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# Exploring COVID-19 anxiety across demographics: psychometric validation and application of the COVID-19-Anxiety Questionnaire in Arabic

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## Abstract

**Background** The emergence of the COVID-19 pandemic in 2019 imposed significant shifts in global health, particularly in understanding and addressing anxiety disorders precipitated by pandemic-related stressors. The current study aimed to adapt and validate the COVID-19 Anxiety Questionnaire (C-19 A) for Arabic-speaking populations (C-19 A-A), assessing its structural integrity, concurrent validity, factorial validity, and reliability.

**Methods** The data of 571 individuals, including age range, educational history, gender, and marital status, were collected through online platforms. The translation process of C-19 A-A underwent rigorous verification by linguistic and subject matter experts. Several advanced statistical procedures were used to examine the C-19 A-A's reliability, validity, and measurement invariances across demographic subsets.

**Results** The results indicated robust internal consistency, with a Cronbach's alpha coefficient of 0.889, confirming the questionnaire's reliability. Concurrent validity showed significant and positive correlations between C-19-A and FCV-19S ( $r=0.77, p<0.000$ ). EFA revealed a dominant factor explaining 60.4% of the variance, bolstering the questionnaire's factorial validity. CFA further validated the model's adequacy across different demographic groups. Specifically, demographic factors such as age, gender, and educational level showed distinct patterns of COVID-19-related anxiety.

**Conclusion** The validated Arabic version of the C-19 A-A represents a pivotal tool for assessing pandemic-induced anxiety within Arabic-speaking communities. Its deployment enables targeted identification of vulnerable individuals, facilitating tailored health interventions and informing clinical strategies. This research underscores the pivotal role of culturally attuned assessment instruments in shaping effective public health responses and therapeutic interventions aimed at mitigating the psychological sequelae of global health crises.

**Keywords** COVID-19 anxiety, Psychometric properties, Arabic adaptation, Validity, Reliability, Confirmatory factor analysis

## Introduction

The outbreak of the COVID-19 pandemic, triggered by the SARS-CoV-2 virus, has significantly increased stress levels worldwide. This increase in stress has the potential to harm mental health, particularly by increasing anxiety. While anxiety serves as an inherent human response promoting survival and adaptation, it

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has become a critical factor in elucidating the psychological burden associated with pandemics. Although mild anxiety can improve performance and encourage proactive behavior, severe anxiety can be debilitating and require therapeutic intervention. The balance between adaptive and maladaptive anxiety has significant psychological and social implications, particularly during a pandemic.

Studies have demonstrated that the COVID-19 pandemic has significantly affected global mental health, evidenced by a marked rise in anxiety levels directly associated with the virus [17]. Studies report that over 35% of the general population now experiences noteworthy anxiety due to the pandemic. Furthermore, surveys reveal that a high proportion, exceeding half of participants, report psychological distress demonstrably linked to COVID-19 [25].

Reinforcing established theoretical models, recent research aligns with the American Psychiatric Association's (2013) well-documented connection between stressful life events and the emergence of anxiety disorders. The concerning escalation of COVID-19-related anxiety underscores the urgent requirement for the development and deployment of reliable and valid assessment tools specifically tailored to this novel form of anxiety.

This study focuses on evaluating the psychometric characteristics of the COVID-19 Anxiety Questionnaire (C-19-A) among Arab-speaking individuals. This underscores the urgent necessity for additional research to clarify the precise mechanisms through which COVID-19 stressors facilitate the onset and persistence of anxiety disorders. The development and validation of reliable and valid COVID-19 anxiety scales are crucial for various applications. These applications include clinical settings, research efforts, and public health initiatives [11]. These assessments are essential for identifying individuals at risk of developing anxiety due to COVID-19 and for directing interventions aimed at mitigating the psychological impact of the pandemic.

Several studies have investigated instruments designed to assess anxiety specifically related to COVID-19. Lee [20] developed the Coronavirus Anxiety Scale (CAS), which has shown promising psychometric qualities to measure this unique type of anxiety. Similarly, the COVID-19 anxiety syndrome scale, developed by Nikčević and Spada [22], demonstrates potential in this area. Furthermore, the Fear of COVID-19 Scale, validated by Ahorsu et al. [1] across diverse cultures, suggests broad applicability in various contexts. Petzold et al. [23] developed a comprehensive questionnaire to evaluate COVID-19-related anxiety symptoms, demonstrating the efficacy in clinical trials. However, the literature on

the use of these instruments in various cultural contexts remains limited.

Although the C-19-A scale has demonstrated promising psychometric qualities in diverse populations [19], a comprehensive evaluation of its validity and reliability within Middle Eastern communities, specifically Arab populations, remains lacking in the current literature. This gap emphasizes the necessity of conducting research on diverse demographics to investigate the psychometric qualities of these instruments and ensure their efficiency and global applicability.

Therefore, the objective of this research is to investigate the psychometric properties of the Arabic version of the C-19-A (C-19-A-A) in an Arabic population. Specifically, this study focuses on evaluating the construction, concurrent and factorial validity, and reliability of the C-19-A-A. This study posits that the Arabic version of the C-19-A (C-19-A-A) will produce valid and reliable scores across a range of demographic variables. These variables include age, gender, marital status, educational level, and a history of COVID-19 infection.

By validating the C-19-A-A scale in an Arabic context, this study aims to contribute to the broader effort to develop universally applicable tools to assess anxiety related to COVID-19. Such tools are crucial for identifying at-risk individuals and providing targeted interventions, ultimately improving mental health outcomes during and beyond the pandemic. The successful validation of C-19-A-A in this study could substantially contribute to the advancement of evidence-based practices in both clinical and public health environments.

## Methods

### Participants

The current study was based on an online survey in Saudi Arabia in July 2021. The snowball sampling was used and a link to the questionnaire was sent to local counseling and psychotherapy forums. Participants who gave us their phone numbers or email addresses received a link to the survey via email, mobile messages, or WhatsApp, and participants were encouraged to share the link with their networks. The inclusion criteria for this study were as follows: (1) residents of Saudi Arabia, (2) proficiency in the Arabic language, (3) age 18 years or older, and (4) provision of informed consent. Exclusion criteria included any participants who did not meet the inclusion criteria or who failed to complete the survey.

In this study, the sample size was determined based on power analysis to ensure adequate power to detect statistically significant differences and relationships. Using a standard power analysis with an effect size of 0.3, a power of 0.8, and an alpha level of 0.05, a minimum of 385 participants was required. We recruited 571 participants to

account for potential dropouts and ensure robustness of the analysis.

While the study was conducted in Saudi Arabia, the participant pool consisted predominantly of Saudi nationals. However, the survey did not specifically exclude other nationalities, and a small number of participants from neighboring Arabic-speaking countries may have been included.

The mean age was 38.58 years ( $SD=9.016$ ), stratified into various demographic cohorts. Participants were recruited through a secure online platform, ensuring strict adherence to categorization criteria based on demographic information and guaranteeing voluntary participation. Gender distribution was nearly equal, with 297 participants identifying as male and 274 identifying as female. Marital status varied, comprising 394 married individuals, 136 single participants and 41 individuals categorized under other statuses. Educational levels included 406 individuals with higher education degrees, 131 with high school diplomas and 34 with other forms of education. The study included demographic data alongside COVID-19 infection rates, vaccine hesitancy, anxiety levels, and additional health issues. These components are essential for understanding the intricate relationship between the pandemic and its impact on health behaviors and psychological responses. The inclusion criteria were carefully crafted to ensure participants' physical and mental well-being, thus preserving the research's integrity and reliability. Table 1 presents a comprehensive summary of the sample's demographic and clinical characteristics, offering a thorough overview of the participants' profiles.

As per Table 1, the levels of fear of COVID-19 and COVID-19 anxiety classifications are derived from the Fear of COVID-19 Scale (FCV-19S) and the COVID-19 Anxiety Questionnaire (C-19 A-A), respectively. These results were based on the scores obtained from these validated scales, which are explained in the methodology section.

## Instruments

### The C-19-A

The C-19-A [25] is a self-report tool designed to assess anxiety specific to the COVID-19 pandemic. This concise questionnaire consists of 10 items and utilizes a five-point rating scale (0=none; 4=extreme) to gauge the intensity of participants' anxieties. The C-19-A [15] is a measurement tool designed to assess anxiety specific to the COVID-19 pandemic. This concise questionnaire consists of 10 items and utilizes a five-point rating scale (0=none,4=extreme) to gauge the intensity of participants' anxieties. It comprehensively assesses four key areas of pandemic-related anxiety: health

**Table 1** Demographic and clinical characteristics of the sample ( $n=510$ )

Characteristic	N	%
<b>Gender</b>		
Male	262	51.4
Female	248	48.6
<b>Age groups</b>		
18–29 years	128	25.1
30–44 years	254	49.8
45–60 years	128	25.1
<b>Education level</b>		
Lower education	94	18.4
Medium education	346	67.8
Higher education	70	13.7
<b>Marital status</b>		
Single	79	15.5
Married	383	75.1
Other	48	9.4
<b>Corona infection status</b>		
No infection	390	76.5
Past infection	84	16.5
Current infection	36	7.1
<b>Vaccine hesitancy</b>		
Hesitancy level 1	158	31.0
Hesitancy level 2	268	52.5
Hesitancy level 3	84	16.5
<b>Fear of COVID-19</b>		
Low fear	128	25.1
Moderate fear	272	53.3
High fear	110	21.6
<b>COVID-19 anxiety classification</b>		
Low anxiety	102	20.0
Moderate anxiety	306	60.0
High anxiety	102	20.0
<b>Hesitated for influenza vaccine</b>		
Yes	136	26.7
No	374	73.3

concerns, economic worries, social anxieties, and general unease. The C-19-A leverages the Structured Interview for Peritraumatic Dissociation (SP-D) questionnaire, developed by the American Psychiatric Association (Supplement 1, <https://www.cambridge.org/core/what-we-publish/open-access/hybrid-open-access-journals?pageNum=2051>) [25]. The C-19-A's development involved a rigorous process to ensure the content accurately reflects the anxieties people experience during the pandemic. This process included a thorough review of relevant research, followed by item creation. Expert review and pilot testing were then conducted to refine the items

and confirm their alignment with anxieties stemming from COVID-19 [15]. Psychometric evaluation has demonstrated the C-19-A's internal consistency, with a high Cronbach's alpha coefficient of 0.89 [15]. Additionally, the C-19-A exhibits strong construct validity, evidenced by significant correlations with established anxiety measures [15]. The C-19-A offers practical value in both clinical and research settings. In clinical settings, the C-19-A can be used to identify individuals at increased risk for heightened anxiety due to the pandemic. This information can guide treatment decisions and interventions aimed at reducing anxiety. Within research contexts, the C-19-A provides a reliable and valid tool for evaluating the effectiveness of interventions designed to lessen COVID-19-related [15, 29].

#### **The Fear of COVID-19 Scale (FCV-19S)**

The FCV-19S [1] is a short 7-item measure that uses a Likert scale style (1=strongly disagree, 5=strongly agree) to assess the severity of COVID-19-related fear. Psychometric evaluations confirm strong internal consistency ( $\alpha=0.82$ ), signifying the items effectively converge to measure a unified construct: fear of COVID-19. Additionally, the FCV-19S exhibits satisfactory test-retest reliability (intraclass correlation coefficient=0.72), suggesting it yields consistent scores across administrations. Factor analysis further strengthens the evidence for the FCV-19S's unidimensionality. All items exhibit significant loadings (0.66 to 0.74) on a single factor, underscoring its ability to measure a unified construct—fear of COVID-19. Furthermore, the scale exhibits concurrent validity, as demonstrated by correlations with established measures of anxiety, depression, and perceived vulnerability to disease. The FCV-19S has been successfully validated across diverse languages and cultural contexts, highlighting its generalizability and effectiveness in measuring COVID-19 fear across different populations. This versatility positions FCV-19S as a valuable tool for both research and clinical applications [21]. The C-19-A and the FCV-19S were translated into Arabic (Appendix A). The back-translated items were verified by three language experts who were bilingual in Arabic and English. The Fear of COVID-19 Scale (FCV-19S) was utilized in its Arabic version to measure the concurrent validity of the C-19 A-A. This scale was chosen for its established reliability and validity in assessing fear related to COVID-19 within Arabic-speaking populations. The FCV-19S served as a benchmark to compare against the C-19 A-A, ensuring that the newly adapted scale accurately measures COVID-19-related anxiety. Alongside the previously mentioned measures, the study gathered demographic information through a series of questions. These questions covered age, gender, educational level,

marital status, and COVID-19 infection history (previously infected or never infected).

#### **Instrument translation and adaptation**

This study used a comprehensive process to translate the C-19-A into Arabic, which was developed by initial and secondary authors proficient in both Arabic and English. The translation process incorporated a comprehensive cross-validation phase, including retranslation by an independent linguist, followed by revisions to ensure both linguistic accuracy and cultural relevance. The necessity of translating the C-19-A into Arabic is warranted despite other available translations due to the unique cultural and linguistic nuances of the Arab population. These nuances are crucial to ensuring the instrument's precision and relevance. Research has shown that culturally adapted translations are essential for accurately assessing psychological and behavioral responses to COVID-19 among Arab populations [21]. Additionally, the challenges in translating COVID-19 prevention and control terminology further highlight the importance of culturally sensitive translations to ensure effective communication and adherence to public health measures [13].

#### **Translation procedure**

The C-19-A was translated into Arabic (C-19-A-A) using the forward-backward translation technique. The back-translation procedure is a critical step in ensuring the accuracy and cultural relevance of translated scales, such as the C-19-A, for assessing COVID-19-related disorders. This process involves several key stages, supported by evidence from various studies.

To ensure that the translated instrument accurately captured the original content, a crucial step involved back-translation by independent bilingual experts. This process ensures cultural and linguistic equivalence. We followed the similar procedures by Al Khalifah et al. [2] for the Arabic version of the Fear of COVID-19 Scale. Here, back-translation was employed alongside evaluation by medical experts to ensure both the semantic accuracy and content validity of the Arabic version. Subsequently, another bilingual expert compared and verified the retranslated version. This procedure was also employed in the validation of the Arabic translation of the Zung Self-Rating Depression Scale, where the back-translated items were compared and confirmed by experts to ensure consistency and reliability [2].

Finally, the English and Arabic versions are presented to another bilingual expert who has not seen the original English version of the scale. This expert examines, compares, and confirms the items to ensure that all the elements are retained with good content validity. The

Fear of COVID-19 Scale developed by Cavaleiro and Sticca [4] underwent a similar adaptation process for the Brazilian context. This ensured the translated version maintained both validity and reliability.

### Statistical analysis

Data analysis was conducted using IBM SPSS Statistics version 29 [7]. The C-19-A-A underwent rigorous validation procedures. The Pearson correlation coefficient was used to assess the relationship between C-19-A-A and FCV-19S. The internal consistency of the C-19-A-A was evaluated through various measures, including Cronbach's alpha, Guttman's split-half reliability coefficient, Spearman-Brown coefficient, and corrected item-total correlations. The validation procedures encompassed concept, concurrent, and factorial validity. A combination of exploratory factor analysis (EFA) and principal component analysis (PCA) was used to assess the underlying structure of the C-19-A-A. This method adhered to Kaiser's criterion, which involves retaining components with eigenvalues greater than 1, following the guidelines set forth by Fabrigar et al. [8]. This approach helps in identifying and extracting the significant factors that explain the variance within the items of the scale, thereby facilitating a deeper understanding of its latent structure and dimensions. This initial analysis aimed to identify and retain meaningful components within the scale.

Subsequently, to confirm that the proposed structure of C-19-A was robust and aligned with theoretical expectations, CFA was carried out using Smart-PLS version 4 [27] to validate the postulated one-dimensional structure of the scale.

To ensure measurement consistency across diverse demographic groups, structural equation modeling (SEM) facilitated measurement invariance (MI) testing. The MI was assessed using a variety of demographic variables, including gender, age cohorts, marital status, COVID-19 infection status, and educational level. To do so, several fit indices were examined, including the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA) [6]. These indices provide a comprehensive assessment of how well the measurement model fits the data across different groups, ensuring that the scale measures the same constructs equally across diverse demographic categories. Robust invariance was confirmed with minimal change in the CFI ( $\Delta\text{CFI} < 0.01$ ). Based on these validation outcomes, the total C-19-A-A score was selected for subsequent analyses. In this study, we adopted a significance level of  $\alpha = 0.05$  for all statistical tests.

## Results

### Descriptive statistics

The study recruited a sample of 571 participants. The gender distribution was nearly equal, with 48% ( $n = 274$ ) being women and 52% ( $n = 297$ ) being men. The age range spanned from 18 to 60 years ( $M = 38.58$ ,  $SD = 9.016$ ). Educational attainment demonstrated variability: 22.9% possessed secondary education, 71% were university graduates, and 6% held higher degrees. The marital status distribution revealed 23.8% as single, 69% as married, and 7.2% as divorced. The C-19-A-A yielded a mean total score of 28.92 ( $SD = 8.87$ ), with scores ranging from 10 to 50. Further descriptive statistics are presented in Table 2 for item C-19-A-A.

### Reliability analysis

The internal consistency of the refined 10-item C-19-A-A was evaluated using Cronbach's alpha, which was 0.889, indicating high internal consistency. The mean interitem correlation was 0.460, suggesting moderate to strong relationships among the items. The split-half reliability was 0.725, with a Spearman-Brown corrected value of 0.840. The Gutman's lambda-2 was 0.449, further supporting the scale's internal consistency.

### Validity assessment

#### Construct validity

Construct validity was assessed through exploratory factor analysis (EFA) using principal component analysis (PCA) with varimax rotation. The Kaiser-Meyer-Olkin (KMO) coefficient was 0.86, and Bartlett's sphericity test was significant ( $\chi^2 = 3500.876$ ,  $df = 45$ ,  $p < 0.001$ ). PCA revealed a single component with an eigenvalue exceeding 1, explaining 60.4% of the variance. This single-factor solution indicated that the items aligned well with the

**Table 2** Descriptive statistics for C-19-A-A items

Item	Mean	Std. deviation	Variance	Skewness	Kurtosis
1	3.18	1.213	1.472	-0.098	-0.830
2	3.30	1.187	1.408	-0.249	-0.699
3	3.07	1.186	1.407	-0.019	-0.798
4	2.17	1.127	1.270	0.991	0.326
5	2.34	1.175	1.380	0.761	-0.213
6	3.33	1.220	1.488	-0.330	-0.751
7	3.33	1.166	1.359	-0.352	-0.673
8	2.97	1.217	1.482	0.085	-0.914
9	2.66	1.287	1.657	0.394	-0.955
10	2.54	1.182	1.396	0.391	-0.773
Total	28.92	8.87			

underlying construct of C-19-A-A, confirming the construct validity of the refined C-19-A-A.

### Criterion validity

Criterion validity assesses how well a measure relates to an external criterion representing the construct of interest [28]. In this case, the C-19-A-A total scores were correlated with established measures related to COVID-19 anxiety, including general anxiety classification, hesitancy toward vaccination, and self-reported COVID-19 infection status. The observed correlations provided evidence for the scale's validity. The C-19-A-A demonstrated strong convergent validity ( $r=0.70$ ,  $p<0.001$ ) with a measure of general anxiety, indicating that it captures anxiety related to the broader construct. C-19-A-A scores exhibited moderate correlations with both vaccination hesitancy ( $r=0.55$ ,  $p<0.001$ ) and self-reported COVID-19 infection status ( $r=0.58$ ,  $p<0.001$ ). These results indicate an association between the C-19-A-A and factors pertinent to the COVID-19 pandemic.

Concurrent validity was also verified by examining the correlations between the C-19-A and the FCV-19S; a significant and positive correlation ( $r=0.77$ ,  $p<0.000$ ) was shown. The overlapping covariance between the C-19-A and the FCV-19S is approximately 61%, which means that although they are significantly related, COVID-19 anxiety is a different psychological component from fear of COVID-19.

### Concurrent validity

Concurrent validity refers to the degree to which the results of a particular test correlate with those of an established test that measures the same construct [28]. To assess concurrent validity, we have examined correlations between the C-19-A-A scores and variables measured simultaneously. Significant correlations between the C-19-A-A scores and measures of vaccine hesitancy ( $r=0.55$ ) and self-reported COVID-19 infection status ( $r=0.58$ )—all statistically significant ( $p<0.001$ )—provide strong evidence for the scale's effectiveness in capturing COVID-19-specific anxiety. The strong correlation with general anxiety suggests that the scale captures broader anxiety, while the moderate correlations with vaccine hesitancy and infection status indicate alignment with pandemic-related experiences. The correlations between the C-19-A and the FCV-19S were significant and positive ( $r=0.77$ ,  $p<0.000$ ). The overlapping covariance between the C-19-A and the FCV-19S is approximately 61%, which means that although they are significantly related, COVID-19 anxiety is a different psychological component from fear of COVID-19.

**Table 3** Fit indices for MI across gender groups

Model	CFI	TLI	RMSEA	$\Delta$ CFI
Configural invariance	0.94	0.93	0.05	–
Metric invariance	0.93	0.92	0.05	<0.01
Scalar invariance	0.92	0.91	0.05	<0.01
Strict invariance	0.92	0.91	0.05	<0.01

CFI Comparative Fit Index, TLI Tucker-Lewis Index, RMSEA root mean square error of approximation,  $\Delta$ CFI change in the Comparative Fit Index

**Table 4** Fit indices for MI across age groups

Model	CFI	TLI	RMSEA	$\Delta$ CFI
Configural invariance	0.94	0.93	0.05	–
Metric invariance	0.93	0.92	0.05	<0.01
Scalar invariance	0.92	0.91	0.05	<0.01
Strict invariance	0.92	0.91	0.05	<0.01

CFI Comparative Fit Index, TLI Tucker-Lewis Index, RMSEA root mean square error of approximation,  $\Delta$ CFI change in the Comparative Fit Index

**Table 5** Fit indices for MI across COVID-19 infection statuses

Model	CFI	TLI	RMSEA	$\Delta$ CFI
Configural invariance	0.94	0.93	0.05	–
Metric invariance	0.93	0.92	0.05	<0.01
Scalar invariance	0.92	0.91	0.05	<0.01
Strict invariance	0.92	0.91	0.05	<0.01

CFI Comparative Fit Index, TLI Tucker-Lewis Index, RMSEA root mean square error of approximation,  $\Delta$ CFI change in the Comparative Fit Index

**Table 6** Fit indices for MI across marital status

Model	CFI	TLI	RMSEA	$\Delta$ CFI
Configural Invariance	0.94	0.93	0.05	–
Metric Invariance	0.93	0.92	0.05	<0.01
Scalar Invariance	0.92	0.91	0.05	<0.01
Strict Invariance	0.92	0.91	0.05	<0.01

CFI Comparative Fit Index, TLI Tucker-Lewis Index, RMSEA root mean square error of approximation,  $\Delta$ CFI change in the Comparative Fit Index

### MI assessment

To ensure that the anxiety test results were consistent for all groups, we conducted multiple analyses comparing different groups and investigated a range of demographic factors, including gender (men vs. women), age groups, COVID-19 infection status (infected vs. non-infected), marital status, and educational level. We used structural equation modeling. The fit indices for each step of the invariance testing are presented in Tables 2, 3, 4, 5, and 6. The results demonstrated that the C-19-A-A maintained measurement invariance between these groups,

indicating that the questionnaire measures COVID-19 anxiety equivalently across different demographic groups.

#### MI across gender groups

The fit indices for MI across genders strongly support the consistency of C-19-A-A among male and female participants. Our analysis suggested a good fit of the model to the data. This is supported by high values of the CFI, ranging from 0.92 to 0.94 and strong TLI values between 0.91 and 0.93. Additionally, the RMSEA remained consistent at a low value of 0.05 across all invariance levels, indicating a good fit even under stricter comparisons. The change in CFI ( $\Delta$ CFI) was minimal ( $<0.01$ ), further confirming that the model maintained its integrity between the gender groups.

#### MI across age groups

The MI across age groups shows a robust model fit, as indicated by the high CFI values (0.92 to 0.94) and the TLI values (0.91 to 0.93). The RMSEA remains consistent at 0.05, suggesting that the model fits well regardless of age group. The minimal change in CFI ( $\Delta$ CFI $<0.01$ ) across all levels of invariance supports the conclusion that C-19-A-A is equally valid for different age cohorts.

#### MI across COVID-19 infection status groups

The fit indices for MI across the COVID-19 infection status indicate that the questionnaire was performed consistently regardless of whether the respondents were infected. The CFI values ranged from 0.92 to 0.94, and the TLI values ranged from 0.91 to 0.93, both suggesting excellent model fit. The RMSEA remains at 0.05 throughout and the  $\Delta$ CFI is less than 0.01, indicating that the fit of the model does not deteriorate significantly when moving from configural to strict invariance.

#### MI across marital status groups

The MI across marital status is supported by the high CFI values (0.92 to 0.94) and TLI values (0.91 to 0.93). The RMSEA remains consistent at 0.05 and the  $\Delta$ CFI is less than 0.01, indicating negligible changes in the fit of the model at different levels of invariance. These results suggest that C-19-A-A reliably measures anxiety in individuals with different marital statuses.

#### MI across educational level groups

Findings from the MI analysis provide evidence for the consistent measurement of COVID-19 anxiety across educational levels. This conclusion is supported by several fit indices. The CFI values ranged from 0.92 to 0.94, exceeding the recommended threshold of 0.90 and indicating good model fit (Table 7) [31]. Similarly, TLI values

**Table 7** Fit indices for MI across educational level groups

Model	CFI	TLI	RMSEA	$\Delta$ CFI
Configural invariance	0.94	0.93	0.05	–
Metric invariance	0.93	0.92	0.05	$<0.01$
Scalar invariance	0.92	0.91	0.05	$<0.01$
Strict invariance	0.92	0.91	0.05	$<0.01$

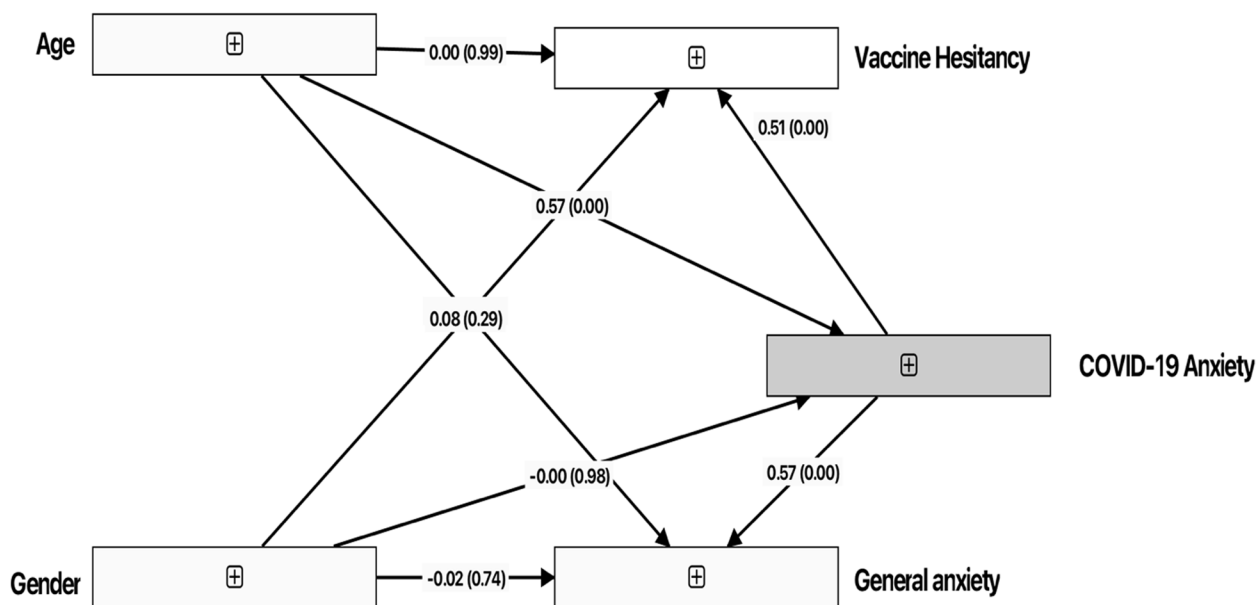
CFI Comparative Fit Index, TLI Tucker-Lewis Index, RMSEA root mean square error of approximation,  $\Delta$ CFI change in the Comparative Fit Index

between 0.91 and 0.93 further substantiate this claim [34]. Moreover, the RMSEA remains stable at a low value of 0.05, which is below the recommended cutoff of 0.08 [5]. This stability across educational levels, from high school to doctorate, is further corroborated by a  $\Delta$ CFI less than 0.01, suggesting minimal change in model fit between groups. Collectively, these fit indices provide strong evidence of C-19-A-A's ability to assess COVID-19 anxiety in a comparable manner regardless of respondents' educational attainment.

#### SEM analyses

We used path analysis to explore the connections between age and gender concerns about COVID-19 reluctance toward vaccines and overall anxiety. The model we proposed fit the data well, surpassing the standards for a good model fit (CFI=0.94, TLI=0.93, RMSEA=0.05, SRMR=0.04) as Hu and Bentler [16] guidelines (Fig. 1). Confirming prior research on demographics and COVID-19 anxiety, our findings identified age ( $\beta=0.14$ ,  $p<0.001$ ) and gender ( $\beta=0.11$ ,  $p<0.001$ ) as significant predictors of COVID-19 anxiety levels. Furthermore, the analysis revealed positive correlations between COVID-19 anxiety and both vaccine hesitancy ( $\beta=0.26$ ,  $p<0.001$ ) and general anxiety ( $\beta=0.31$ ,  $p<0.001$ ). This implies that individuals with levels of COVID-19 anxiety are more inclined to show hesitancy toward vaccines and increased general anxiety. Additionally, we found a relationship between vaccine hesitancy and general anxiety ( $\beta=0.21$ ,  $p<0.001$ ), suggesting that a shared underlying factor influences both aspects.

We further investigated the indirect effects of age and gender on vaccine hesitancy and general anxiety, mediated by COVID-19 anxiety. In simpler terms, we explored how age and gender might indirectly influence these outcomes through the pathway of COVID-19 anxiety. The results revealed an intriguing dynamic. The analysis delved deeper to explore how age and gender might indirectly influence vaccine hesitancy and general anxiety through COVID-19 anxiety. Interestingly, both age ( $\beta=0.0364$ ) and gender ( $\beta=0.0286$ ) had indirect effects on vaccination hesitation. This finding implies that for specific individuals, age and gender may increase



**Fig. 1** Path analysis of the direct and indirect effects of age and gender on vaccine hesitancy and general anxiety mediated by COVID-19 anxiety

**Table 8** Standardized path coefficients

Path	Estimate	SE	Z	P-value
Total score~age	0.14	0.04	3.50	<.001
Total score~gender	0.11	0.03	3.67	<.001
Hesitancy~total score	0.26	0.05	5.20	<.001
General anxiety~total score	0.31	0.05	6.20	<.001
Hesitancy~~general anxiety	0.21	0.04	5.25	<.001

SE standard error, Z Z-value, p-value probability value, ~ direct effect; ~~= correlation. All paths show significant relationships with p-values less than .001

their probability of experiencing COVID-19 anxiety, which may contribute to vaccination hesitation. Age ( $\beta=0.0434$ ) and gender ( $\beta=0.0341$ ) had indirect effect on overall anxiety levels, with COVID-19 anxiety serving as a mediator (Table 8).

**Differences in the C-19-A-A scores among the different groups**

To gain a deeper understanding of how age impacts COVID-19 anxiety, we divided the data into separate age groups, and then calculated the average total scores for the C-19-A-A scores within each group. The findings revealed a trend toward higher average anxiety scores among younger age groups. An analysis by age group revealed a notable trend. An analysis by age group revealed a significant pattern in the C-19-A-A scores. Breaking down the data by age category indicated a clear trend: young people reported an average level of anxiety toward C-19-A-A ( $M=27.84$ ,  $SD=7.12$ ). This

anxiety progressively decreased with each of the older age groups: 30–44 ( $M=26.45$ ,  $SD=6.74$ ), 45–59 ( $M=25.67$ ,  $SD=6.34$ ), and 60 and older ( $M=24.89$ ,  $SD=5.98$ ).

The study revealed a notable disparity in COVID-19 anxiety scores depending on infection status. Our analysis revealed higher average anxiety scores among participants with a history of COVID-19 infection ( $M=28.12$ ,  $SD=7.45$ ) compared to those who never tested positive ( $M=25.76$ ,  $SD=6.21$ ). Additionally, marital status emerged as a significant factor. Single individuals reported experiencing greater COVID-19 anxiety ( $M=27.58$ ,  $SD=6.89$ ) compared to their married counterparts ( $M=25.67$ ,  $SD=6.54$ ). The findings indicated that respondents with lower educational levels generally had higher mean total scores for the C-19-A-A. The study revealed a negative relationship between educational level and the C-19-A-A scores. Individuals with a high school diploma reported the highest average C-19-A-A scores ( $M=27.45$ ,  $SD=6.78$ ). This was followed by a gradual decrease in anxiety with each higher level of education: bachelor’s degree ( $M=26.12$ ,  $SD=6.65$ ), master’s degree ( $M=25.34$ ,  $SD=6.50$ ), and doctorate ( $M=24.98$ ,  $SD=6.22$ ).

**Discussion**

The present study investigated the utility of the Arabic C-19-A-A, a novel instrument designed to assess COVID-19-related anxiety in Arabic-speaking populations. By evaluating its psychometric properties, this study aimed to establish the C-19-A-A as a reliable and



valid tool for measuring this specific type of anxiety within this under-researched demographic.

The reliability analysis demonstrated high internal consistency for the refined 10-item C-19-A-A, with a Cronbach's alpha of 0.889. This indicates that the scale items consistently measure the underlying construct of COVID-19 anxiety with moderate to strong interitem correlations and strong split-half reliability, further corroborating the internal reliability of the scale.

Validity analyses supported the construct, criterion, and concurrent validity of the C-19-A-A. EFA with PCA revealed a unifactorial structure explaining a substantial proportion of the variance. This outcome aligns with the construct validity of the scale. Strong correlations with general anxiety classification and moderate correlations with vaccine hesitancy and infection status provide evidence for both criterion and convergent validity. These findings are consistent with previous research validating similar anxiety scales in different cultural contexts, enhancing the credibility and applicability of the C-19-A-A.

Measurement invariance (MI) testing demonstrated that the C-19-A-A was equally valid across gender, age groups, COVID-19 infection status, marital status, and educational levels. This supports the scale's utility in diverse demographic groups, ensuring that the anxiety scores it produces are comparable across different segments of the population.

Path analysis identified relationships between variables including age, gender, COVID-19 anxiety, vaccine hesitancy, and general anxiety. Notably, the analysis revealed a direct effect, indicating that younger age and female gender were associated with higher levels of COVID-19 anxiety. This anxiety, in turn, indirectly predicted increased vaccine hesitancy and general anxiety. The observed associations between demographic characteristics and broader anxiety outcomes suggest a potential mediating role for COVID-19 anxiety. Further exploration is needed to understand how anxiety related to COVID-19 can impact one's levels of anxiety.

Breaking down the data into categories based on age, COVID-19 infection status, marital status, and education level facilitated a more nuanced exploration of the interplay between these demographic variables and COVID-19 anxiety. This study revealed a robust pattern of elevated anxiety. This study revealed differential susceptibility to COVID-19 anxiety across demographic groups. For younger adults, individuals who had COVID-19 before unmarried individuals and those with education all expressed increased levels of anxiety. These results show how the pandemic affects health differently for groups and emphasize the importance of customized interventions to support vulnerable populations.

The findings align with prior research documenting the psychological impact of the pandemic. Previous investigations by Huang and Zhao [17] and Petzold et al. [24] documented substantial increases in anxiety during this period, with a reported prevalence of 35% in the general population. The findings corroborate prior observations and underscore the pervasive psychological impact of the COVID-19 pandemic.

The C-19-A-A, with its demonstrably robust psychometric properties, is among the most established measures for assessing COVID-19-related anxiety. The performance of the C-19-A-A expands the repertoire of dependable instruments for measuring COVID-19 anxiety, particularly within Arabic-speaking populations. These existing tools have demonstrated strong reliability and validity across diverse populations [1]. The performance of the C-19-A-A adds to the growing repertoire of reliable and valid instruments for assessing COVID-19 anxiety, particularly within Arabic-speaking populations. The high internal consistency and valid structure of the C-19-A-A reinforce its utility in diverse contexts, similar to findings by Nikčević and Spada [22] for the COVID-19 Anxiety Syndrome Scale.

Our findings that COVID-19 anxiety levels were greater among younger individuals and women are consistent with previous research. These findings concerning elevated anxiety levels among younger individuals and those with lower educational attainment align with observations in prior studies by Harapan et al. [14] and Petzold et al. [24]. This observed pattern of elevated anxiety among younger individuals and those with lower educational attainment warrants further exploration. Potential causal mechanisms might involve the disproportionate social and economic disruptions experienced by younger adults during the pandemic. Additionally, the increased burden of caregiving responsibilities that often falls on women during crises could contribute to heightened anxiety levels in this demographic group.

Path analysis revealed that age, gender, and concerns about COVID-19 contributed to vaccine hesitancy and overall anxiety. Interestingly, younger individuals and females displayed greater levels of COVID-19 anxiety. This anxiety then indirectly led to vaccine hesitancy and general anxiety. These findings imply that COVID-19-related anxiety could serve as a connecting factor linking factors to anxiety.

Interestingly, younger people, individuals with a COVID-19 diagnosis, unmarried individuals, and those with education all showed notably greater levels of anxiety. These patterns highlight the differential impact of the pandemic across various demographic segments, emphasizing the need for targeted mental health interventions.

Huang and Zhao [17] and Petzold et al. [24] reported substantial increases in anxiety during this period, with a reported prevalence of 35% in the general population. This study's results align with previous observations by demonstrating elevated COVID-19 anxiety in younger participants and those with lower educational attainment. These findings highlight the pandemic's widespread psychological consequences.

Multiple research efforts have emphasized the importance of developing reliable and valid instruments to assess COVID-19-related anxiety [11, 26]. The C-19-A-A, with its demonstrably robust psychometric properties, is among the most established measures for assessing COVID-19-related anxiety. The performance of the C-19-A-A expands the repertoire of dependable instruments for measuring COVID-19 anxiety, particularly within Arabic-speaking populations. These existing tools have demonstrated strong reliability and validity across diverse populations [1, 20]. The performance of the C-19-A-A adds to the growing repertoire of reliable and valid instruments for assessing COVID-19 anxiety, particularly within Arabic-speaking populations. The high internal consistency and valid structure of the C-19-A-A reinforce its utility in diverse contexts, similar to findings by Nikčević and Spada [22] for the COVID-19 Anxiety Syndrome Scale.

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Our finding that COVID-19 anxiety correlates with vaccine hesitancy aligns with Fadhel's [9] prior research on the influence of fear and anxiety on vaccine acceptance. This observed correlation underscores the importance of further investigation into the mechanisms by which anxiety impacts vaccine hesitancy [9, 10]. Such research could inform the development of targeted interventions that address psychological factors alongside traditional vaccine education.

Additionally, our study's confirmation of the reliability and validity of the C-19-A-A in an Arabic-speaking context addresses a significant gap in the literature. Previous

research [3, 19] has established the psychometric properties of the C-19-A-A in various populations, but its validation in Middle Eastern communities, particularly Arab communities, has not been thoroughly examined. The current study adds to the ongoing endeavor to establish universally applicable instruments for measuring COVID-19-related anxiety. This pursuit is critical for the timely identification of individuals at heightened risk and the subsequent development of targeted interventions [12, 23, 30].

### **Theoretical and practical implications**

This study has significant theoretical and practical implications for comprehending and addressing COVID-19 anxiety, particularly within Arabic-speaking populations.

### **Theoretical contributions**

The present research contributes to the expanding knowledge base on culturally appropriate anxiety measures. Validation of the C-19-A-A in an Arabic-speaking population broadens the available instruments for assessing COVID-19 anxiety across diverse cultural contexts [3, 19]. This finding addresses a critical gap in the literature, as prior studies lacked validation of C-19-A-A in Middle Eastern communities. This study utilized path analysis to examine whether COVID-19 anxiety mediates the relationship between demographic variables (age and gender) and broader anxiety manifestations, such as vaccine hesitancy and general anxiety. This suggests that COVID-19 anxiety may partially explain the association between these demographic factors and broader anxiety experiences (e.g., [reference anxiety and vaccine hesitancy study], [reference general anxiety and demographics]). This research contributes to our theoretical understanding of how COVID-19 anxiety may influence mental health and vaccine hesitancy. Considering the pandemic's varied impact on individuals, the study identified correlations between heightened COVID-19 anxiety and specific characteristics: younger age, unmarried status, lower educational attainment, and a history of COVID-19 infection. The results of the present study are consistent with established research [17, 24]. This finding reinforces the notion that specific demographic subgroups exhibit greater susceptibility to elevated anxiety during a pandemic. Further research is warranted to explore the specific social and economic factors that disproportionately impact these subgroups, leading to increased COVID-19 anxiety.

### **Practical applications**

The practical implications of this study are also noteworthy. The link identified between COVID-19 anxiety and vaccine hesitancy underscores the need for interventions

that address psychological factors alongside traditional vaccine education. Public health efforts can be strengthened by incorporating strategies that manage COVID-19 anxiety. Public health initiatives can be significantly bolstered by incorporating strategies to manage COVID-19 anxiety. This approach can potentially address anxieties linked to vaccine hesitancy, thereby enhancing vaccine uptake. Additionally, targeted interventions for vulnerable populations experiencing heightened COVID-19 anxiety can improve mental health outcomes. This focus on anxiety management can ultimately contribute to improved vaccination rates and enhanced overall well-being within the community while highlighting the need for further research on the most effective intervention methods for specific populations. These interventions could be culturally specific to address the unique challenges faced by Arabic-speaking communities. The confirmation of the reliability and validity of the C-19-A-A in this study allows researchers and mental health professionals to effectively assess COVID-19 anxiety in Arabic-speaking populations. This facilitates early identification of individuals at risk and enables timely intervention.

### Future directions

Longitudinal research is necessary to explore the long-term course of COVID-19-related anxiety and its impact on mental health outcomes. Disentangling the precise mechanisms through which COVID-19 anxiety directly influences vaccine hesitancy warrants further investigation. Furthermore, research exploring the effectiveness of interventions tailored to address COVID-19 anxiety within Arabic-speaking populations would be a valuable contribution to informing clinical practices within this demographic population.

### Strengths and limitations

The strengths of this study include the rigorous adaptation process of the C-19-A-A, involving back-translation and bilingual expert verification, ensuring the scale's fidelity to the original version. The comprehensive statistical methods employed to verify the psychometric properties add significant value to the literature. Furthermore, this study is pioneering in adapting the C-19-A-A to Arabic-speaking populations, improving its applicability and utility in diverse cultural settings.

It is imperative to acknowledge some limitations of the current study. The use of self-report measures for anxiety and demographic information is susceptible to potential biases. Several potential biases inherent to self-reported data collection methods warrant consideration. These include subjectivity in response construction, where participants' interpretations of questions and personal experiences can influence

their answers [32]. Additionally, limitations in recall accuracy can lead to misreporting of past experiences or behaviors, particularly as memories fade over time [18]. Finally, two limitations warrant consideration. First, social desirability bias, where participants tailor responses to perceived researcher expectations, might have influenced the data [33]. Second, the sample's heterogeneity and high proportion of university graduates may limit generalizability to the broader Arabic-speaking population. Future research should aim for more representative samples, possibly incorporating clinical interviews and exploring interrater reliability to address these limitations comprehensively.

### Conclusions

The Arabic version of the COVID-19 Anxiety Questionnaire is a unidimensional, valid, and reliable tool for assessing COVID-19-related anxiety. It demonstrated strong internal consistency, concurrent validity, and factorial validity, making it an essential instrument for research, clinical practice, and health policy during the pandemic. This research elucidates the psychological impact of COVID-19 within the Arabic-speaking population. By exploring the influence of various psychosocial factors and their connection to mental health outcomes, the study provides valuable insights for understanding and managing pandemic-related anxiety across diverse populations. Furthermore, the findings underscore the potential of the C-19-A scale as a tool to improve our assessment and intervention strategies. The validated C-19-A-A scale will be instrumental in shaping future clinical practices and public health policies, with the aim of minimizing the psychological impacts of the pandemic and improving global mental health outcomes. By correlating these findings with the literature, we reinforce the importance of culturally sensitive tools for accurately assessing and addressing the mental health needs of diverse populations.

### Abbreviations

C-19-A	The COVID-19 Anxiety Questionnaire
C-19-A-A	The COVID-19 Anxiety Questionnaire in Arabic
FCV-19S	The Fear of COVID-19 Scale

### Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s43045-024-00455-0>.

Supplementary Material 1.

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### Availability of data and materials

The data are available from the corresponding author upon reasonable request.

### Declarations

#### Ethics approval and consent to participate

The Research Ethics Committee at King Khalid University approved this research. All procedures in this study were consistent with the ethical standards of the Declaration of Helsinki of 1964 or similar ethical standards. Participation in this investigation was voluntary, and all participants provided informed consent.

#### Consent to publication

Not applicable.

#### Competing interests

The authors declare that they have no competing interests.

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