



# COVID-19 anxiety, psychological well-being and preventive behaviors during the COVID-19 pandemic in Latin America and the Caribbean: relationships and explanatory model

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## Abstract

This study assesses the relationship between COVID-19 anxiety and subjective well-being in terms of the mediating role of COVID-19 preventive behaviors. Additionally, the contribution of sociodemographic factors (sex and age) and risk perception on COVID-19 anxiety and its potential measurement invariance was tested in 5655 participants from 12 countries in Latin America and the Caribbean. A mixture of both latent and observable variables were analyzed using a system of structural equations. The Coronavirus Anxiety Scale (CAS), Preventive COVID-19 Infection Behaviors Scale (PCIBS) and single-item measures were used to assess the perceived probability of death, perceived severity and concern about transmitting COVID-19. The results indicated that there is a significant and relevant direct effect of COVID-19 anxiety on participants' well-being. Furthermore, COVID-19 anxiety significantly predicted both preventive behavior ( $\beta = .29, p < .01$ ) and well-being ( $\beta = -.32, p < .01$ ). The effects of COVID anxiety and preventive behavior explained 9.8% of the variance in well-being ( $R\text{-square} = .098$ ); whereas, 8.4% of the variance in preventive behavior was associated with COVID anxiety ( $R\text{-square} = .084$ ). Likewise, perceived likelihood of death from COVID, perceived severity of COVID, and concerns about COVID transmission were positively related to anxiety. Age was negatively related to anxiety, with men being less anxious than women. The results are invariant by country, i.e., the broad relationships found in the combined sample are also present in each individual country. The findings indicate that, although the exact relationships between variables may vary between countries, there are enough similarities to provide useful information about the impact of the COVID-19 pandemic in each of the countries included in the study.

**Keywords** COVID-19 anxiety · Wellbeing · Preventive behaviors · COVID-19 · Latin America

## Introduction

The COVID-19 has spread rapidly worldwide. As of February 4, 2022, there were more than 389 million reported cases of COVID-19 throughout more than 200 countries worldwide, which have led to more than 5 million reported deaths.

COVID-19 has become a major global health crisis, threatening people's lives and also affecting their mental health (Kola et al., 2021; O'Brien et al., 2020). During the current pandemic, different health professionals around the world have reported high levels of depression, anxiety and stress in the general population (Aknin et al., 2021; Nochaiwong et al., 2021; Wu et al., 2021; Xiong et al., 2020). It has been suggested that the effects of COVID-19 on mental health and well-being will linger even after the pandemic ends (Holmes et al., 2020), extending beyond people who have been directly affected by the disease (O'Connor et al., 2021).

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Mental health problems may be caused by direct effects of the COVID-19 pandemic, such as those associated with fear of COVID-19 infection and perceived danger from the disease (Pfefferbaum & North, 2020). However, they can also be a product of indirect effects associated with financial and economic problems, originated by the COVID-19 pandemic, which contribute to the presence of mental health problems among people in general (Nochaiwong et al., 2021). The pandemic has generated economic complications worldwide, especially in those countries with a higher prevalence of COVID-19, limited healthcare system capacity to cope with the pandemic and greater economic vulnerability (Conceição et al., 2020). Latin America is comprised of middle-income countries that have major economic challenges and limited health resources to cope with the pandemic and maintain physical and mental health (Bargain & Aminjonov, 2021; Bassey et al., 2022; Cifuentes-Faura, 2021). As a result, Latin American countries reported more mental health problems from COVID-19 compared to other geographical regions (Olf et al., 2021). In addition to economic difficulties and fragile healthcare systems, the greater impact of the pandemic on health in Latin America could also be associated with low perceived government effectiveness in managing the spread of COVID-19 (Benítez et al., 2020; Mækela et al., 2020a, b). This highlights the importance of deeper research on mental health in the general population of Latin America and the Caribbean with the aim of providing knowledge that will serve for the development of public policies that address the mental health problems generated during the current pandemic (Gallegos et al., 2020a, b; Hernández et al., 2021). To this end, transnational policies should be generated and an agenda of priorities to be addressed in the Latin American and Caribbean region should be defined (Gallegos et al., 2021).

During the course of the pandemic, a decrease in people's level of well-being has been reported, which has been related to an increased presence of anxiety symptoms (Sønderskov, et al., 2021). Specifically, increased worry has been reported about people's present and future situation (Giallonardo et al., 2020; Usher et al., 2020). The perceived severity of the pandemic, the increase in the perceived probability of death and the concern about transmitting the disease have led to symptoms of anxiety (Roy et al., 2020), which negatively impacts subjective well-being (Paredes et al., 2021). Likewise, evidence suggests that anxiety has a significant impact on preventive behavior (Velikonja et al., 2020). Excessive avoidance and increased preventive behaviors may result in increased COVID-19 anxiety symptoms; while those with very low levels of anxiety are often less likely to comply with recommended steps to diminish the spread of the pandemic, because they don't think it is necessary (Wong et al., 2020). Similarly, preventive behaviors are an important predictor of mental health and well-being. In this

sense, the performance of preventive behaviors, associated with increased anxiety, and their improvement through different strategies, contribute to people's mental health and well-being (Yıldırım, & Güler, 2020).

Several factors may explain the variations in the relationship between anxiety, preventive behaviors and their effects on well-being. For example, those who feel that they are likely to become infected with COVID-19 and those who feel they are likely to die from it are more likely to exhibit higher levels of anxiety and higher likelihood of preventive behaviors (Velikonja et al., 2020). It appears that higher perceived vulnerability and anxiety tend to increase levels of preventive behaviors, which can contribute to improving overall public health during a pandemic. However, at excessive levels, maladaptive behaviors may be used (Taylor, 2019). Gender may also play a role, as women have reported higher levels of not only anxiety but also perceived vulnerability and preventive behaviors in comparison to levels reported by men (Liu et al., 2020; Olaimat et al., 2020). On the other hand, anxiety seems to significantly mediate the effect of age on preventive behaviors; specifically, anxiety would increase preventive behaviors through higher perceived risk in both middle-aged and younger people (Pasion et al., 2020).

On the other hand, the COVID-19 pandemic could provoke diverse consequences in different societies, and the response to the pandemic could also be very different between countries (Buyukkececi, 2021). In this sense, psychological well-being may vary as a function of the intensity of the COVID-19 pandemic and associated social constraints in a country or region (Sønderskov, et al., 2021). Furthermore, well-being can be used as an important outcome measure of quality of life in different populations and an indicator of the efficacy of various treatment conditions (Sischka et al., 2020). With this in mind, it is imperative to have a cross-national understanding of potential predictors of well-being. Therefore, the main objective of this study was to assess the relationship between anxiety related to COVID-19 and subjective well-being as mediated by preventive behaviors meant to slow the spread of COVID-19. Additionally, the contribution of sociodemographic factors (sex and age) and risk perception on COVID-19 anxiety and its potential measurement invariance.

First, an a priori pattern of relationships was postulated. Based on the existing scientific literature, women are expected to show higher levels of COVID anxiety (hypothesis 1); older individuals exhibit lower levels of anxiety (hypothesis 2); higher perceived severity of COVID-19, higher likelihood of COVID-19 risk of death, and greater concern about transmitting disease lead to higher levels of COVID-19 anxiety (hypothesis 3); COVID-19 anxiety significantly predicts preventive behavior and subjective well-being (hypothesis 4); and finally, preventive behavior

predicts wellbeing (hypothesis 5). However, two models have been tested because we want to know whether the effect of COVID anxiety on well-being is fully mediated or not. Therefore, to the previous hypotheses, we could add hypothesis 6 (COVID anxiety mediates the effects of antecedent variables on well-being) and hypothesis 7 (preventive behavior mediates the effects of antecedents and COVID anxiety on well-being). Figure 1 outlines the hypothesized models tested. Second, we examined measurement invariance across countries using multigroup models. Developing a model that evaluates the impact of different factors on subjective well-being in a sample of 12 Latin American and Caribbean countries has important implications for public health. Thus, the findings would help explain the role of some of the factors involved, which in turn could lead to the development of interventions that address problems related to subjective well-being in Latin American and Caribbean countries during the COVID-19 pandemic (Wilke et al., 2021). This would help to improve mental health services (Thorncroft & Slade, 2014) and guide the health decisions of the different governments in the region (Kusier, & Folker, 2020). Finally, the findings would allow for a general and multinational view of the relationships between variables, generating comparable data among the participating countries.

**Method**

**Design, sample and procedure**

The study used a cross-sectional and explanatory design based on structural equation models (Ato et al., 2013). The target population consisted of individuals from 12 countries in Latin America and the Caribbean: Bolivia, Chile, Paraguay, Cuba, Uruguay, Argentina, Peru, El Salvador, Mexico, Colombia, Guatemala and Ecuador. They were selected by

snowball convenience sampling, according to the following inclusion criteria: 1) being of legal age, 2) residing in one of the 12 participating countries, and 3) giving informed consent to participate in the research study. Snowball sampling has been a widely used technique in studies during the pandemic, as it facilitates obtaining a large number of responses (Roy et al., 2020). The target sample size was 300 people per country, but ranged from 266 to 961 persons depending on the data collection possibilities in each participating country. The recommended total sample size to identify a minimum effect size ( $\delta=0.1$ ) with 80% power and  $\alpha=0.05$  in a model with 3 latent and 5 observed variables was 1258 (Soper, 2022). The final total sample of the present study, 5655 people, exceeded the recommended number of participants.

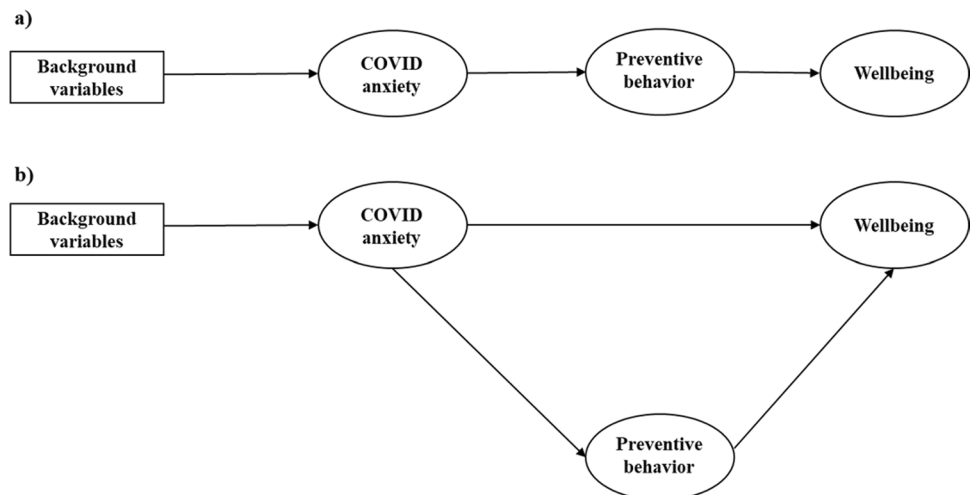
Table 1 shows that the participants who lived in Argentina (M=43.8 years; SD= 16.5 years) had the highest average age; while participants from Cuba (M= 24.8 years

**Table 1** Sociodemographic characteristics of the participants

Countries	Age (M ± SD)	Sex n (%)	
		Male	Female
Bolivia (n=266)	39.4 ± 14.6	78 (29.3%)	188 (70.7%)
Chile (n=560)	36.5 ± 12	134 (24%)	424 (76%)
Paraguay (n=961)	30.8 ± 11.1	225 (23.5%)	733 (76.5%)
Cuba (n=351)	24.8 ± 7.2	132 (37.6%)	219 (62.4%)
Uruguay (n=415)	38.7 ± 14.4	86 (20.7%)	329 (79.3%)
Argentina (n=337)	43.8 ± 16.5	78 (23.1%)	259 (76.9%)
Peru (n=374)	31.5 ± 10.9	119 (31.8%)	255 (68.2%)
El Salvador (n=750)	29.1 ± 8.9	282 (37.8%)	465 (62.2%)
Mexico (n=349)	32.9 ± 13.7	122 (35.2%)	225 (64.8%)
Colombia (n=457)	28.9 ± 13	129 (28.2%)	328 (71.8%)
Guatemala (n=350)	41.3 ± 12.5	125 (35.7%)	225 (64.3%)
Ecuador (n=485)	28.9 ± 10.7	146 (30.1%)	339 (69.9%)

Values highlighted in black show missing values

**Fig. 1** A priori models to predict wellbeing



old;  $SD = 7.2$  years), Colombia ( $M = 28.9$  years old;  $SD = 13$  years) and Ecuador ( $M = 28.9$  years old;  $SD = 10.7$  years) had the lowest average age. It is also worth noting that overall, there were more females ( $> 60\%$ ) than males ( $< 40\%$ ) who participated in this study.

The data were obtained from an online survey, elaborated in Google Forms, which was shared via e-mail and social networks in each of the participating countries. Responding to the survey took approximately 15 to 20 min. In the online survey, first, the study objectives, informed consent, and instructions were presented. Second, questions related to each of the study variables were included. Individuals participated in the study anonymously, voluntarily, and without receiving any financial compensation. The research proposal was approved by the Ethics Committee of the corresponding author's university (registration number: 20213002).

Data in participating countries were collected between the first three months of 2021. In that period, according to Our World in Data (2021), Bolivia had reported 66.33 diagnosed cases per million populations; Bolivia 66.33 cases per million populations; Chile 361.10 cases; Paraguay 268.67 cases; Cuba 81.72 cases; Uruguay 767.75 cases per million populations; Argentina 266.68 cases; Peru 262.33 cases; El Salvador 21.37 cases; Mexico 32.60 cases; Colombia 161.30 cases; Guatemala 27.78 cases; finally, Ecuador had 93.69 cases per million populations. Likewise, according to Oxford University's stringency index, Bolivia had a stringency level of 25.00/100; Chile 79.17/100; Paraguay 50.00/100; Cuba 79.63/100; Uruguay 72.22/100; Argentina 79.19/100; Peru 80.56/100; El Salvador 46.30/100; Mexico 71.76/100; Colombia 81.02/100; Guatemala 54.63/100; finally, Ecuador had a stringency level of 69.44/100. The stringency index measures the level of restrictions that a government applies to the pandemic, based on seven indicators that are rescaled and can vary from 0 to 100, where a higher value indicates the presence of more restrictions in a given country (Hale et al., 2020).

## Measures

### Sociodemographic questionnaire

A simple questionnaire was constructed requesting information on country of residence, gender and age.

### Coronavirus anxiety scale (CAS)

The CAS was originally developed by Lee (2020) with the aim of assessing the frequency of COVID-19 related dysfunctional anxiety symptoms. The CAS is a unidimensional measure originally comprised of 5 items with 5 Likert-type response options ranging from 0 = never to 4 = every day during the past two weeks. The CAS has

been previously translated into Spanish (Caycho-Rodríguez et al., 2020; Caycho-Rodríguez, Carbajal-León, et al., 2021); however, a 4-item Spanish version of the CAS was used in the present study which has been shown to be unidimensional, reliable, and invariant in 12 Latin American countries (Caycho-Rodríguez et al., 2022). High CAS scores express a high frequency of anxiety symptoms related to COVID-19.

### Preventive COVID-19 infection behaviors scale (PCIBS)

The original PCIBS was developed by Chang et al. (2020) and measures the frequency of COVID-19 preventive behaviors. Originally the PCIBS was comprised of five items; however, in the present study a 4-item Spanish version was used, which has been shown to be unidimensional, with adequate reliability and invariance in 12 Latin American countries (Caycho-Rodríguez et al., 2021b). This version has five Likert-type response options for each of the items (1 = almost never to 5 = almost always). The score of each item can be added to give a total score that varies between 4 to 20, where higher scores indicate a higher frequency of preventive behaviors in relation to COVID-19.

### Other measures

Additionally, single-item measures were used. To measure the perceived probability of death from COVID-19 we used the question "How likely is it that a person who gets COVID-19 will die as a result of the disease?" ["¿Qué tan probable es que una persona que se contagie de COVID-19 muera como resultado de la enfermedad?"] which had 6 answer alternatives (1 = virtually nonexistent [prácticamente inexistente], 2 = very small [muy pequeña]; 3 = small [pequeña]; 4 = large [grande]; 5 = very large [muy grande]; 6 = practically 100% [prácticamente 100%]). The COVID perceived risk assessment was conducted with the question "How serious do you consider COVID-19 to be?" ["¿Qué tan grave considera usted que es la COVID-19?"] which had 5 response options (1 = not at all serious [nada grave]; 2 = somewhat serious [algo grave]; 3 = serious [grave]; 4 = quite serious [bastante grave]; 5 = very serious [muy grave]). To assess concern about transmitting COVID-19, the question "How concerned are you about transmitting COVID-19 to another person?" ["¿Cuánto le preocupa transmitir la COVID-19 a otra persona?"] with four response options (1 = not at all [nada]; 2 = somewhat [algo]; 3 = quite a bit [bastante]; 4 = a lot [muchísimo]). These questions, in Spanish, have been used in previous studies during the current COVID-19 pandemic (Caycho-Rodríguez et al., 2021c, d).

## Statistical analyses

Descriptive statistics and a sequence of Structural Equation Models (SEM) were estimated. Descriptive statistics were calculated in SPSS 26, whereas the SEMs were estimated in Mplus 8.7 (Muthén & Muthén, 1998–2017). The sequence of models tested is shown in Fig. 1. The first model is a total mediation model in which several background variables impact on anxiety related to COVID-19, which impacts on wellbeing through a mediator, the preventive behavior. The second model is a partial mediation model. It is exactly like model 1, but includes an additional parameter, the direct effect of anxiety related to COVID-19 on wellbeing. These two models are nested.

The two models in Fig. 1 were estimated with Weighted Least Squares Mean and Variance corrected (WLSMV) which performs well for ordinal and non-normal variables (Hancock & Mueller, 2013). Several goodness-of-fit indexes from different families, as suggested by Tanaka (1993), were employed to analyze data-model fit. Specifically, we considered: a) the chi-square test; b) the Comparative Fit Index (CFI); c) the Standardized Root Mean Residual (SRMR); and d) the Root Mean Square Error of Approximation (RMSEA) with its 90% confidence interval. CFI above 0.90 (even better above 0.95), as well as RMSEA and SRMR below 0.08, indicate good model fit (Marsh et al., 2004).

These two models were first estimated in the overall sample coming from 12 different countries. Once the best-fitting model was established, this model was compared across countries with a multigroup SEM routine by country (van de Schoot et al., 2012). The multigroup routine had three steps. First, a configural model was tested for each country's data, without confining equalities across countries, thus serving as a baseline for further models. Second, all factor loadings were constrained to be equal for the entire dataset (i.e., across countries) to assess the moderating effect across countries. Third, a SEM was evaluated where the effects between observed and latent variables were equal across countries. Since each model builds on the one before it, statistical tests, such as chi-square differences or a modeling

strategy of CFI differences, can be used to evaluate if there is a statistically significant difference between the strictest and models with the less constrained models before them in the series (Little, 1997). The most parsimonious model was identified if the chi-square differences are low and the CFI differences are less than 0.01 (Cheung & Rensvold, 2002).

## Results

Table 2 presents the descriptive statistics of the variables in this study. The models in Fig. 1 were estimated and tested. The total mediation model was close to an acceptable model fit:  $\chi^2(123) = 5400.28$ ,  $p < 0.001$ ; RMSEA = 0.087 [0.085, 0.089]; CFI = 0.960; and SRMR = 0.086. However, the partial mediation model had a very good model fit:  $\chi^2(122) = 3275.08$ ,  $p < 0.001$ ; RMSEA = 0.068 [0.066, 0.070]; CFI = 0.976; and SRMR = 0.056. Therefore, there was a significant and relevant direct effect of COVID-19 anxiety on the wellbeing of the participants.

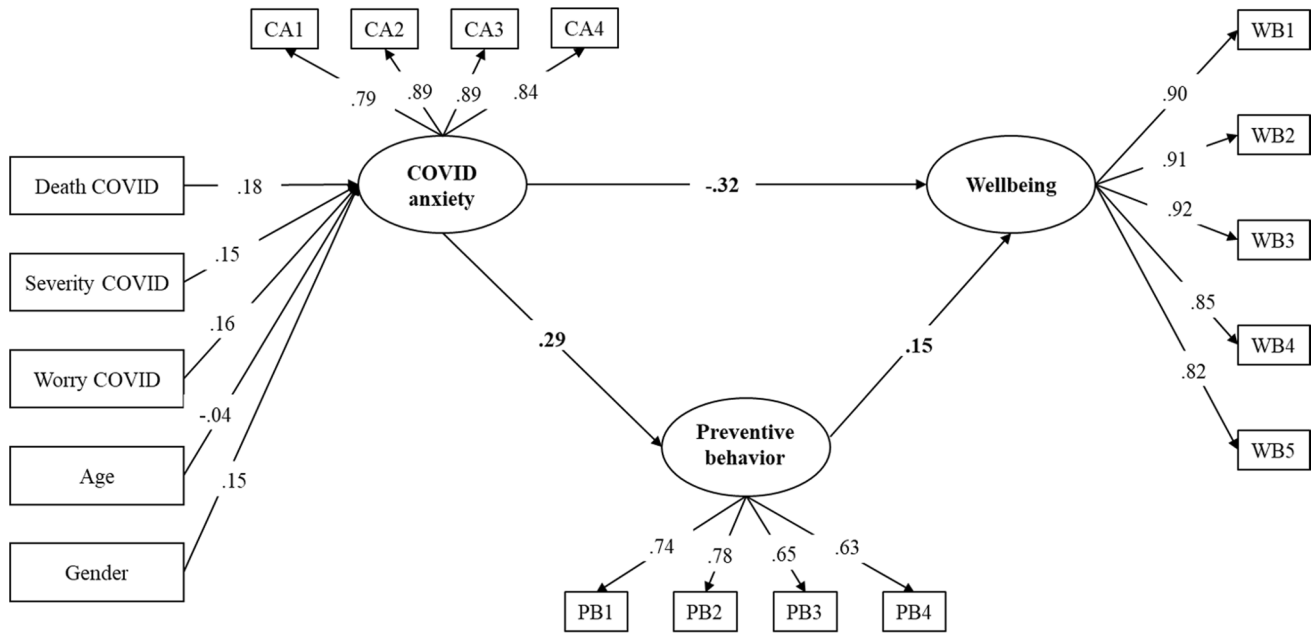
The parameter estimates for this partial mediation SEM are shown in Fig. 2. Anxiety related to Covid-19 significantly predicted both preventive behavior ( $\beta = 0.29$ ,  $p < 0.01$ ) and wellbeing ( $\beta = -0.32$ ,  $p < 0.01$ ), the former positively and the latter negatively. The effects of anxiety related to COVID and preventive behavior were able to explain 9.8% of the wellbeing variance (R-square = 0.098). Regarding preventive behavior, 8.4% of its variance was associated with anxiety related to COVID (R-square = 0.084). The effects of all background variables were statistically significant to predict anxiety related to COVID although with a small magnitude (R-square = 0.187). Perceived probability of death by COVID, perceived severity of COVID and worries about transmitting COVID were all positively related with anxiety. Age was negatively related with anxiety, and men were less anxious than women. The correlations among the background variables are presented in Table 3 (Caycho-Rodríguez, 2017).

After conducting an overall SEM analysis for the entire dataset, the multigroup procedure was tested (Table 4). The

**Table 2** Descriptive statistics, including means, standard deviations (SD), and correlations among the variables in the model

Variable	Mean	SD	LD	RC	WT	Age	GE	CA	AS	WB
Likelihood death COVID (LD)	3.56	1.14	1							
Risk of COVID (RC)	3.83	1.07	.53**	1						
Worry transmit COVID (WT)	3.53	0.75	.27**	.42**	1					
Age	33.04	13.02	-.10**	-.05**	-.08**	1				
Gender (GE)	70.5% female	29.3% male	.11**	.05**	.07**	-.00	1			
COVID anxiety (CA)	3.37	4.31	.28**	.24**	.16**	-.05**	.08**	1		
Preventive behavior (PB)	15.04	3.90	.18**	.27**	.29**	.09**	.10**	.17**	1	
Wellbeing (WB)	9.06	3.66	-.03*	-.04**	-.08**	.18**	-.17**	-.21**	-.00	1

Note: \*Correlations are statistically significant  $p < .05$ ; \*\*Correlations are statistically significant  $p < .01$



**Fig. 2** Final Structural Equation Model to predict wellbeing. Note: for the sake of clarity, correlation among background variables not shown

**Table 3** Correlations among the exogenous variables in the model in Fig. 2

	Age	Sex	Death COVID	Risk COVID	Worry COVID
Age	1				
Sex	-.002 ns	1			
Death COVID	-.085**	.108**	1		
Risk COVID	-.053**	.052**	.535**	1	
Worry COVID	-.087**	.072**	.283**	.441**	1

Note: \*\*Correlations are statistically significant  $p < .01$

small chi-square and CFI differences suggest the absence of moderating effects across countries. When factor loadings are constrained, the differences in chi-square were statistically significant, but this is likely due to the large sample sizes involved, especially since the other fit indices improved. Therefore, the factor loadings can be considered invariant across countries. This is even clearer when effects

are constrained, as the chi-square was significantly reduced, and the CFI improved. This means that the broad relationships found in the overall sample are also found in each individual country included in the study.

### Discussion

The COVID-19 pandemic is the biggest public health problem of the twenty-first century. In this regard, this study assessed more than 5,000 individuals from 12 countries in Latin America and the Caribbean to examine the relationship between COVID-19 anxiety and subjective well-being in terms of the mediating role of COVID-19 preventive behaviors. The findings indicated that preventive behaviors mediated the relationship between COVID-19 anxiety and subjective well-being. In this sense, the hypothesis about the relationship between COVID-19 anxiety, preventive behaviors, and subjective well-being was confirmed.

**Table 4** Model fit indexes for the multigroup models across countries

Models	$\chi^2$	df	$p$	$\Delta\chi^2$	$\Delta df$	$p$	RMSEA [CI 90%]	SRMR	CFI	$\Delta CFI$
Configural	5480.38	1805	<.001	–	–	–	.066 [.064, .068]	.067	.970	–
Equal loadings	5737.84	1915	<.001	316.58	110	<.001	.065 [.063, .067]	.068	.969	.001
Equal loadings and structural effects	5096.60	2003	<.001	202.77	88	<.001	.057 [.055, .059]	.075	.975	.006

The chi-square difference tests and CFI differences are comparing with the less constrained model

Consequently, well-being is threatened by COVID-19 anxiety directly and indirectly, as well as by the infrequency of preventive behaviors.

First, the results suggest that age, sex, and risk perception had an indirect impact on well-being through the presence of COVID-19 anxiety. Age and being female were negatively related to anxiety, which is consistent with other research during the pandemic that reported that the presence of anxiety problems is less prevalent in men and as age increases (e.g., Betron et al., 2020; Hou et al., 2020; Özdin, & Bayrak Özdin, 2020; Xiong et al., 2020). The present study's findings regarding age may be associated with job loss and uncertainty generated by COVID-19, which could be especially stressful for younger people as they may perceive that their academic, social, occupational, and economic prospects are threatened by the pandemic (Huang, & Zhao, 2020; Xiong et al., 2020). The finding that anxiety levels decrease as age increases is curious, as COVID-19 is known to cause greater morbidity and mortality as age increases compared to younger groups of people (Onder et al., 2020). The apparent relationship between age and COVID-19 anxiety seems to suggest that the pandemic may be disproportionately affecting younger people. On this point, further studies are needed to understand more deeply whether this situation is due to a decline in economic prospects or social relationships (Burkova et al., 2021). The finding that women presented greater anxiety than men may be associated with women's greater concern with family care and their greater susceptibility to social isolation (Gebhard et al., 2020; Spagnolo et al., 2020). Likewise, it has been suggested that women are more likely to present anxiety symptoms due to greater genetic sensitivity to disturbing situations, such as COVID-19, the presence of hormonal imbalances, and a higher prevalence of different pre-existing mental health problems among women (Kan et al., 2021). Furthermore, another argument points out that women are socialized to experience emotions more openly compared to men (Fu et al., 2020). This would indicate that women are suffering a greater negative burden to their mental health, leading to the need to develop specific actions to reduce gender-based anxiety (Xiao et al., 2020). However, the results do not agree with another study that reported higher levels of anxiety in men (Wang et al., 2020). This could be associated with lower compliance with preventive measures (Solomou & Constantinidou, 2020), higher frequency of risky behaviors and higher prevalence of contagion in men (Shi et al., 2020). Despite the fact that women presented greater anxiety, the pandemic may be an opportunity to address social dynamics and benefit both men and women, promoting flexible work policies and shared care roles between men and women (Betron et al., 2020). As a whole, studies are inconclusive regarding the prevalence of anxiety according to gender and age. More studies will be needed to assess the impact

of different variables on the relationship between anxiety and well-being, so that they can provide further evidence of the factors involved, and particularly for the population of Latin America and the Caribbean. Identifying the explanatory mechanisms of the relationship between age, gender and COVID-19 anxiety will allow for the implementation of targeted interventions. Although some interventions aimed at improving the mental health of young people based on the Internet have already been used (Ye et al., 2014), there is a need to develop broader interventions for this heterogeneous population group.

In addition, the results suggest that young adults and middle-aged people tend to have a higher perceived risk of COVID-19 than older people. This is similar to what was previously reported, where older people tend to have a lower perceived risk of COVID-19 (Barber & Kim, 2021; Rosi et al., 2021). Increased perceived risk in younger people was found to have direct consequences on COVID-19 anxiety and indirectly impact the adoption of preventive behaviors. This finding is contrary to previous studies that suggest that younger people minimize the risk of COVID-19 infection and, therefore, report less perceived risk and less frequency of protective measures against COVID-19 (Bruine de Bruin, 2021; Carlucci et al., 2020). However, these ideas may be biased and stem from the belief that COVID-19 is an exclusive concern of older people (Jimenez-Sotomayor et al., 2020). While the risk of developing severe symptoms from COVID-19 increases with age (Zhou et al., 2020), it appears that as people age, they focus more on present events, emphasizing meaning and positive emotions, and less on future events (Bechard et al., 2021; Rosi et al., 2021). This has been observed in other studies where older adults had a more positive attitude towards the COVID-19 pandemic and less negative emotions related to exposure to the disease (Carstensen et al., 2020; Ceccato et al., 2021). The fact that older people have more life experiences may have contributed to their higher levels of resilience in coping adequately with the psychological impact of the pandemic (Nwachukwu et al., 2020). The findings in the present study confirm in turn that concerns about the impact of COVID-19 on people's health vary with age.

The above would lead to propose that sex, age and perceived risk would be risk factors for a higher level of COVID-19 anxiety, which independently and negatively predicted subjective well-being. That is, being female, being middle-aged or younger, and having a higher perceived risk of COVID-19 increased the level of COVID-19 anxiety, which decreased subjective well-being. This is in line with previous findings that reported such relationships between anxiety and well-being (Ojiaku et al., 2020; Paredes et al., 2021; Sønderskov, et al., 2021). This relationship can be explained by the sources of information and the presence of conspiracy beliefs about the nature of COVID-19. Probably,

the more individuals in the participating countries believe that COVID-19 is part of a global conspiracy, the greater the anxiety they feel (Leibovitz et al., 2021; Sallam et al., 2020). It has been suggested that emphasizing the idea of death generates more anxiety in people and, consequently, they express less well-being (Juhl & Routledge, 2016). In this sense, being exposed daily to news highlighting deaths by COVID-19, would tend to lead people to feel anxious and present lower well-being (Silva et al., 2021). The importance of resilience in this relationship has also been indicated, where the most resilient people report lower levels of anxiety, which causes a lower impact on well-being (Paredes et al., 2021). Thus, greater resilience would make it possible to better cope with the emotional problems caused by the pandemic. Likewise, it has been argued that measures to contain the pandemic, such as traffic blockades and lockdowns, have had a negative impact on well-being (Galea et al., 2020; Rossi et al., 2020; Wang et al., 2020; Xiao & Torok, 2020).

Additionally, compliance with preventive behaviors is an important factor to consider in models relating different variables during the pandemic (Eržen et al., 2020). In this study, it was also suggested that anxiety had an indirect impact on well-being through the performance or non-performance of preventive behaviors. That is, a higher level of COVID-19 anxiety was associated with a higher frequency of preventive behaviors against disease, which may affect the experience of well-being, as documented by previous studies (Magdy et al., 2022; Velikonja et al., 2020; Wong et al., 2020). This relationship can be explained, since anxiety symptoms may appear in the presence of a potential threat, leading people to perceive a greater vulnerability to risk (assessed in this study from the perception of risk of severity, death or infecting others), which leads them to perform protective behaviors against the disease and, ultimately, protect their mental health and well-being (Barlow, 2004; Brug et al., 2004; Sadique et al., 2007; Yıldırım et al., 2021). This finding is in line with the health belief model, where it is argued that cognitive aspects of health beliefs, where risk perception is included, affect health-related behaviors (Dobe, 2012). On the other hand, it has also been reported that, in situations of outbreak of a new infectious disease, the performance of preventive behaviors can decrease the symptoms of anxiety due, in this case, to COVID-19 (Ersin, & Kartal, 2020; Huang et al., 2020). Thus, it is possible that COVID-related anxiety and preventive behaviors may interact with each other to affect well-being. This interaction between the two variables should be considered in future studies to understand the role of anxiety and preventive behaviors related to COVID in the well-being of people in Latin America during the pandemic.

It has been indicated that appropriate use of the media is important to increase people's confidence from awareness of the disease and its consequences, giving information on

transmission mechanisms, risks and severity of the disease, availability and efficacy of vaccines, advice on pandemic prevention and management, and pandemic information at local and regional levels (Yıldırım, & Güler, 2020). However, while the relationship between COVID-19 anxiety, prevention behaviors, and well-being is clear, public health policy makers in participating countries should use the finding with caution. This is because previous studies have suggested that interventions based on fear or other negative emotions may fail, as increases in these types of emotions may trigger avoidance of disease information (Broomell et al., 2020; Witte, & Allen, 2000).

In large-scale problems, such as the COVID-19 pandemic, it is important to understand the factors associated with psychological consequences in different countries and cultural contexts (Kimhi et al., 2021). The increase in cross-national studies is driven by globalization and cross-cultural awareness (Boer et al., 2018). However, studies on the impact of the COVID-19 pandemic on mental health and well-being in Latin America and the Caribbean have been focused on single-country samples, for example, in Brazil (Vitorino et al., 2021), Peru (Krüger-Malpartida et al., 2020; Ruiz-Frutos et al., 2021), El Salvador (Lobos-Rivera et al., 2022), and Mexico (Martinez Arriaga et al., 2021), among others. This provides a limited opportunity to generalize and apply research results at the regional level. While there may be cross-cultural differences in mental health responses to traumatic experiences (Olf et al., 2021), in this study, it is suggested that the relationships between variables were not different between participating countries. Having an invariant relational model can allow us to better understand the similarities between different countries and help to develop efficient and country-specific measures to address mental health and well-being difficulties in the region (Kimhi et al., 2021). It is possible that the stringent policies implemented by the participating countries to mitigate the spread of the disease affected people in similar ways (Olf et al., 2021). In this regard, it is suggested that dissatisfaction and low perceived effectiveness of government responses to the COVID-19 pandemic would be associated with higher levels of psychological distress (Benítez et al., 2020; Mækela et al., 2020a, b).

The study presents as strengths a large sample size and the focus on the general population in different countries in Latin America and the Caribbean. However, the study has limitations that suggest the results should be applied with caution. First, the findings were based on 12 countries in Latin America, and information could not be generated for other countries in the region. South America was more represented than other regions of the Americas (Central America). In this sense, future studies should try to involve as many Latin American and Caribbean countries as possible in order to have a Latin American explanatory model.



Second, due to the cross-sectional nature, it is only possible to establish associations between study variables. Therefore, future studies should examine how the relationships between variables are affected in the medium and long term through the use of longitudinal designs. Third, since a voluntary, self-administered online survey was used, response bias is possible. To avoid this bias, future studies could consider information derived from objective assessments conducted by mental health professionals, and evaluate if self-reported levels of anxiety, well-being, or risk perception actually coincide with these objective assessments. However, anxiety, well-being, and risk perception are based on personal feelings, highlighting the fact that self-report measures are important during the COVID-19 pandemic (Wang et al., 2021). Also, the use of the snowball recruitment method, and not a randomized method, may limit the generalizability of the results. Therefore, probability sampling should be used in future studies to obtain more representative samples. Fourth, the online survey link was distributed via social, personal, and professional networks. The difficulty in controlling the distribution of the online survey and the variation of contact networks across countries meant that the number of participants in each country was different. Similarly, the participants were predominantly female and with an average age between  $28.9 \pm 13$  and  $43.8 \pm 16.5$  years old. This may raise some concerns, so the results should be interpreted carefully. The higher representation of females in the samples across countries is something commonly observed in psychological studies; therefore, generalizing the findings to males should be done with a degree of caution (Kolakowsky-Hayner et al., 2021). In addition, conducting any study using online surveys is limited to samples that have easy access to the Internet, which is problematic for those places where access is limited or nonexistent. All of the above leads to the existence of a possible risk of sampling bias. Thus, future studies should control the distribution of the online survey by considering homogeneous groups with respect to different sociodemographic characteristics.

Fifth, no data were recorded on the presence of pre-existing mental illness in the participants. Considering this aspect in future research could help to understand whether the relationships between the variables described here may be affected by the presence or absence of pre-existing mental problems. Sixth, although the use of single-item measures can be useful in contexts where participants show low levels of attention, save time, reduce fatigue, lack of motivation and dropout (Konrath et al., 2014), some suggest that they simplify multidimensional variables and prevent the assessment of specific differences between individuals (Nunnally & Bernstein, 1994), generating measurement bias. Therefore, to avoid this bias, the possibility of developing a scale from these single items to measure the likelihood of COVID-19 risk should be evaluated. Seventh, although important

models relating sociodemographic, health, COVID-19 anxiety, preventive behaviors and well-being variables were tested, it is possible that other important models have not been analyzed based on the results reported here. Thus, the findings that women have higher levels of COVID-19 anxiety and preventive behaviors compared to men, and that higher COVID-19 anxiety symptoms increase preventive behaviors through higher perceived risk in different age groups, could imply that gender and age may also moderate the relationship between COVID-19 anxiety and preventive behaviors, and not only be considered antecedent variables. Future studies incorporating the evaluation of models that consider these moderating variables could provide a better understanding of the effect of age and gender on the relationship between COVID-19 anxiety, preventive behaviors, and well-being. Finally, the rates of diagnosed cases of COVID-19 and deaths from the disease and preventive measures varied between countries. This was not evaluated, so it is recommended that the impact of these factors on mental health be investigated in the future.

In conclusion, the present study demonstrated that COVID-19 anxiety significantly predicted preventive behavior and well-being; whereas, perceived probability of COVID death, perceived severity of COVID, and concerns about COVID transmission were positively related to anxiety. Age was negatively related to anxiety and women were more anxious than men. In addition, the relationships between variables were invariant across all countries.

Despite its limitations, this study provides important information at several levels. First, it reports on the impact of sociodemographic, cognitive, emotional and behavioral variables on subjective well-being during the COVID-19 pandemic. Second, although the relationships between variables may vary across countries, there are also similarities that aid in understanding of the impact of COVID-19 on the general population in the participating countries. On a practical level, the findings may be useful for public health practitioners and researchers to identify and support individuals with high levels of COVID-19 anxiety and risk perception, lower levels of preventive behaviors, females, and youth, with the goal of mitigating risks in these subpopulations in all countries assessed. In addition, it is important that COVID-19 preventive behaviors be adequately communicated to the population, but it is also essential to emphasize strategies that contribute to a higher frequency of such behaviors (Lipke et al., 2022). In this sense, the findings could contribute to the development of intervention strategies that seek to reduce the anxiety generated by the pandemic in order to promote both the implementation of preventive behaviors against COVID-19 and promote well-being at the level of the Latin American and Caribbean countries evaluated. For example, the evidence that COVID-19 anxiety has a negative impact on well-being (Gallagher et al., 2021; Silva, et al.,

2021), has served as a basis for digital, Internet or virtual reality intervention procedures that can be useful to reduce its effects (Figuerola & Aguilera, 2020; Lakhtakia & Torous, 2022). Finally, it is worth clarifying that this study does not affirm that the variables evaluated are the only factors that can be used in interventions, but that they are feasible to be addressed through interventions (Lin et al., 2020; Shabahang et al., 2021).

**Data availability** The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Informed consent** Informed consent was obtained from all individual participants included in the study.

**Competing interest** The authors declare that they have no conflict of interest.

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