



E-learning during COVID-19 and anxiety levels among university students: a systematic review

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Background: E-learning was widely used in universities during the COVID-19 epidemic to guarantee students' ongoing education and learning. This systematic review summarizes and synthesizes evidence elucidating the association between e-learning during the COVID-19 pandemic and anxiety among university students.

Methods: A systematic search from five databases (PubMed, Wiley, Science Direct, EBSCO, and Scopus) was done, with the last search conducted on the 30th of November 2021. Full-text English articles published from November 2019 to November 2021. Mostly cross-sectional study designs were included, excluding non-peer-reviewed documents and non-English language studies. The data was recorded in the data extraction form, and all seven articles were assessed for quality using the Joanna Briggs Institute (JBI) Checklist for Analytical Cross-Sectional studies.

Results: The search yielded seven eligible articles, with a total of 12,481 participants. Four articles aimed to determine the direct association between e-learning and anxiety levels. While three aimed to identify e-learning as a potential stressor during the COVID-19 pandemic, which is associated with anxiety levels. Five different tools were used to measure anxiety in the chosen articles. Four out of seven articles reviewed in this systematic review concluded that e-learning was significantly associated with anxiety. The remaining three found no association. Several factors were found to be associated with anxiety due to e-learning: females, sex/gender minorities, younger students, medical students, and staying alone.

Conclusions: University students reported mild to high levels of anxiety during the COVID-19 pandemic. The effect of e-learning on anxiety levels is determined by the diverse socio-demographic backgrounds. Internet connectivity and facilities also contributed to anxiety levels during e-learning. Limitations of this review include selection bias, small sample size, and the cross-sectional study designs, which could not establish a causal relationship. Evidence from stronger study designs is needed to confirm the association and establish a causation link of anxiety due to e-learning methods.

Keywords: E-learning; anxiety; university; students; COVID-19

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Introduction

Background

The COVID-19 pandemic has negatively impacted the livelihood of many. This includes university students studying remotely, who are at high risk of poor mental health. Nevertheless, studying remotely proved beneficial to some students, as it allowed them to spend more time at home in a comfortable environment with continuous access to online learning materials (1). As reported in a study done across seven states in the United States, psychological impacts on university students were at high levels (2). Lack of motivation, anxiety, stress, isolation, and worry due to the COVID-19 pandemic were among the reported factors attributed to their changing emotions. This is evidenced by a study in Saudi Arabia, where 35% of university students showed signs of moderate to severe anxiety during the epidemic (3).

Rationale and knowledge gap

Universities all over the world utilized electronic learning (e-learning), otherwise known as distance learning, to assure the continuity of delivery of higher education. However, home quarantine measures, necessitated by the pandemic, increased depression, anxiety, and stress levels among undergraduate students, as observed in a study done among 1,380 university students in Jordan (4).

Similar psychological changes were seen among students in Indonesia (5), Lebanon (6), and Italy (7).

Furthermore, acclimatizing to the change toward e-learning creates new obstacles for students. These include increased work and information received from lecturers, the inability to afford devices to support their online studies, namely laptops or internet access, as well as health issues, such as pre-existing anxiety or stress disorders, which may worsen due to the implementation of a new form of learning (8).

Nevertheless, different students possess individualized perceptions regarding the utilization of e-learning. Some perceive it as a convenient alternative and are more comfortable with electronic devices for e-learning. A study conducted among 40 undergraduate health students found that returning to online classes decreased depressive symptoms among students (9). Not only that, but student satisfaction with distance learning also was found to be one of the predictors of anxiety, depression, and stress symptoms (6). Therefore, this systematic review was conducted with the research question in mind: do e-learning methods during COVID-19 affect the anxiety levels among university students?

Objective

This review aimed to summarize and synthesize evidence to elucidate the association between e-learning during the early years of COVID-19 pandemic (November 2019 to November 2021) and the prevalence of anxiety among university students. A more comprehensive understanding of the subject matter would encourage policymakers, stakeholders and teachers involved in formulating teaching methods for students to take into account the mental health of students, especially during this pandemic. If policymakers, stakeholders, and teachers had a deeper awareness of this topic, they might be more inclined to include students' mental health when developing instructional strategies, particularly during pandemics. We present this article in accordance with the PRISMA reporting checklist (available at <https://jphe.amegroups.com/article/view/10.21037/jphe-22-61/rc>).

Methods

Search strategy

A systematic approach comprising searching, screening, reviewing, and data extraction was applied based on the Preferred Reporting Items for Systematic Review (PRISMA)

Highlight box

Key findings

- This review found studies that identified an association between e-learning and anxiety levels among university students.
- The effect of e-Learning on anxiety levels is determined by the diverse socio-demographic backgrounds, internet connectivity and facilities.

What is known and what is new?

- Higher education institutions utilized electronic learning (e-learning) to assure the continuity of delivery of education during the COVID-19 pandemic.
- University students reported mild to high levels of anxiety during the COVID-19 pandemic.

What is the implication, and what should change now?

- Anxiety could affect student's academic performance and their health in general.
- Higher education institutions should evaluate their students for mental health issues, including e-learning-related anxiety.

2020 guidelines (10). A multi-stage process, beginning with a highly sensitive search to identify relevant literature, was procured with multiple hits. A comprehensive search strategy was implemented when searching five medical databases: EBSCO, Wiley, Science Direct, PubMed, and Scopus related to e-learning during COVID-19 and anxiety levels among university students. Six investigators performed the search independently (JJP Amalaraj, TA Saminathan, TG Robert Lourdes, NA Mohd Yusoff, MAA Al-Malaiki, MAF Abdul Aziz). One author searched all electronic databases, and another author replicated the search. The databases were fully accessible. Articles published within the time frame of the COVID-19 pandemic, between November 2019 and November 2021, were searched. The last search was conducted on the 30th of November 2021. Manual searching among references found in the electronic search was also performed. Predefined search terms determined by the Medical Subject Headings (MeSH) and keywords were used for the search. The combination of keywords used, and the Boolean search performed for each database was included in our search strategy, which can be found in [Appendix 1](#) and [Appendix 2](#). A total of 2,031 articles were found from the search of the mentioned databases.

Inclusion and exclusion criteria for screening

This review includes full-text English articles published in journals and only observational studies, primarily cross-sectional study designs. We performed the search for studies published in the past three years, from November 2019–November 2021. We included articles whose participants were of the adult population attending institutes of higher education. The exposure of interest is online learning, distance learning, or e-learning platforms, which is learning done by studying at home using computers or any technological gadgets, and courses provided on the internet during the COVID-19 pandemic. The outcome of interest was the level of anxiety among our population of interest. Only studies that discussed “anxiety/anxiousness” among university students were chosen for the review. We excluded non-peer-reviewed documents (i.e., protocols, abstracts, news, reports, short communication, letters to the editor, etc.), non-English language studies, and studies that have investigated e-learning with anxiety, not as the outcome. The search results were managed using EndNote Version X9 to export references from databases, store full-text articles, insert citations into Word documents, format referencing style, and identify duplicate articles from different databases.

After removing nine duplicates, a total of 37 abstracts and full texts of articles were reviewed. Three pairs of reviewers (JJP Amalaraj, TA Saminathan) (TG Robert Lourdes, NA Mohd Yusoff) (MAA Al-Malaiki, MAF Abdul Aziz) independently screened the titles and abstracts according to the inclusion and exclusion criteria using the Rayyan systematic review software [Ouzzani *et al.* (11)]. Any disagreements were resolved through discussions with a third reviewer (RA Zaki). Between December 1st, 2021, and January 15th, 2022, data were extracted from the finalized articles using a standardized data extraction form and tabulated using Microsoft Excel.

Quality appraisal and risk of bias in individual studies

Joanna Briggs Institute’s (JBI) Critical Appraisal tool was used to critique the articles in this review. JBI assists in determining the quality of the study and in examining the potential risk of bias in terms of study design, methodology, and analysis. JBI Checklist for Analytical Cross-Sectional Studies utilized in this review contains eight questions to guide the appraisal process. The questions assess the inclusion criteria, description of subjects and settings, measurement of the exposures, measurement of the condition, identification of confounders, strategies to overcome confounders, measurement of the outcome, and statistical analysis used in the study.

Analyses

We conducted a descriptive analysis of the included articles, the characteristics of which were described in detail. This includes details of the authors, year of publication, location, and duration of the study, tools used, the mean age of the respondents, gender, ethnicity, residence while studying, study design, sample size, field and level of analysis, funding of the respondents’ studies and internet connectivity as summarized in *Table 1*. *Table 1* also describes the implementation of e-learning (mode and frequency), outcome (anxiety levels and tools of measurement), and the summary of the studies’ main findings.

Results

Characteristics of included studies

An initial search was conducted in November 2021 using five databases: PubMed, Scopus, Science Direct, Wiley, and EBSCO. The search yielded a total of 2,031 publications.

Table 1 Characteristics of included studies

Author/year, location & duration	Study design, sample size (N)	Measurement tools used	Participant characteristics							Summary of main findings
			Age, year	Male	Female	Ethnicity	Residence while studying	Academic information: field & level of study	Internet connectivity	
Alqudah <i>et al.</i> , 2021, Jordan; April–May 2020	Cross-sectional (N=736)	Hamilton Anxiety Scale (HAM-A); Online questionnaire using Google Form, distributed across social media (Facebook, WhatsApp)	Mean =20.9 (SD =2.2)	24.9%	75.1%	NA	City =78.9%, countryside =21.1%, more than 300 m ² =22.4%	Health-related (64.1%), Others (35.9%)	NA	(I) Significantly high between anxiety level with distance learning during COVID-19; mean score 23.72 (SD 11.29), P value <0.05 (II) Cause affected students: (i) Increase in workload while distance learning (ii) Negatively affected interaction with and acquisition of information (iii) Assessment and evaluation system implemented during the lockdown has been both frustrating and unfair
Fruehwirth <i>et al.</i> , 2021, North Carolina, USA; (October 2019–February 2020) and after (June/July 2020)	Longitudinal study (N=472)	Generalized anxiety disorder scale (GAD-7); Online questionnaire; email to first-year college students	Mean =18.9 (SD =0.1)	NA	NA	Non-Hispanic White =61.6%, non-Hispanic Black =6.7%, non-Hispanic Asian =18.1%, Hispanic =8.4%	Home	First-year students	NA	(I) Moderate-severe anxiety increased from 18.1% (pre-pandemic) to 25.3% within four months (II) White, female and sexual/gender minority (SGM) students have the highest risk of an increase in anxiety symptoms (III) General difficulties associated with distance learning contributed to the increase in anxiety symptoms
Moy and Ng, 2021, Malaysia; April–June 2020	Cross-sectional (N=367)	Depression, Anxiety and Stress Scale - 21 Items (DASS-21); Online questionnaire via RedCap platform; DASS-21	Median age =23	21.6%	78.4%	Malay =37.4%; Chinese =39.9%; Indian =11.2%; Sikh =1.4%; Bumiputera =2.5%; International =7.7%	Hometown =56.3%; own/rented accommodation near university =28.1%; hostel =8.5%; home country =7.1%	Tertiary education	48.9% good	(I) The level of anxiety was 51.3% (95% CI: 45.6%, 57.0%) (II) Most participants had good perception towards e-learning but negative perception on COVID-19 (III) From the multivariate analysis, participants with a positive perception on COVID-19 were protective towards anxiety (aOR: 0.94, 95% CI: 0.90, 0.98) (IV) Older students were 14% (aOR: 0.86, 95% CI: 0.79, 0.94) less likely to have anxiety (V) Perception of e-learning was not associated with mental health status (anxiety)
Saddik <i>et al.</i> , 2020, United Arab Emirates; 11 March–21 March 2020	Cross-sectional (N=1,385)	Generalized anxiety disorder scale (GAD-7); Online questionnaire: survey link through their university email, WhatsApp and other social media platforms using snowball sampling	Mean =20.5 (SD =2.3)	28.20%	71.80%	NA	NA	Medical, dental, non-medical	NA	(I) The median GAD-7 scores for students before the introduction of online learning was 4 and after online learning was 3 (II) Females reported higher levels of anxiety in GAD-7, both before and after online learning (III) The medical students reported higher levels of anxiety before online learning in comparison to non-medical students (IV) After switching to online learning, anxiety levels significantly decreased for females and for medical students whilst non-medical students reported higher levels of anxiety
Sundaresan <i>et al.</i> , 2020, Malaysia; 20 April–24 May 2020	Cross-sectional (N=983)	Zung's self-rating anxiety scale (ZSAS); Online questionnaire using Google Forms, sent to students via WhatsApp messages, with periodic reminders	17–18 years =3.8%, 19–25 years =85.0%, >25 years =11.2%	33.60%	66.40%	Malay =46.0%, Chinese =21.9%, Indian =27.5%, East Malaysian =4.3%	Currently staying with: alone =4.3%, friends =8.4%, family =87.3%. Current accommodation: outside campus =5.5%, residency =8%, family home =86.5%	Public Institution =50.6%, Private Institution =49.4%. Field of study: Pre-University =3.9%, Management Studies =30%, Sciences =26.3%, Arts/Communication/Languages =12%, Health Sciences =27.8%. Level of study: Pre-University =5.5%, Diploma/Certificate =11%, Degree =72.6%, Postgraduate =10.9%	NA	(I) Demography significantly associated with higher levels of anxiety: (P value significant) (i) Female gender (OR =2.261, 95% CI: 1.248, 4.100, P=0.007) (ii) Age below 18 years (OR =4.147, 95% CI: 1.331, 12.918, P=0.014) (iii) Age 19 to 25 (OR =3.398, 95% CI: 1.431, 8.066, P=0.006) (iv) Pre-university level of education (OR =2.882, 95% CI: 1.212, 6.854, P=0.017) (v) Management studies (OR =2.278, 95% CI: 1.526, 3.399, P<0.001) (vi) Staying alone (OR =2.208, 95% CI: 1.127, 4.325, P=0.021) (II) Virtual Education as a cause for anxiety (P=0.295, not significant) Mild to moderate anxiety =5.5%; moderate to severe anxiety =2.8% (III) Qualitative feedback: Remote online classes identified as common stressors. Technological infrastructure challenges, poor internet connection and using long hours of mobile phones (6–8 hours/day) Instructors still use the same curricula and learning outcomes meant for face-to-face teaching Adjustment of distance learning - isolated from friends causes frustration, anger, resentment and ultimately, anxiety (IV) Limitations Period of data collection from April to May, 2020—most students moved back to their family homes

Table 1 (continued)

Table 1 (continued)

Author/year, location & duration	Study design, sample size (N)	Measurement tools used	Participant characteristics							Summary of main findings
			Age, year	Male	Female	Ethnicity	Residence while studying	Academic information: field & level of study	Internet connectivity	
Wang <i>et al.</i> , 2020, China; (February 15 to 17, 2020), and (March 15 to 17 2020)	Longitudinal study (N=1,172)	Zung's self-rating anxiety scale (ZSAS). Self-Rating Anxiety Scale (ZSAS)	Range =18 to 22	39.10%	60.90%	Chinese =100.0%	NA	Non-graduating undergraduate students (arts or sciences)	NA	(I) Mild anxiety in the second study (N=151, 12.88%) than in the first study (N=117, 9.98%); (II) Roughly the same number of students with moderate anxiety; but more students with severe anxiety in the second study (N=18, 1.54%) than the first one (N=13, 1.11%)
Yaghi <i>et al.</i> , 2021, Jordan; (February & May 2020), (August & December 2020) and February 2021)	Longitudinal study (N=6,242)	Generalized anxiety disorder scale (GAD-7); Online survey distributed by email	Range =18 to 22	43.00%	57.00%	Local citizens =86.0%, expatriates =14.0%	Living in urban area 1,095 (86.0%), living in rural area 178 (14.0%)	Freshman =23.0%; sophomore =22.0%; junior =19.0%; senior =26.0%; first year Master's degree =7.0%; second year Master's degree =3.0%	Has monthly Internet package 1,044 (82.0%), does not have monthly Internet package 356 (28.0%)	(I) General nervous, anxious, on edge (mean score =16.11); cannot stop worrying (mean score =18.73); feeling suspicious/uncertain of future (mean score =16.31) (II) Moderate anxious: trouble in relaxing (mean score =12.75) and feeling restless (mean score =11.93) (III) Results indicate that stress level is high (aggregate mean score =2.8): Feeling stressed and nervous (mean score =3.8) Feeling upset (mean score =3.8) Feeling one is not in control of things (mean score =3.2) Inability to cope with things (mean score =3.2)

SD, standard deviation; NA, not applicable; COVID-19, coronavirus disease 2019; 95% CI, 95% confidence interval; aOR, adjusted odds ratio; OR, odds ratio.

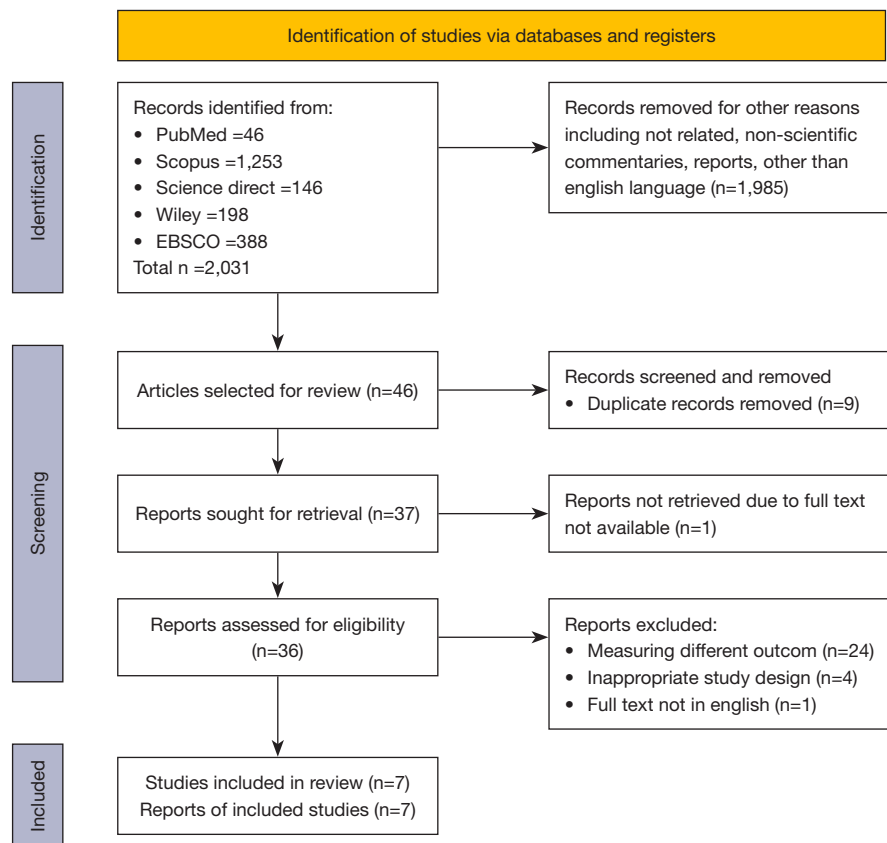


Figure 1 Study selection process shown by PRISMA 2020 flow diagram (10).

After excluding 1,985 articles that did not meet the criteria, 46 articles were available for this review. After removing nine duplicates, a total of 37 abstracts and full texts of articles were reviewed and included for the first screening. The selection process and the number of articles excluded at each stage were shown in the PRISMA flow diagram (Figure 1). Reasons as to why articles were excluded after reviewing are also stated in Figure 1.

A total of seven (n=7) studies with a total of 12,481 participants were included in this systematic review. The study characteristics are shown in Table 1. The included studies were conducted in Jordan (n=2) (12,13), United States (n=1) (14), Malaysia (n=2) (15,16), United Arab Emirates (n=1) (17) and China (n=1) (18). Four were cross-sectional (analytical) studies, while the remaining three were longitudinal observational studies.

Four out of seven studies were conducted within three months (12,15-17), while another three studies were conducted over two time periods, respectively (13,14,18) (Table 1). The most common study design was cross-

sectional (n=4), followed by longitudinal studies (n=3). Among the seven studies in this review, four studies specified that they aimed to determine the association between online learning with anxiety levels (13,15,16,18). The remaining three studies aimed to identify online learning as a potential stressor of COVID-19 and associated with anxiety levels (12,14,17) (Table 1).

Characteristics of participants

Age

The study by Sundarasan *et al.* included those >25 years of age (16), while Moy and Ng documented a median age of 23 among participants (15). However, most participants included in this study had a mean age range of 18 to 21 years, as reported in Table 1.

Gender

All studies had a higher proportion of female respondents than males. Two studies recorded three times more females

than males (12,15). Saddik *et al.* saw 2.5 female respondents for one male respondent (17). The remaining studies (13,16,18) had 1.34, 1.56, and 1.97 female respondents for every male respondent, respectively.

Ethnicity

The ethnicity profile varies from study to study due to geographic distributions, and generalizations could not be made. Most of the studies reflected the number of respondents as per the local population where the study was conducted. Fruehwirth *et al.*, in North Carolina USA, recorded 61% of non-Hispanic white respondents (14), while Yaghi, recorded the participation of 86% of local respondents compared to expatriates (13). Two studies conducted in Malaysia (15,16) documented respondents of primarily Malay respondents, followed by Chinese, Indian, and East Malaysians. No information regarding ethnicity was obtained from the remaining studies (12,17).

Residence while studying

Many participants were living in their hometowns and the city. Alqudah *et al.* noted that over 78% of respondents in their study live in the city (12). This is reflected in another study population, where 86% of respondents live in an urban setting (13). The two studies conducted in Malaysia (15,16) reported that 87.3% and 56.3% of respondents respectively are living in their hometowns. While less than 10% of them live in campus residencies during the e-learning period.

Academic information

Field & level of study: the academic information in the studies was not uniform. Two studies (12,17) obtained respondents specifically from health-related and non-health-related fields. Furthermore, Sundarasan *et al.* reported respondents primarily from the management studies field, followed by health sciences and sciences (16). Over half of the total respondents (72.6%) were from degree programs and 50.6% from public institutions. Information regarding public or private universities was not discussed in the other studies.

Funding

Only one study by Moy and Ng gathered information regarding tuition fee funding, with one-third of respondents reporting having a scholarship (15).

Internet connectivity

Two studies analyzed internet connectivity during

e-learning. Most respondents had stable internet access (82%) (13), while 48% of respondents said it was good (15).

Study outcomes

The outcome measured in this review is 'anxiety.' Four different tools were used to measure anxiety levels in our included articles. Nevertheless, all the included anxiety measurement tools were those that had been widely accepted and recognized globally. Three articles used the Generalized Anxiety Disorder Scale (GAD-7) (13,14,17), while two studies used 'Zung's self-rating anxiety scale (ZSAS)' (16,18). The remaining two studies used different scales of measurement; Alqudah *et al.* used the Hamilton Anxiety Scale (HAM-A) (12), and Moy and Ng used the Depression Anxiety and Stress Scale (DASS-21) (15).

GAD-7

The GAD-7 score is calculated by summing the scores for the seven questions and assigning 0, 1, 2, and 3 to the response categories of 'not at all', 'several days', 'more than half the days', and 'almost every day', respectively. The cut-off points for mild, moderate, and severe anxiety are 5, 10, and 15, respectively (19). When employed as a screening tool, a score of 10 or higher necessitates additional investigation (20). The GAD-7 has an 89 percent sensitivity and an 82 percent specificity for GAD when using a threshold score of 10.

ZSAS

The ZSAS is calculated by assigning scores of 1, 2, 3, and 4 to the response categories of 'none or a little of the time', 'some of the time,' 'good part of the time,' and 'most of the time,' respectively by adding all the scores of twenty questions. Scores of 20–44, 45–59, 60–74, and 75–80 are taken as a range for: Normal Range, Mild to Moderate Anxiety Levels, Severe Anxiety Levels, and Extreme Anxiety Levels, respectively (21). There are fifteen questions in these scales that are expressed towards increasing anxiety levels and five questions expressed towards decreasing anxiety levels. Standard scores above 50 suggest clinically significant anxiety levels in the Chinese population (22). In a comparison study among Ho Chi Minh medical students, the ZSAS records the internal reliability coefficient of Cronbach's alpha of 0.88 (23). Another comparison study shows the positive correlation between ZSAS and Beck Depression Inventory (BDI)-II questionnaires among the population of adolescents who studied at a high school in

Indonesia (24).

The HAM-A

The HAM-A was one of the first rating scales to be developed to determine the severity of anxiety symptoms, and it is widely used in clinical and research settings today. The scale has 14 items, each characterized by symptoms, and assesses both psychic and somatic anxiety (mental agitation and psychological distress). Each item is graded on a scale of 0 (not present) to 4 (very severe), with a total score range of 0–56. Anxiety between 14 and 17 is mild. Anxiety between 18 and 24 is classified as moderate. Severe anxiety is defined as a score between 25 and 30. The Arabic version of HAM-A has been validated (25).

The DASS-21

The DASS-21 has been used to assess depression, anxiety, and stress symptoms worldwide (26). The DASS-21 is based on the tripartite model of psychopathology, which assumes that depression, anxiety, and stress are all parts of a larger distress construct with distinct characteristics. Moreover, depression is characterized by low levels of positive affect, anxiety is marked by physiological hyperarousal, and stress is marked by irritability, nervous tension, difficulty relaxing, and agitation (27). The DASS-21 has been validated in non-clinical samples (28,29).

Students who struggled with e-learning had a higher level of moderate to severe anxiety when tested with GAD-7. According to Fruehwirth *et al.*, an 8.1% increase in moderate to severe anxiety was linked to a one-standard-deviation increase in e-learning difficulties (14). E-learning was the most difficult for First-Generation College (FGC) students, Hispanic, and Sexual/Gender Minority (SGM) students. However, there were no significant changes in moderate to severe anxiety among Hispanic or FGC students. On the other hand, SGM students had a considerable rise in anxiety levels. Anxiety levels increased by 59 percent among SGM students in the moderate-to-severe range (14).

GAD-7 anxiety levels showed mixed results during e-learning (17), according to Saddik *et al.* compared to non-medical students, medical students reported higher levels of anxiety prior to e-learning. Anxiety levels decreased significantly for medical students ($P < 0.001$) and females ($P < 0.001$), after switching to online learning, with a higher percentage of decreased anxiety among dental students. However, non-medical students reported higher levels of anxiety after switching to online learning ($P < 0.001$).

The high levels of total reported anxiety (mean score = 16.78) revealed the severity of the impact of e-learning on students' mental health (13). Using the GAD-7 with a cut-off point of 15.0 revealed significant anxiety in five of the instrument's seven items. The five anxiety items had a mean value of 15.91 to 18.73, whereas two had a mean value of 11.93 to 12.75. Switching to e-learning during the pandemic, according to Özdin and Bayrak Özdin, may result in a higher (66%) level of anxiety than before the pandemic (30).

When measured using the DASS-21, Malaysian university students exhibited a very high degree of anxiety during the COVID-19 pandemic (15). According to Moy and Ng, anxiety levels were 51.3% (95% CI: 45.6%, 57.0%) among Malaysian public and private university students during COVID-19, with post-graduate students having a higher risk of anxiety (15).

According to a study in Jordan by Alqudah *et al.*, which utilizes the HAM-A, switching to e-learning during the COVID-19 pandemic worsened anxiety scores among undergraduate university students (12). The prevalence of moderate to severe anxiety was 40.6%, with a significant correlation when shifting to distance learning (12). Furthermore, most students indicated that their study responsibilities had become more difficult and that the new evaluation techniques proposed by Jordan's minister of higher education during the COVID-19 pandemic were inappropriate for them, causing a rise in their anxiety levels ($P = 0.0001$).

A study by Sundarasan *et al.* using ZSAS found a significant association between the demographic variables with anxiety levels during e-learning at home; namely, female gender; age categories below 18 to 25 years; pre-university level of education; management studies and groups that stay alone at home (16). In the second study utilizing ZSAS, by Wang *et al.*, the self-rating anxiety questionnaire revealed that 12.88% had mild anxiety compared to the first study with 9.98% (18). They further reinforced the factor of poor internet facilities as a contributor to anxiety during e-learning, as observed in another study done in Bangladesh among 206 undergraduate students (31).

Quality of included studies

The JBI Tools for Critical Appraisal, a specific checklist for analytical cross-sectional studies, was used to assess each study's quality (32). Based on the articles, four articles were cross-sectional, and three were longitudinal. We defined

the three longitudinal studies as repeated analytical cross-sectional studies. Therefore, the checklist for an analytical cross-sectional study was used to assess the quality of all the studies. The checklist contains eight questions to detect potential bias, and at the end of the assessment, the study quality will be rated with the top score of 8. The studies were ranked by high quality (scores of 7–8), medium quality (scores of 5–6), low quality (scores of 3–4), and very low quality (scores of 0–2). All the articles were appraised by all authors, and the rates were given by averaging the scores. In our review, seven studies were assessed for methodological quality and risk of bias. Five studies were classified as medium quality (12-14,16), and two studies were classified as high quality (15,17). The result of the assessment is summarized in [Appendix 3](#).

Discussion

Key findings

University students reported mild to high levels of anxiety during the COVID-19 pandemic. Four out of seven articles reviewed in this systematic review concluded that e-learning was significantly associated with anxiety. The effect of e-learning on anxiety levels is determined by the diverse socio-demographic backgrounds. Internet connectivity and facilities also played an important factor for students, as some faced poor connectivity issues while some had access to high-speed internet. This review also identified different strategies of e-learning or distance learning employed for students. Some are from disciplines of study that required distinct methods of learning, such as laboratory sessions, whereas some were fully lecture-based.

Strengths and limitations

To the best of our knowledge, this study is the first systematic review that examines and summarizes existing literature relevant to e-learning and anxiety among higher education students at the beginning of COVID-19 pandemic. This type of evidence is essential, particularly in understanding the psychosocial impacts of a new form of learning necessitated by COVID-19 measures, on university students. In this systematic review, some limitations were identified.

Firstly, we have included mostly cross-sectional studies (five of the seven included studies), which may not establish causal relationships between anxiety and e-learning. More

longitudinal studies are required to show a significant relationship between anxiety and e-learning. Secondly, this paper investigates the association primarily between e-learning and anxiety. Some students may have reported other mental health outcomes such as stress and depression as a consequence of e-learning implementation.

Furthermore, all investigations were completed independently by research participants via online surveys, which presents two concerns. First, individual replies in self-assessment differ in objectivity, due to the absence of a professional psychiatrist/interviewer. Next, students with limited internet access were likely to be excluded from the study, resulting in a selection bias in the population investigated. Another issue was female students were overrepresented in most studies. Due to selection bias and over-representation of certain groups, most studies may not represent the genuine population. Importantly, studies on inclusion have only been undertaken in a few countries. As a result, generalizations regarding mental health in the global university student population cannot be determined.

In addition, the article search for this review was done primarily from five medical databases PubMed, Scopus, Wiley, Science Direct, and EBSCO. These databases were selected as they had increased flexibility and are freely available for access. Relevant articles procured from this search are not exhaustive, and a search in other databases can be done in the future to gather more evidence on the subject.

We also identified sources of potential bias in the studies selected. Almost all the studies included were conducted via an online survey, which might lead to selection bias, as only students with good internet connectivity could participate in those studies. Most of the studies used non-probability sampling, which may also lead to selection bias. In general, most articles addressed the issue of sampling bias. Saddik *et al.* and Alqudah *et al.* used non-probability sampling, such as convenience sampling, to gather respondents in the study (12,17). While Moy and Ng included only university students who had access to an internet connection (15). Fruehwirth *et al.* recruited respondents from a single institute of higher learning consisting of only first-year students (14), and Wang *et al.* recruited only public affairs students (18). Participants in the study conducted by Alqudah *et al.* consisted of more female respondents compared to males (12). Other studies also reported a gender bias among female respondents. This affects the generalisability of the study. Future studies should have more generalized respondent samples to represent the

university population as a whole. Moreover, certain studies utilized a small sample size. Fruehwirth *et al.* and Wang *et al.* had limited statistical analyses of variables due to the small size of their samples (14,18). In fact, Wang *et al.* stated that the data collected cannot be generalized to non-graduating undergraduate students due to the limit observed in their sample size (18).

The time frame of data collection in the studies is an important factor as well. Sundarasan *et al.* conducted their study in April and May 2020 (16). During this period, some students may have left campus for their hometowns, as universities were closed. Therefore, the anxiety levels measured could have been biased as the respondent's data may have been different if the study were to be done before the lockdown. Time factor played a significant role in the longitudinal study by Fruehwirth *et al.* Their study collected data in two waves (14). The time lapse between both studies could have seen multiple events occurring, such as the police shooting of African Americans (as reported in the study), a potential confounder in influencing the anxiety levels among specific populations of university students. Not only that, another longitudinal study by (18) which studied the participants on two separate occasions, saw considerable attrition of participants in the second phase of the study as compared to 99.8% of respondents in the first phase. Thus, explaining the concept and design of the study before the initiation is crucial to ensure the continued participation of respondents.

Reporting bias due to the usage of self-reported data should be considered, as all studies utilized pre-validated self-anxiety questionnaires. Socially acceptable answers and self-reported anxiety levels are not always accurate. The descriptive nature of online surveys may hinder the identification of proper causal relationships with regards to anxiety. Other factors found to have influenced the anxiety levels among university students in this study besides e-learning include conditions at home and social support.

Comparison with similar researches

Anxiety, especially prolonged anxiety, could affect a student's academic performance. The more anxious the student is, the less focused and confident they will be in their studies. This is evident in a study conducted among 322 Master of Education students who switched to e-learning resulting in poorer academic performances (33). Due to reduced exposure to actual COVID-19 risk in healthcare settings, medical students may have experienced less anxiety during

e-learning. E-learning may not be an advantage to scientific advancements for students working on research projects that require laboratory or mechanical work in their last year of studies. As a result, postgraduate students may have more anxiety compared to undergraduate students due to the need of completing their research on time. The majority of study participants had moderate-to-good internet connectivity. However, Moy and Ng reported no association between e-learning perception with stress or anxiety (15). One factor could be that certain universities had already implemented e-learning before the COVID-19 pandemic. According to a study in Jordan by Alqudah *et al.*, which utilizes the HAM-A, switching to e-learning during the COVID-19 pandemic worsened anxiety scores among undergraduate university students (12).

E-learning utilization is ubiquitous; however, it still poses various challenges. For example, some students do not have a conducive environment in their homes for a focused online class. They tend to lack private learning space and are distracted by noisy environments and members of the household (34). These circumstances may contribute to mental health issues as the student is left without an option to switch to alternative studying environments. Furthermore, instructors who use the same curricula and learning outcomes meant for face-to-face teaching tend to overlook the students' need to adjust to distance learning.

However, Sundarasan *et al.* reported that virtual study is not a significant factor leading to anxiety among university students in all states in Malaysia (16). This contradicts the qualitative feedback by students, with the reports of their uphill struggles to perform tasks. Namely, poor internet connection and technological infrastructure, which saw some students attend 6–8 hours of daily online classes using their mobile phones, further contributing to stress and health issues. Moreover, being isolated from friends causes frustration, anger, resentment, and anxiety. The conversation on poor internet access is relevant to developing countries, particularly in rural areas where internet connectivity is not as optimized as in urban areas.

Explanations of findings

Four studies found a significant association between e-learning and anxiety, but three articles found no significant association. This could be attributed to the diverse socio-demographic backgrounds and cultures of the participants in the studies, as well as the difference in the

tools utilized to assess their anxiety. The different strategies of e-learning or distance learning employed for students identified in this review were from disciplines of study that required distinct methods of learning, such as laboratory sessions, whereas some were fully lecture-based. In addition, the reviewed studies were from different countries and settings where the COVID-19 severity varied. These factors could have contributed to the different levels of anxiety reported. Evidence from stronger study designs is needed to confirm the association and establish a causation link of anxiety due to e-learning methods.

Implications and actions needed

E-learning or distance learning has become ingrained in a student's daily norm, requiring an adjustment and adaptation to this new reform. In a study conducted among 150 students, student engagement was critical in determining students' satisfaction with e-learning. By conducting ice-breaker sessions and working in groups using online communication methods, engagement and communication among peers could be achieved (35). To form a practical learning experience for students, institutions of higher learning should adopt a method suitable for the type of study and the student's preference. An integrative review of nursing students' assessment skills and knowledge concluded that e-learning and face-to-face learning methods should be combined to create a superior learning style (36). Institutions could offer both modes of learning (face-to-face and online instruction) in a way where the students would be able to make a choice themselves. Not only that, activities that emphasize collaboration should be encouraged to prevent learning in isolation. For students experiencing challenges with internet connectivity, institutions should create avenues for students to receive internet access at economical prices/subsidized rates to ensure they are well supported to attend e-learning sessions.

Importantly, having easy access to avenues for mental health care is crucial during a prolonged quarantine period, especially for students who require immediate psychological assistance and those who live in rural locations (37). Higher education institutions should evaluate their staff and students during the COVID-19 pandemic to screen for mental health issues, including e-learning-related anxiety. Online counselling and hotlines can offer remote mental health services as in-person health services are limited and delayed due to the COVID-19 pandemic. Online counselling and hotlines can offer remote mental health

services as in-person health services are limited and delayed due to the COVID-19 pandemic (38,39). Feedback from students regarding e-learning should be conducted at regular intervals, to screen and gather information related to their anxiety profiles.

Mixed methods study, such as including focus group discussion or in-depth interviews, should be utilized to expand data collection methods to understand the long-term effects of e-learning on anxiety. Different study designs could be adopted as opposed to cross-sectional to establish a better causal relationship between anxiety and e-learning. However, due to the unpredictable and uncertain nature of the pandemic, this could not have been easily implemented.

Overall, the biases in the studies should be addressed when future research is conducted. Due to multiple factors influencing the anxiety levels during the COVID-19 pandemic, a more direct study design involving university students from various courses, ages and gender are needed to obtain a more representative data sample.

Conclusions

In conclusion, university students reported mild to high levels of anxiety during the COVID-19 pandemic. Four out of seven articles concluded that e-learning was significantly associated with anxiety levels. Whereas the remaining three found no significant association. The effect of e-learning on anxiety levels is determined by the diverse socio-demographic backgrounds. Internet connectivity and facilities also contributed to anxiety levels during e-learning. Nevertheless, evidence from stronger study designs is needed to confirm the association and establish a causation link of anxiety due to e-learning methods.

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Appendix 1

Keywords combination

("university students" OR "undergraduate students" OR "postgraduate students" OR "higher education students" OR "college students" OR "tertiary education students")

AND

("e-learning" OR "distance learning" OR "virtual learning" OR "online education" OR "online learning" OR "electronic learning" OR "online class")

AND

(COVID-19 OR coronavirus OR "SARS-CoV-2" OR "2019-nCoV Infection" OR "COVID-19 pandemic" OR "COVID-19 outbreak")

AND

(anxiety OR anxious).

Appendix 2

1) PUBMED

Database	Search limitation according to database	Search term/strategy	Total Hits	Total	Relevant After screened
PubMed	Years 2019-2021	#1 ("University students" OR "Undergraduate students" OR "postgraduate students" OR "higher education students" OR "College students" OR "Tertiary education students")	12,320		
	Years 2019-2021	#2 ("e-learning" OR "online learning" OR "distance learning" OR "virtual learning" OR "online education" OR "online learning" OR "Electronic learning" OR "online class")	3,867		
	Years 2019-2021	#3 ("COVID-19" OR coronavirus OR SARS-CoV-2 OR "2019-nCoV Infection" OR "COVID-19 Pandemic" OR "COVID-19 outbreak")	153,560		
	Years 2019-2021	#4 (Anxiety OR anxious*)	59,999		
	Year (2019 -2021)	#5 - #1 AND #2 AND #3 AND #4	46		
	Year (2019 -2021), Language (English), Human	#6 - #1 AND #2 AND #3 AND #4	17		
	Remove unrelated/ irrelevant articles	#7	4		
	Total			4	4

2) SCIENCE DIRECT

Database	Search limitation according to database	Search term/strategy	Total Hits	Total	Relevant After Screened
Science Direct	Years 2019 -2021 Journal article	#1 ("University students" OR "Undergraduate students" OR "postgraduate students" OR "higher education students" OR "College students" OR "Tertiary education students")	21,204		
	Years 2019 -2021	#2 ("e-learning" OR "online learning" OR "distance learning" OR "virtual learning" OR "online education" OR "online learning" OR "Electronic learning" OR "online class")	7,601		
	Years 2019 -2021	#3 ("COVID-19" OR coronavirus OR SARS-CoV-2 OR "2019-nCoV Infection" OR "COVID-19 Pandemic" OR "COVID-19 outbreak")	40,167		
	Years 2019 -2021	#4 (Anxiety OR anxious*)	59,870		
	Years 2019 -2021 Research articles,	#5 - #1 AND #2 AND #3 AND #4	146		
	Year (2019 -2021), Language (English), Full-text	#6 - #5	48		
	Remove unrelated/ irrelevant articles	#7	1		
	Total			1	1

3) EBSCO

Database	Search limitation according to database	Search term/strategy	Total Hits	Total	Relevant After Screened
EBSCO	Years 2019 -2021	#1 ("University students" OR "Undergraduate students" OR "postgraduate students" OR "higher education students" OR "College students" OR "Tertiary education students")	32,414		
	Years 2019 -2021	#2 ("e-learning" OR "online learning" OR "distance learning" OR "virtual learning" OR "online education" OR "online learning" OR "Electronic learning" OR "online class")	9,735		
	Years 2019 -2021	#3 ("COVID-19" OR coronavirus OR SARS-CoV-2 OR "2019-nCoV Infection" OR "COVID-19 Pandemic" OR "COVID-19 outbreak")	197,637		
	Years 2019 -2021	#4 (Anxiety OR anxious*)	137,429		
	Year 2019 -2021	#5 #1 AND #2 AND #3 AND #4	388		
	Year (2019 -2021), Language (English).	#5 - #1 AND #2 AND #3 AND #4	314		
	Year (2019 -2021), Human, full text.	#6 - #1 AND #2 AND #3 AND #4	210		
	Year (2019 -2021), Language (English). Human, full text.	#7 - #5 AND # 6	69		
	Remove unrelated/ irrelevant articles	#7	1		
	Total			1	1

4) WILEY

Database	Search limitation according to Database	Search term/strategy	Total Hits	Total	Relevant After Screened
WILEY	Title, Abstract, Keywords, Years 2019-2021	#1 ("University students" OR "Undergraduate students" OR "postgraduate students" OR "higher education students" OR "College students" OR "Tertiary education students")	134		
	Title, Abstract, Keywords, Years 2019-2021	#2 ("e-learning" OR "online learning" OR "distance learning" OR "virtual learning" OR "online education" OR "online learning" OR "Electronic learning" OR "online class")	70		
	Title, Abstract, Keywords, Years 2019-2021	#3 ("COVID-19" OR coronavirus OR SARS-CoV-2 OR "2019-nCoV Infection" OR "COVID-19 Pandemic" OR "COVID-19 outbreak")	8240		
	Title, Abstract, Keywords, Years 2019-2021	#4 (Anxiety OR anxious*)	1058		
	Anywhere, Years 2019- 2021	#5- #1 AND #2 AND #3 AND #4	198		
	Title, Abstract, Keywords, Years 2019-2021	#6 - #1 AND #2 AND #3 AND #4	5		
	Remove unrelated/ irrelevant articles	#7	5		
	Total			5	5

5) SCOPUS

Database	Search limitation according to Database	Search term/strategy	Total Hits	Total	Relevant After Screened
SCOPUS	Years 2019-2021	#1 ("University students" OR "Undergraduate students" OR "postgraduate students" OR "higher education students" OR "College students" OR "Tertiary education students")	182,081		
	Years 2019 -2021	#2 ("e-learning" OR "online learning" OR "distance learning" OR "virtual learning" OR "online education" OR "Electronic learning" OR "online class")	125,140		
	Years 2019 -2021	#3 ("COVID-19" OR coronavirus OR SARS-CoV-2 OR "2019-nCoV Infection" OR "COVID-19 Pandemic" OR "COVID-19 outbreak")	265,808		
	Years 2019 -2021	#4 (Anxiety OR anxious*)	449,692		
	Year (2019 -2021)	#5 - #1 AND #2 AND #3 AND #4	1,253		
	Year (2019 -2021), Language (English), Journal	#6 - #1 AND #2 AND #3 AND #4	1,047		
	Remove unrelated/ irrelevant articles	#7	35		
		Total			35

Appendix 3

Joanna Briggs Institute Critical Appraisal Tool for Analytical Cross-sectional Study Design

No	ARTICLE	TYPE OF STUDY	REVIEWER	Checklist from Joanna Briggs Institute (JBI) Critical Appraisal tools								Total Score	Result of Quality
				Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8		
1	Alqudah <i>et al.</i> , 2021	Cross-Sectional (Observational)	MAF	Y	Y	Y	Y	N	N	Y	Y	6/8	Average score =5/8 (medium)
			MAA	y	y	N	Y	N	N	Y	Y	6/8	
			NA	Y	Y	N	Y	N	N	Y	Y	5/8	
			TA	Y	Y	N	Y	N	N	Y	Y	5/8	
			TG	Y	Y	N	Y	N	NA	Y	Y	5/8	
			JJP	Y	Y	N	Y	N	N	Y	Y	5/8	
2	Fruehwirth <i>et al.</i> , 2021	Longitudinal (Repeated cross-sectional)	MAF	Y	Y	Y	Y	N	N	Y	Y	6/8	Average score =6/8 (medium)
			MAA	Y	Y	Y	Y	N	N	Y	Y	6/8	
			NA	Y	Y	Y	Y	N	N	Y	Y	6/8	
			TA	Y	Y	Y	Y	N	N	Y	Y	6/8	
			TG	Y	Y	Y	Y	Y	Y	Y	Y	8/8	
			JJP	Y	Y	Y	Y	N	N	Y	Y	6/8	
3	Moy <i>et al.</i> , 2021	Cross-Sectional (Observational)	MAF	Y	Y	Y	Y	N	N	Y	Y	6/8	Average score =7/8 (high)
			MAA	Y	Y	Y	Y	N	N	Y	Y	7/8	
			NA	Y	Y	Y	Y	N	N	Y	Y	6/8	
			TA	Y	Y	Y	Y	N	N	Y	Y	6/8	
			TG	Y	Y	Y	Y	Y	Y	Y	Y	8/8	
			JJP	Y	Y	Y	Y	Y	N	Y	Y	7/8	
4	Saddik <i>et al.</i> , 2020	Cross-Sectional (Observational)	MAF	Y	Y	Y	Y	N	N	Y	Y	6/8	Average score =7/8 (high)
			MAA	Y	Y	Y	Y	N	N	Y	Y	6/8	
			NA	Y	Y	Y	Y	N	N	Y	Y	6/8	
			TA	Y	Y	Y	Y	N	N	Y	Y	6/8	
			TG	Y	Y	Y	Y	Y	Y	Y	Y	8/8	
			JJP	Y	Y	Y	Y	Y	N	Y	Y	7/8	
5	Sundaresan <i>et al.</i> , 2020	Cross Sectional (Observational)	MAF	Y	Y	Y	Y	N	N	Y	Y	6/8	Average score =5/8 (medium)
			MAA	Y	Y	Y	Y	N	N	Y	Y	6/8	
			NA	U	U	U	U		N	Y	Y	2/8	
			TA	Y	Y	Y	Y	N	N	Y	Y	6/8	
			TG	Y	Y	Y	Y	N	Y	Y	Y	7/8	
			JJP	U	Y	N	U	U	N	Y	Y	3/8	
6	Wang <i>et al.</i> , 2020	Longitudinal (Repeated cross-sectional)	MAF	Y	Y	Y	Y	N	N	Y	Y	6/8	Average score =5/8 (medium)
			MAA	Y	Y	Y	Y	N	N	Y	Y	5/8	
			NA	Y	Y	Y	Y	N	N	U	Y	5/8	
			TA	Y	Y	Y	Y	N	N	U	Y	5/8	
			TG	Y	Y	Y	Y	U	U	U	Y	5/8	
			JJP	Y	Y	Y	Y	N	N	U	Y	5/8	
7	Yaghi <i>et al.</i> , 2021	Longitudinal (Repeated cross-sectional)	MAF	Y	Y	Y	Y	N	N	Y	Y	6/8	Average score =6/8 (medium)
			MAA	Y	Y	Y	Y	N	N	Y	Y	6/8	
			NA	Y	Y	Y	Y	N	N	U	Y	5/8	
			TA	Y	Y	Y	Y	N	N	Y	Y	6/8	
			TG	Y	Y	Y	Y	N	Y	U	Y	6/8	
			JJP	Y	Y	Y	Y	N	N	Y	Y	6/8	