

Prevalence of anxiety due to coronavirus in preclinical medical students after 20 months of pandemic in Mexico

Prevalencia de ansiedad por coronavirus en estudiantes preclínicos de Medicina tras 20 meses de pandemia en México

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ABSTRACT

This study assesses the prevalence of COVID-19-related anxiety and associated factors among preclinical students enrolled in the Medical Surgeon degree program at the University of Guanajuato, 20 months after the onset of the pandemic in Mexico. A cross-sectional study based on an online survey administered from October 28 to November 16, 2021. The survey collected demographic data, history of infection, fear, concern, COVID-19-related anxiety (measured using the Coronavirus Anxiety Scale - CAS), and self-perceived achievement of learning objectives from 258 students. Associations between the studied factors and anxiety levels were analyzed. After 20 months of the pandemic, students reported high levels of fear and concern: 70.54 % expressed fear of contracting the infection, and 74.03% reported fear of dying from COVID-19. Although only 28.29 % had been diagnosed with COVID-19, 74.03 % reported that a cohabitant had been infected, and 39.15% experienced the loss of a relative or friend. Additionally, 80.23 % expressed concern about reduced social contact, and 66.28 % about their family's financial situation. Nevertheless, 82.56 % indicated that their fear had decreased compared to earlier phases of the pandemic. The average CAS score was 2.57 ± 3.74 , indicating a low prevalence of anxiety (8.53 %). Women presented significantly higher levels of anxiety compared to men (3.03 ± 4.02 vs. 1.58 ± 2.81 ; $p = 0.004$). Factors associated with higher anxiety levels included: being female, having contracted COVID-19, experiencing severe illness, fear of a loved one becoming infected, financial concern, and perceived failure to achieve academic goals. Although the prevalence of clinical anxiety was low, a vulnerable subgroup of students remains affected by multiple personal, familial, economic, and academic factors. These findings underscore the importance of implementing institutional strategies for psychological and academic support to mitigate the prolonged emotional impact of the pandemic on medical training.

KEY WORDS: Prevalence, anxiety, COVID-19, medical students, Mexico.



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RESUMEN

Este estudio evaluó la prevalencia de ansiedad relacionada con COVID-19 y los factores asociados en estudiantes preclínicos de la Licenciatura en Médico Cirujano de la Universidad de Guanajuato, después de 20 meses transcurridos desde el inicio de la pandemia en México. Estudio transversal basado en una encuesta en línea, administrada del 28 de octubre al 16 de noviembre de 2021, que recopiló datos demográficos, historial de contagio, miedo, preocupación, ansiedad por COVID-19 (a través de la Escala de Ansiedad por Coronavirus – CAS), así como la autopercepción del logro de objetivos de aprendizaje en 258 estudiantes. Se analizaron asociaciones entre los factores estudiados y los niveles de ansiedad. Después de 20 meses de pandemia, los estudiantes reportaron elevados niveles de miedo y preocupación: el 70.54 % manifestó temor a infectarse y el 74.03 % miedo a morir por COVID-19. Aunque solo el 28.29 % había sido diagnosticado con COVID-19, el 74.03 % reportó algún conviviente infectado y el 39.15 % refirió la pérdida de un familiar o amigo. Además, el 80.23 % expresó preocupación por la reducción del contacto social y el 66.28 % por la situación financiera familiar. No obstante, el 82.56 % indicó que su miedo ha disminuido en comparación con fases anteriores de la pandemia. El puntaje promedio en la CAS fue de 2.57 ± 3.74 , encontrándose una baja prevalencia de ansiedad (8.53 %). Las mujeres presentaron niveles significativamente mayores de ansiedad en comparación con los hombres (3.03 ± 4.02 vs. 1.58 ± 2.81 ; $p = 0.004$). Los factores asociados con mayores niveles de ansiedad fueron: ser mujer, haber contraído COVID-19, presentar enfermedad severa, temor al contagio de un ser querido, preocupación económica y percepción de no haber alcanzado los objetivos académicos. Conclusiones: Aunque la prevalencia de ansiedad clínica fue baja, persiste un subgrupo vulnerable de estudiantes afectados por múltiples factores personales, familiares, económicos y académicos. Estos hallazgos resaltan la necesidad de implementar estrategias institucionales de apoyo psicológico y académico para mitigar los efectos emocionales prolongados de la pandemia en la formación médica.

PALABRAS CLAVE: Prevalencia, ansiedad, COVID-19, estudiantes de medicina, México.

Introduction

In February 2020, the first case of COVID-19 in Mexico was confirmed, caused by the SARS-CoV-2 virus (Suárez *et al.*, 2020). In response to the rapid global spread of the COVID-19 pandemic, many countries, including Mexico, implemented a range of restrictive measures aimed

at mitigating community transmission. Within the university setting, these measures included the suspension of in-person academic activities and the temporary closure of educational facilities, which prompted a swift transition to distance learning through digital platforms. At the University of Guanajuato, similar to other higher education institutions in Mexico, the COVID-19 pandemic led to substantial modifications in both academic and administrative activities. Beginning in March 2020, in-person classes were suspended, and virtual teaching modalities were implemented via digital platforms, requiring rapid adaptation by both students and faculty.

The abrupt shift to distance learning posed a significant challenge for university students during the COVID-19 pandemic. These new educational methodologies not only altered conventional academic dynamics but also subjected students to continuous assessment of their capacity to successfully meet academic demands in a virtual environment. Self-efficacy, understood as the self-perception of competence in the face of such demands, has been identified as a key factor in student adaptation. Inadequate perceptions of self-efficacy can give rise to dysfunctional thinking patterns, negative emotions, and consequently, increase the risk of mental health issues such as anxiety, stress, and depressive symptoms (Wang *et al.*, 2020). Furthermore, the pandemic itself has functioned as an additional stressor, generating immediate psychological consequences such as fear of infection, concern for family members' health, academic and financial uncertainty, and fear of death (Tsang *et al.*, 2004; Wang *et al.*, 2011).

The mental health of university students represents a pressing public health concern, as several studies have documented consistently higher rates of anxiety, depression, and other mental disorders among university students compared to the general population (Auerbach *et al.*, 2016; Zivin *et al.*, 2009). This situation has been particularly pronounced among medical students during the COVID-19 pandemic. In addition to facing intense academic loads and the theoretical-practical demands intrinsic to their training, medical students have encountered further challenges compared to other student populations.

Social distancing measures and the suspension of in-person activities disrupted essential components of their professional education, such as preclinical training, clinical rotations, practical workshops, simulation activities, and participation in conferences, presentations, and academic medical update events (García-Espinosa *et al.*, 2021; Halperin *et al.*, 2021). Furthermore, access to university facilities was restricted, in-person events were canceled, and ongoing adherence to federal and state health authority guidelines was enforced. These changes to the teaching-learning process, combined with ongoing health-related uncertainty and the emotional impact inherent to the medical environment during the pandemic, highlight the risk of mental health disturbances within this student population, which is considered particularly vulnerable due to the high academic demands and constant pressure associated with medical training.

The deterioration of mental health in this population not only compromises emotional well-being but also affects fundamental aspects of student life, such as academic performance, social participation, integration into the university environment, and self-perception of professional competence (García-Espinosa *et al.*, 2021; Halperin *et al.*, 2021). This vulnerability is particularly relevant given that most mental health disorders begin during early adulthood, coinciding with

the university trajectory (Eisenberg *et al.*, 2007). Even prior to the pandemic, studies had already documented a high prevalence of stress, anxiety, depression, and impulse control disorders among Mexican university students (Lazarevich *et al.*, 2013; Reyes Carmona *et al.*, 2017).

The prevalence of anxiety in the context of COVID-19 has commonly been assessed using the GAD-2 and GAD-7 scales, which have demonstrated adequate internal and concurrent validity, allowing for a general overview of anxiety and exploration of various variables that may influence its onset and development during the pandemic (Crockett *et al.*, 2022; Franco-Jimenez & Nuñez-Magallanes, 2022; Pagano & Vizioli, 2021). However, these scales were designed to measure generalized anxiety and do not specifically account for stressors related to SARS-CoV-2 infection. In this context, the Coronavirus Anxiety Scale (CAS), developed by Lee in 2020 in the United States, offers a more precise alternative, as it is specifically designed to assess anxiety caused by COVID-19, comprising aspects such as fear of infection (self or relatives) and physiological reactions associated with this concern. Therefore, the use of the CAS allows for a more targeted evaluation adjusted to the current context of individuals exposed to SARS-CoV-2.

Assessing COVID-19-related anxiety in preclinical medical students is particularly relevant due to the sustained impact of the pandemic on their academic training, psychological well-being, and future professional practice. While numerous early studies documented elevated anxiety levels during the initial stages of the pandemic, there is limited evidence regarding the evolution of these symptoms as the health crisis has persisted, especially in high-risk student populations such as medical students. Twenty months after the pandemic began in Mexico, it is necessary to analyze whether anxiety levels have remained stable, decreased, or changed because of emotional adaptation, access to preventive measures, the partial return to in-person activities, and adjustments in academic dynamics. In this context, the present study aimed to evaluate the prevalence of COVID-19-related anxiety and associated factors among preclinical students enrolled in the Medical Surgeon degree program at the University of Guanajuato, twenty months after the onset of the pandemic in Mexico.

Materials and Methods

Study design and participants

This cross-sectional study was conducted between October 28th and November 16th, 2021. Data were collected using the *Google Forms* platform via a self-administered, anonymous online questionnaire distributed through institutional email. Sample size estimation was based on the formula for proportions in cross-sectional studies, considering a finite population of approximately 650 preclinical students, a 95 % confidence level, an expected prevalence of 25 % for COVID-19-related anxiety, and a 5 % margin of error (Mas Camacho *et al.*, 2022). The minimum required sample size was 242 students. The final sample consisted of 258 participants. Inclusion criteria were: being an active student in the Medical Surgeon degree program at the University of Guanajuato, enrolled in any of the first six semesters (preclinical phase), being at least 18 years of age, and voluntarily agreeing to participate through electronic informed consent. Students who were already in the clinical phase of the program, as well as those whose questionnaires

were incomplete or showed inconsistent responses, were excluded. This study was conducted in accordance with the Mexican Official Standard NOM-012-SSA3-2012 and the Declaration of Helsinki.

Questionnaire

The questionnaire consisted of 21 items (Table 1) aimed at collecting sociodemographic data, prevalence of infection among students and household members, fear, concern, COVID-19-related anxiety, and self-perception regarding the achievement of learning goals.

To assess anxiety, the Coronavirus Anxiety Scale (CAS) was used. This instrument includes five items that evaluate symptoms of dysfunctional anxiety associated with coronavirus: dizziness, sleep disturbances, tonic immobility, loss of appetite, and nausea or stomach problems. Each item is rated on a 5-point scale reflecting the frequency of symptoms over the past two weeks, ranging from 0 (not at all) to 4 (nearly every day). The total score ranges from 0 to 20, with higher scores indicating greater COVID-19-related anxiety. Scores from 0 to 9 are considered normal, while scores from 10 to 20 indicate anxiety (González-Rivera *et al.*, 2020; Lee, 2020).

The CAS is a validated scale, translated into Spanish and used in Mexico (García-Reyna *et al.*, 2022; Lieven, 2021). It has demonstrated adequate psychometric properties, with high internal reliability ($\alpha > 0.90$) as well as convergent and discriminant validity in various populations, including Latin American university students (González-Rivera *et al.*, 2020; Lee, 2020). Its use enables the specific assessment of anxiety related to the pandemic context, distinguishing it from other types of anxiety not directly linked to the health crisis.

Statistical analysis

Descriptive statistics were used for categorical variables with frequencies and percentages, and for continuous variables using means (M) and standard deviations (SD). The normal distribution of variables was assessed using the Kolmogorov-Smirnov test. Associations between main categorical variables were analyzed using the chi-square test. A univariate generalized linear model with main effects was applied to evaluate associations between total CAS scores and the other variables. Associations were reported through beta coefficients, confidence intervals, and *p-values*. The significance level was set at 0.05. Statistical analysis was performed using IBM SPSS Statistics software (version 25.0).

Table 1. Study questionnaire.

QUESTIONS	RESPONSE OPTIONS
Sociodemographic data	
1. Sex	Male/Female
2. Age	Open (years)
History of infection	
3. Have you contracted COVID-19?	Yes/No
4. If yes, how severe was your illness?	Yes/No
5. Has anyone you share a home with contracted COVID-19?	Yes/No
6. Has anyone you share a home with died from COVID-19?	Yes/No
7. Has any family member or close friend died from COVID-19?	Yes/No
Fear	
8. Are you afraid of getting COVID-19?	Yes/No
9. Are you afraid of dying from COVID-19?	Yes/No
10. Are you afraid that a loved one will get COVID-19?	Yes/No
11. Are you afraid that a loved one will die from COVID-19?	Yes/No
12. Do you think that your level of fear regarding the pandemic has decreased at this time compared to how you felt during other phases of the pandemic?	Yes/No
Worry	
13. Are you worried about the lack of regular contact you had with other people before the pandemic?	Yes/No
14. Are you worried about your family's financial situation due to COVID-19?	Yes/No
Anxiety	
15. Do you think your level of anxiety regarding the pandemic has decreased at this time compared to how you felt during other phases of the pandemic?	Yes/No
Coronavirus Anxiety Scale (CAS)	16. I felt dizzy, lightheaded, or weak when I read or heard news about the coronavirus
	17. I had trouble falling or staying asleep because I was thinking about the coronavirus
	18. I felt paralyzed or frozen when I thought about or was exposed to information about the coronavirus
	19. I lost interest in eating when I thought about or was exposed to information about the coronavirus
	20. I felt nauseous or had stomach problems when I thought about or was exposed to information about the coronavirus
Achievement of academic goals	
21. Do you think that due to the pandemic situation you have not achieved the learning objectives necessary for your preparation for the bachelor's degree?	Yes/No

Note: The Coronavirus Anxiety Scale (CAS) is a standardized instrument. Responses are typically scored as follows: 0 (Not at all), 1 (Rarely, for 1-2 days), 2 (Several days), 3 (More than 7 days), 4 (Nearly every day for the past two weeks).

Results and Discussion

The present study aimed to evaluate the prevalence of COVID-19-related anxiety and associated factors among preclinical students in the Medical Surgeon degree program at the University of Guanajuato, twenty months after the onset of the pandemic in Mexico. The sample consisted of 258 preclinical students. Of the total participants, 68.6 % were women and 31.4 % were men. Students' ages ranged from 18 to 26 years ($M = 20.32$; $SD = 1.63$).

Findings related to infection history, pandemic-related fear, social and economic concern, and COVID-19-related anxiety are presented in Table 2. After twenty months of the COVID-19 pandemic, a substantial proportion of preclinical medical students in Mexico continued to report significant levels of anxiety and concern related to the pandemic. Although only 28.29 % of participants reported having contracted the disease, a considerable number indicated indirect exposure, as 74.03 % reported that someone in their household had been infected, and 39.15 % stated that they had lost a relative or close friend due to the virus. Fear levels remained elevated: 70.54 % reported fear of becoming infected, and 74.03 % expressed fear of dying from COVID-19.

Table 2. Prevalence of history of infection, fear, worry, self-perception regarding academic goal achievement, and anxiety.

QUESTIONS		n (%)	
History of infection	Have you contracted COVID-19?	No	185 (71.71)
		Yes	73 (28.29)
	If yes, how severe was your illness?	Asymptomatic	16 (21.92)
		Mild	40 (54.80)
		Moderate	16 (21.92)
		Severe	1 (1.37)
	Has anyone you share a home with contracted COVID-19?	No	67 (25.97)
		Yes	191 (74.03)
	Has anyone you share your home with died from COVID-19?	No	247 (95.74)
		Yes	11 (4.26)
Have any family members or close friends died from COVID-19?	No	157 (60.85)	
	Yes	101 (39.15)	

Continuation

Table 2. Prevalence of history of infection, fear, worry, self-perception regarding academic goal achievement, and anxiety.

Fear	Are you afraid of getting infected with COVID-19?	No	76 (29.46)
		Yes	182 (70.54)
	Are you afraid of dying from COVID-19?	No	67 (25.97)
		Yes	191 (74.03)
	Are you worried that a loved one might get COVID-19?	No	133 (51.56)
		Yes	125 (48.44)
Are you afraid that a loved one will die from COVID-19?	No	126 (48.84)	
	Yes	132 (51.16)	
Worry	Do you think your level of fear regarding the pandemic has decreased at this time compared to how you felt during other phases of the pandemic?	No	45 (17.44)
		Yes	213 (82.56)
	Are you worried about the lack of regular contact you had with other people before the pandemic?	No	51 (19.77)
		Yes	207 (80.23)
	Are you worried about your family's financial situation?	No	87 (33.72)
		Yes	171 (66.28)
Anxiety	Do you think your level of anxiety regarding the pandemic has decreased at this time compared to how you felt during other phases of the pandemic?	Yes	209 (81)
		No	236 (91.47)
	Presence of anxiety according to CAS (>10)	Yes	22 (8.53)
		No	237 (91.47)
	Total score	2.57±3.74.	
	Self-perception regarding the achievement of learning objectives	Do you think that due to the pandemic situation you have not achieved the learning objectives necessary for your preparation for the bachelor's degree?	No
Yes			213 (82.56)

Note: Data are presented as number of participants and percentage (n (%)). The total score for the Coronavirus Anxiety Scale (CAS) is presented as mean ± standard deviation. A total score > 10 is considered indicative of the presence of coronavirus-related anxiety

Additionally, 51.16 % reported fear that a loved one might die from the disease. The pandemic also impacted social and economic aspects, with 80.23 % expressing concern over reduced social contact and 66.28 % reporting worry about their family's financial situation. Nonetheless, 82.56 % perceived a reduction in their level of fear compared to the early stages of the pandemic.

Regarding COVID-19-related anxiety, the findings of this study show that, after twenty months of the pandemic, most preclinical medical students in Mexico presented low levels of anxiety specifically associated with COVID-19. The average score on the CAS was 2.57 ± 3.74 , which falls below the established cutoff (>10) for identifying coronavirus-related anxiety.

Likewise, a low prevalence of anxiety was observed, as only 8.53 % of participants scored above the cutoff (>10), reflecting the presence of anxiety in a small proportion of the sample. Consistently, 81 % of students reported that their anxiety levels had decreased compared to earlier phases of the pandemic. This finding indicates a significantly lower prevalence compared to that previously reported in medical students in Mexico (García-Espinosa *et al.*, 2021; Ruvalcaba Pedroza *et al.*, 2021), and other countries (Halperin *et al.*, 2021; Perissotto *et al.*, 2021). It must be highlighted that the studies were conducted between March and June 2020, during the most intense period of the pandemic. In contrast, our study was conducted nearly two years after the pandemic began in Mexico.

The low prevalence of anxiety observed in our sample may be related to a progressive process of emotional adaptation and resilience in the face of the pandemic. Human beings tend to develop psychological coping mechanisms even under prolonged adverse conditions, a process widely described as resilience, understood as “the capacity to maintain or regain mental health despite experiencing adversity” (Herrman *et al.*, 2011). Given that the present study was conducted twenty months after the onset of the pandemic, students likely underwent a sustained process of adaptation, leading to a natural reduction in anxiety levels associated with the pandemic context. This hypothesis is supported by the findings of Shuster *et al.* (2021), who observed that the passage of time has an attenuating effect on mental health symptoms, particularly among young people.

This process of sustained emotional adaptation was further supported by the positive impact of mass vaccination against SARS-CoV-2, which was widely available to the student population during the data collection period (Gobierno de México, 2022). Vaccination may have contributed directly to lowering anxiety by reducing fear of infection and its potential complications, while also strengthening perceptions of safety and personal control (Koltai *et al.*, 2021; Perez-Arce *et al.*, 2021). In addition, vaccine access among youth was facilitated by greater acceptance, likely attributable to higher health literacy, better access to information, and familiarity with technology use (Babicki *et al.*, 2021; Ramonfaur *et al.*, 2021).

Likewise, the low prevalence of anxiety identified in our sample may also be related to students' prior familiarity with the use of technological tools for learning. Although such tools were mainly complementary before the pandemic, their adoption was not entirely novel nor a source of stress for participants. Current generations of medical students exhibit a high level of exposure to and proficiency with electronic devices and advanced technologies, which may have facilitated their adaptation to virtual teaching modalities implemented during the health emergency.

In line with this, previous studies conducted with students in the United States and Turkey have reported a negative association between eHealth literacy and both fear and anxiety related

to COVID-19, as well as a positive association between fear and anxiety in this context (Ayaz-Alkaya & Belay, 2025). These findings support the hypothesis that higher levels of technological competence may help mitigate anxiety during crisis situations such as the pandemic.

This technological familiarity may have acted as a protective factor, preventing the emergence of an additional source of anxiety linked to the learning process. By not encountering significant difficulties in transitioning to virtual environments, students were likely able to focus their emotional resources on coping with the pandemic itself, thereby strengthening their resilience mechanisms.

Altogether, the combination of progressive emotional adaptation, resilience developed over time, technological familiarity, and the protective effect of vaccination appears to be the main factors explaining the low prevalence of COVID-19-related anxiety observed in this population of medical students. These results suggest that, overall, students have succeeded in developing effective adaptive mechanisms to cope with the prolonged stress generated by the pandemic. Nonetheless, the presence of a subgroup that continues to exhibit significant anxiety levels underscores the importance of maintaining and strengthening psychological support services within educational institutions to allow for the early identification of students who may be at risk of developing long-term emotional complications or functional difficulties.

On the other hand, the present study identified significant sex-based differences in anxiety levels related to the pandemic, as assessed by the Coronavirus Anxiety Scale. Women showed significantly higher scores than men (3.03 ± 4.02 vs. 1.58 ± 2.81 ; $p = 0.004$), suggesting greater susceptibility among women to experience anxiety in response to this public health crisis.

These results are consistent with previous literature documenting that women are at greater risk of developing anxiety disorders in general (Perissotto *et al.*, 2021; Robles *et al.*, 2021), including specifically during the COVID-19 pandemic (Nakhostin-Ansari *et al.*, 2020; Saraswathi *et al.*, 2020). It has been estimated that women may be up to three times more likely to develop anxiety compared to men (Wang *et al.*, 2021). This disparity may be attributed to the complex interplay of multiple genetic, biological, hormonal, environmental, psychological, and social factors (Albert, 2015).

Supporting this, research across various populations during pandemic-related lockdowns has shown that women exhibited higher levels of stress, anxiety symptoms, depression, and sleep disturbances compared to men (Liu *et al.*, 2020; Mazza *et al.*, 2020; Qiu *et al.*, 2020; Zhang *et al.*, 2023). Moreover, some studies have explored differential adaptive responses to stress, observing that in experimental models, females did not exhibit the same adaptive stress responses as males during prolonged testing periods (Dong *et al.*, 2017).

In this context, the greater susceptibility observed in women to develop COVID-19-related anxiety can be explained by the interaction of various biological, hormonal, genetic, psychological, and social factors (Farhane-Medina *et al.*, 2022). From a biological perspective, women experience greater hormonal fluctuations throughout life (puberty, menstrual cycle, pregnancy, postpartum,

and menopause), which have been associated with increased vulnerability to mood and anxiety disorders (Hulubá *et al.*, 2025; Wieczorek *et al.*, 2023). In the neurobiological domain, differences have been identified in the response of the hypothalamic-pituitary-adrenal (HPA) axis, cortisol regulation, and synaptic plasticity, which may contribute to greater emotional reactivity to stress in women (Horváth *et al.*, 2024; Mbiyzenyuy & Qulu, 2024).

On the other hand, social and cultural factors continue to play an important role: women are often more exposed to multiple caregiving roles, greater emotional burdens at home and work, as well as higher levels of perceived vulnerability during health crises (Berg *et al.*, 2022; Stefanova *et al.*, 2021). Additionally, recent post-pandemic meta-analyses have confirmed the persistence of this gender difference in anxiety prevalence, both among students and in the general population, highlighting the need to implement gender-sensitive prevention and treatment strategies (Ariha *et al.*, 2024; Panchal *et al.*, 2023).

These findings emphasize the importance of considering sex differences in mental health assessments and the development of specific interventions. Early identification of vulnerable groups, such as women, will allow for the design of more effective prevention and treatment strategies tailored to the specific needs of each subpopulation, especially in crisis contexts such as that experienced during the COVID-19 pandemic.

The present study identified multiple factors significantly associated with the presence of COVID-19-related anxiety in medical students (Tables 3, 4, and 5). Among them, the direct or indirect experience of infection with the virus stands out. Students who reported having contracted COVID-19, especially those who experienced a severe course of the illness, showed higher levels of anxiety, in line with previous research documenting an increased risk of developing psychiatric sequelae in COVID-19 survivors (Taquet *et al.*, 2021), as well as an association between the severity of the illness and mood disorders, particularly in young patients (Durbas *et al.*, 2021). Although these findings suggest a relationship between illness severity and emotional impact, additional longitudinal studies are needed to clarify the underlying neurobiological mechanisms and potential long-term sequelae.

Table 3. Chi-square test results for infection history and COVID-19-related anxiety.

<i>HISTORY OF CONTAGION</i>			
Anxiety	Have you contracted COVID-19?		
	No	Yes	
Without anxiety	185	51	$\chi^2=60.951$
With anxiety	0	22	$p > 0.001^*$

Continuation

Table 3. Chi-square test results for infection history and COVID-19-related anxiety.

Anxiety	If yes, how severe was your illness?				
	Asymptomatic	Mild	Moderate	Severe	
Without anxiety	16	10	7	0	$\chi^2=31.846$ $p > 0.001^*$
With anxiety	0	30	9	1	
Anxiety	Has anyone you share a home with contracted COVID-19?				
	No	Yes			
Without anxiety	67	169			$\chi^2=8.437$ $p = 0.004^*$
With anxiety	0	22			
Anxiety	Has anyone you share your home with died from COVID-19?				
	No	Yes			
Without anxiety	228	8			$\chi^2=5.137$ $p = 0.023^*$
With anxiety	19	3			
Anxiety	Have any family members or close friends died from COVID-19?				
	No	Yes			
Without anxiety	147	89			$\chi^2=2.394$ $p = 0.122$
With anxiety	10	12			

Note: Data are presented as observed frequencies (n). The chi-square value (χ^2) and p-value (p) are reported for each test. An asterisk (*) denotes statistical significance ($p < 0.05$).

Table 4. Chi-square test results for fear, worry, and anxiety with COVID-19-related anxiety.

FEAR			
Are you afraid of getting infected with COVID-19?			
Anxiety	No	Yes	
Without anxiety	76	160	$\chi^2=10.043$ $p = 0.002^*$
With anxiety	0	22	
Are you afraid of dying from COVID-19?			
Anxiety	No	Yes	
Without anxiety	67	169	$\chi^2=8.437$ $p = 0.004^*$
With anxiety	0	22	
Are you afraid that a loved one might get COVID-19?			
Anxiety	No	Yes	
Without anxiety	133	103	$\chi^2=25.590$ $p > 0.001^*$
With anxiety	0	22	
Are you afraid that a loved one will die from COVID-19?			
Anxiety	No	Yes	
Without anxiety	126	110	$\chi^2=0.002$ $p = 0.964$
With anxiety	0	22	
Do you think your level of fear regarding the pandemic has decreased at this time compared to how you felt during other phases of the pandemic?			
Anxiety	No	Yes	
Without anxiety	33	203	$\chi^2=1.958$ $p = 0.325$
With anxiety	3	19	
WORRY			
Are you worried about the lack of regular contact you had with other people before the pandemic?			
Anxiety	No	Yes	
Without anxiety	47	189	$\chi^2=0.038$ $p = 0.845$
With anxiety	4	18	

Continuation

Table 4. Chi-square test results for fear, worry, and anxiety with COVID-19-related anxiety.

Anxiety	Are you worried about your family's financial situation due to the pandemic?		
	No	Yes	
Without anxiety	84	152	$\chi^2=4.341$ $p = 0.037^*$
With anxiety	3	19	

ANXIETY

Anxiety	Do you feel that your level of anxiety regarding the pandemic has decreased at this time compared to how you felt during other phases of the pandemic?		
	No	Yes	
Without anxiety	53	183	$\chi^2=0.256$ $p = 0.607$
With anxiety	6	16	

Note: Data are presented as observed frequencies (n). The chi-square value (χ^2) and p-value (p) are reported for each test. An asterisk (*) denotes statistical significance ($p < 0.05$).

Table 5. Chi-square test results for academic achievement and COVID-19-related anxiety.

ACHIEVEMENT OF ACADEMIC OBJECTIVES

Anxiety	Do you think that due to the pandemic situation you have not achieved the learning objectives necessary for your preparation for the bachelor's degree?		
	No	Yes	
Without anxiety	44	192	$\chi^2=12.778$ $p = 0.046^*$
With anxiety	1	21	

Note: Data are presented as observed frequencies (n). The chi-square value (χ^2) and p-value (p) are reported for each test. An asterisk (*) denotes statistical significance ($p < 0.05$).

Similarly, living with people who had contracted or died from COVID-19 was also associated with higher levels of anxiety. This finding is consistent with previous studies identifying having infected family members or friends as a major predictor of poorer mental health, including elevated levels of anxiety (Cao *et al.*, 2020; Saraswathi *et al.*, 2020). The close experience of illness in the family environment may generate an increased perception of vulnerability and fear, exacerbating adverse emotional responses.

Furthermore, students who expressed concern about their family's financial situation during the pandemic showed a higher prevalence of anxiety. These results align with previous reports documenting a strong relationship between financial insecurity and mental health problems, including anxiety (Shuster *et al.*, 2021; Witteveen & Velthorst, 2020). Economic difficulties not only represent a direct source of stress but also increase mental burden, affecting perceptions of job stability and future economic security. In this context, future research has suggested the need to explore the potential protective effects of governmental financial support on students' mental health (Shuster *et al.*, 2021).

Moreover, fear of COVID-19 also showed a strong correlation with anxiety levels, a finding consistent with the meta-analysis by Şimşir *et al.*, (2021) and with the conceptualization of COVID-19 fear as a phobic-type manifestation within the anxiety disorder spectrum (American Psychiatric Association, 2013). While a certain level of concern in the face of a real threat can be adaptive and promote protective behaviors (Taylor, 2020), excessive and persistent fear may lead to significant emotional and functional deterioration (Prihidko *et al.*, 2020).

Taken together, these results highlight the multifactorial complexity of the anxiety experienced during the pandemic, combining personal experiences of illness, close exposure to the virus, economic factors, and individual emotional responses such as fear. Identifying these risk factors is crucial for designing targeted interventions and more effective psychological support programs for medical students, particularly in the context of health crises.

Finally, several factors were found to be associated with higher levels of COVID-19-related anxiety, including being female, having contracted the disease, having had a more severe clinical course, fear that a loved one might become infected, and the perception of not having achieved the necessary academic learning goals (**Table 6**).

Table 6. Association between history of infection, fear, worry, and students' self-reported perception of academic goal achievement and scores on the Coronavirus Anxiety Scale.

Variables	Scores on the Coronavirus Anxiety Scale		
	β	CI 95 %	p
Sex			
Female	0.460	-1.242 a 0.584	0.040*
Male	Reference		
Age			
Teenagers	0.378	-1.232 a 1.988	0.645
Young adults	Reference		
Have you contracted COVID-19?			
Yes	5.762	5.135 a 6.389	<0.001*
No	Reference		
If yes, how severe was your illness?			
Severe	1.791	1.072 a 2.509	<0.001*
Moderate	0.362	-0.119 a 0.843	0.140
Mild	0.072	-1.055 a 1.199	0.901
Asymptomatic	0.018	0.003 a 0.092	0.932
Not applicable	Reference		
Has anyone you share a home with contracted COVID-19?			
Yes	-0.265	-0.747 a 0.217	0.282
No	Reference		
Has anyone you share your home with died from COVID-19?			
Yes	0.301	-0.689 a 1.290	0.552
No	Reference		
Have any family members or close friends died from COVID-19?			
Yes	0.377	-0.035 a 0.789	0.073
No	Reference		
Are you afraid of getting infected with COVID-19?			
Yes	0.039	-0.508 a 0.586	0.890
No	Reference		

Continuation

Table 6. Association between history of infection, fear, worry, and students' self-reported perception of academic goal achievement and scores on the Coronavirus Anxiety Scale.

Are you afraid of dying from COVID-19?			
Yes	-0.116	-0.652 a 0.419	0.670
No	Reference		
Are you worried that a loved one might get COVID-19?			
Yes	1.559	0.491 a 2.627	0.004*
No	Reference		
Are you afraid that a loved one will die from COVID-19?			
Yes	-0.070	-1.123 a 0.982	0.896
No	Reference		
Do you think your level of fear regarding the pandemic has decreased at this time compared to how you felt during other phases of the pandemic?			
Yes	0.279	-0.319 a 0.877	0.361
No	Reference		
Are you worried about the lack of regular contact you had with other people before the pandemic?			
Yes	-0.218	-0.736 a 0.300	0.410
No	Reference		
Are you worried about your family's financial situation due to COVID-19?			
Yes	-0.008	-0.427 a 0.412	0.971
No	Reference		
Do you feel that your level of anxiety regarding the pandemic has decreased at this time compared to how you felt during other phases of the pandemic?			
Yes	-0.075	-0.560 a 0.410	0.762
No	Reference		
Do you think that due to the pandemic situation you have not achieved the learning objectives necessary for your preparation for the bachelor's degree?			
Yes	2.014	-0.338 a 2.765	0.004*
No	Reference		

Note: Results present beta regression coefficients (β), 95% confidence intervals (95% CI), and p-values. An asterisk (*) denotes statistical significance ($p < 0.05$). "Reference" indicates the reference category for each variable.

In particular, students who felt they had not achieved their learning goals reported both higher prevalence and levels of anxiety. This finding aligns with previous studies that have identified an inverse relationship between anxiety levels and perceptions of academic self-efficacy (Alemany-Arrebola *et al.*, 2020). Likewise, it has been described that anxiety may be negatively related to academic performance, affecting both student achievement and their confidence in their own abilities (Gutiérrez-García & Landeros-Velázquez, 2018).

During the pandemic, the abrupt shift to virtual teaching modalities posed a significant challenge for many students, who were unable to fully adapt to the new learning dynamics. Recent studies have reported that online learning was not entirely accepted by students, and that some experienced a decline in academic performance under this format (Basheti *et al.*, 2021; Bolatov *et al.*, 2021). This perception of academic insufficiency, combined with uncertainty regarding the development of essential clinical and practical competencies in medical training, may have contributed to the increased anxiety observed in this subgroup of students.

In this regard, the findings reinforce the need for educational institutions to consider not only emotional aspects but also academic and training-related factors when designing comprehensive support strategies for medical students. Implementing competency recovery programs, personalized tutoring, and emotional support services may be crucial to mitigating the impact of anxiety associated with perceived learning deficits.

This study has several limitations. It is a cross-sectional design, which prevents the establishment of causal relationships between the variables studied. Additionally, the questionnaire was self-administered, which may affect the accuracy of the results due to self-reporting or social desirability biases, potentially leading to underestimation or overestimation of anxiety levels. Another important limitation is the absence of longitudinal follow-up, which would have allowed for the assessment of anxiety trends over time and the determination of symptom persistence or fluctuation depending on the progression of the pandemic and other contextual factors such as vaccination or the return to in-person activities. Nevertheless, this study provides evidence on the prevalence of anxiety among medical students 20 months after the onset of the pandemic in the country, and highlights that the mental health burden may be greater in particular groups. Therefore, tailoring specific psychological interventions for each vulnerable group constitutes a priority for future research and prevention strategies.

Conclusions

Twenty months after the onset of the COVID-19 pandemic, preclinical medical students continue to experience significant levels of fear, concern, and, to a lesser extent, anxiety related to the pandemic. Although the prevalence of anxiety was low, multiple factors were associated with its presence, including a personal or familial history of COVID-19 infection, fear of self or loved ones becoming infected, concern about the family's financial situation, and the perception of not having met academic goals during the pandemic. Additionally, female students exhibited

significantly higher levels of anxiety compared to male students, reflecting potential sex-based differences in emotional vulnerability.

Furthermore, several factors were found to be associated with higher COVID-19-related anxiety scores, including being female, having contracted the disease, having experienced a more severe clinical course, fear of a loved one becoming infected, and the perception of not having achieved the necessary learning outcomes for academic training.

These findings underscore the multifactorial nature of anxiety in this context, where personal, familial, economic, academic, and psychological aspects converge. Despite the emotional adaptability demonstrated by most students, a vulnerable subgroup persists that could benefit from preventive interventions and psychological support. Therefore, educational institutions must implement comprehensive strategies for emotional support, academic recovery, and continuous monitoring to mitigate the long-term adverse effects on the mental health and professional training of future physicians.

Author contributions

Work conceptualization: LGMM, CRVO, TGC, LELV, NYCA; Methodology: LGMM, CRVO, TGC, LELV, NYCA; Software management: LGMM, CRVO, TGC, LELV, NYCA; Experimental validation: LGMM, CRVO, TGC, LELV, NYCA; Data analysis: LGMM, CRVO, TGC, LELV, NYCA; Data management: LGMM, CRVO, TGC, LELV, NYCA; Manuscript writing and preparation: LGMM, CRVO, TGC, LELV, NYCA; Drafting, reviewing, and editing: LGMM, CRVO, TGC, LELV, NYCA; Project administration: LGMM, CRVO, TGC, LELV, NYCA.

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Informed consent statement

Participants (>18 years old) were required to be actively enrolled in the Bachelor of Medicine program at the University of Guanajuato and to provide informed consent. This study was conducted in compliance with the Mexican Official Standard NOM-012-SSA3-2012 and the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

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