Positive and Negative Affect Schedule	2
GSRH, General Self-Rated Health	2
CES-D, Center for the Epidemiological Studies-Depression	2
*Other	50

*Other in this case refers to tools that were only used one time across all the studies (see Supplement Table 2).

Supplemental Table 2.*List of validated measurement tools that were used only once across all studies*

1. 3-PSCS, Three-Factor Psychological Sense of Community Scale
2. ASSIS, Acculturative Stress Scale for International Students
3. AIS, Athens Insomnia Scale
4. BMMRS, Brief Multidimensional Measurement of Religiousness and Spirituality
5. BPM, Brief Problem Monitor
6. BRS, Brief Resilience Scale
7. B-MACQ, Brief Marijuana Consequences Questionnaire
8. B-YAACQ, Brief Young Adult Alcohol Consequences Questionnaire
9. BSI, Brief Symptom Inventory
10. CCAPS-J, Counseling Center Assessment of Psychological Symptoms-Japanese
11. CPSS, Chinese perceived stress scale
12. CES-D, Center for the Epidemiological Studies-Depression
13. CISS, Coping Inventory for Stressful Situations
14. CAS, Coronavirus Anxiety Scale
15. CSS, COVID-19 Stress Scale
16. CAMM, Child and Adolescent Mindfulness Measure
17. CIDI, Composite International Diagnostic Interview Screening Scales
18. DDQ, Daily Drinking Questionnaire
19. DSM-5 CCSM, DSM-5 Level 1 Cross-Cutting Symptom Measure
20. E-RRI, Event-Related Rumination Inventory
21. FCV-19S, Seven-item Fear of COVID-19 Scale
22. GHQ-12, General Health Questionnaire
23. GHQ-28, General Health Questionnaire
24. GQ-6, Gratitude questionnaire-6
25. HAD, Hospital Anxiety and Depression
26. HAI, Health Anxiety Inventory
27. IES-6, Impact of Event Scale-6
28. ISI, Insomnia Severity Index
29. MUG, Marijuana Use Grid

30. MHLCS, Multidimensional Health Locus of Control Scale
31. MHI-5, Mental Health Inventory-5
32. NIAAA-RAQ, National Institute on Alcohol Abuse and Alcoholism's Task Force on Recommended Alcohol Questions
33. PIC, Perceived Impact of Coronavirus
34. PAQ, Physical Activity Questionnaire
35. PSQ, Physical Self Questionnaire
36. PSQI, Pittsburgh Sleep Quality Index
37. PTSD, posttraumatic stress disorder
38. PC-PTSD, Primary Care PTSD
39. RLS, Reactions to Loss Scale
40. RES, Regulatory Emotional Self-efficacy scale
41. SWEMWBS, Short-Warwick Edinburgh Mental Well-Being Scale
42. SWLS, Satisfaction With Life Scale
43. SPSS, Scale of Perceived Social Support
44. STSS-SM, 17-item Secondary Traumatic Stress Scale for Social Media Users
45. SH-SI, Self-Harm or Suicidal Ideation
46. SRQ-20, Self-Reporting Questionnaire-20
47. SES, socioeconomic status
48. SCL-90, Symptom Checklist
49. WMH-CIDI, World Mental Health-CIDI
50. Y-BOCS, Yale-Brown Obsessive Compulsive Disorder

Supplemental Table 3.*Risk of Bias Assessment - Cohort Studies*

Author, Year	Did the Study Attempt To Enroll All (or a Random Sample of) Patients Meeting Inclusion Criteria (Inception Cohort), or a Consecutive Sample?	Were the Groups Comparable at Baseline on Key Prognostic Factors? (5 Years for Age, <10% for Others)	Did the Study Use Accurate Methods for Ascertaining Exposures and Potential Confounders (i.e., Age, Sex, Other Medications) ?	Were Outcome Assessors and/or Data Analysts Blinded to the Intervention Being Studied?	Did the Article Report Attrition or Missing Data?	Is There Important Differential Loss to Followup (<10%) or Overall High Loss to Followup (<20%) or Missing Data?	Did the Study Perform Appropriate Statistical Analyses on Potential Confounders (i.e., Age, Sex, Underlying Health)?	Were Outcomes Prespecified and Defined, and Ascertained Using Accurate Methods?	Assessment of Bias Low/Moderate/High
Copeland et al. (January 2021)	Yes	Yes	Yes	Unclear	Yes	No on main outcomes; yes on nightly mood	Yes, but data not provided	Yes	Moderate
Giusti et al. (December 2021)	Yes	Yes	Yes	Unclear	Yes	No	Yes	Yes	Low
Hood et al. (March 2021)	Yes	Yes	Yes	Unclear	NA; different samples	Unclear	Yes	Yes	Moderate

Author, Year	Did the Study Attempt To Enroll All (or a Random Sample of) Patients Meeting Inclusion Criteria (Inception Cohort), or a Consecutive Sample?	Were the Groups Comparable at Baseline on Key Prognostic Factors? (5 Years for Age, <10% for Others)	Did the Study Use Accurate Methods for Ascertaining Exposures and Potential Confounders (i.e., Age, Sex, Other Medications) ?	Were Outcome Assessors and/or Data Analysts Blinded to the Intervention Being Studied?	Did the Article Report Attrition or Missing Data?	Is There Important Differential Loss to Followup (<10%) or Overall High Loss to Followup (<20%) or Missing Data?	Did the Study Perform Appropriate Statistical Analyses on Potential Confounders (i.e., Age, Sex, Underlying Health)?	Were Outcomes Prespecified and Defined, and Ascertained Using Accurate Methods?	Assessment of Bias Low/Moderate/High
Horita et al. (January 2021)	Yes	Unclear	Yes	Unclear	NA; retrospective	Unclear	Yes	Yes	Moderate
Hoyt et al. (February 2021)	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Moderate
Ji et al. (September 2020)	Yes	No	Yes	Unclear	Yes	Yes	Yes	Yes	High
Li et al. (February 2021)	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Moderate

Author, Year	Did the Study Attempt To Enroll All (or a Random Sample of) Patients Meeting Inclusion Criteria (Inception Cohort), or a Consecutive Sample?	Were the Groups Comparable at Baseline on Key Prognostic Factors? (5 Years for Age, <10% for Others)	Did the Study Use Accurate Methods for Ascertaining Exposures and Potential Confounders (i.e., Age, Sex, Other Medications) ?	Were Outcome Assessors and/or Data Analysts Blinded to the Intervention Being Studied?	Did the Article Report Attrition or Missing Data?	Is There Important Differential Loss to Followup (<10%) or Overall High Loss to Followup (<20%) or Missing Data?	Did the Study Perform Appropriate Statistical Analyses on Potential Confounders (i.e., Age, Sex, Underlying Health)?	Were Outcomes Prespecified and Defined, and Ascertained Using Accurate Methods?	Assessment of Bias Low/Moderate/High
Post et al. (September 2021)	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Moderate
Prokes et al. (February 2021) ^a	Yes	Unclear	Yes	Unclear	Unclear	Unclear	Yes	Yes	High
Saraswathi et al. (October 2020)	Yes	No on sex, yes on everything else	Yes	Unclear	Yes	No	Yes	Yes	Moderate