

The Coronavirus Anxiety Scale: Cross-National Measurement Invariance and Convergent Validity Evidence

Veljko Jovanović¹, Maksim Rudnev², Mohamed Abdelrahman³, Nor Ba'yah Abdul Kadir⁴,
Damilola Fisayo Adebayo⁵, Plamen Akaliyski⁶, Rana Alaseel⁷, Yousuf Abdulqader Alkamali⁸,
Luz Marina Alonso Palacio⁹, Azzam Amin³, Andrii Andres¹⁰, Alireza Ansari-Moghaddam¹¹,
John Jamir Benzon Aruta¹², Hrant M. Avanesyan¹³, Norzihan Ayub¹⁴, Maria Bacikova-Sleskova¹⁵,
Raushan Baikanova¹⁶, Batoul Bakkar⁷, Sunčica Bartoluci¹⁷, David Benitez¹⁸, Ivanna Bodnar¹⁹,
Aidos Bolatov¹⁶, Judyta Borchet²⁰, Ksenija Bosnar¹⁷, Yunier Broche-Pérez²¹, Carmen Buzea²²,
Rosalinda Cassibba²³, Maria del Pilar Grazioso^{24, 25}, Sandesh Dhakal²⁶, Radosveta Dimitrova²⁷,
Alejandra Dominguez²⁸, Cong Doanh Duong²⁹, Luciana Dutra Thome³⁰, Arune Joao Estavela³¹,
Emmanuel Abiodun Fayankinnu^{32, 33, 34}, Nelli Ferenczi³⁵, Regina Fernández-Morales^{36, 37},
Maria-Therese Friehs³⁸, Jorge Gaete³⁹, Wassim Gharz Edine⁷, Shahar Gindi⁴⁰,
Rubia Carla Formighieri Giordani⁴¹, Biljana Gjoneska⁴², Juan Carlos Godoy⁴³,
Camellia Doncheva Hancheva⁴⁴, Given Hapunda⁴⁵, Shogo Hihara^{46, 47}, Md. Saiful Islam^{48, 49},
Anna Janovská¹⁵, Nino Javakhishvili⁵⁰, Russell Sarwar Kabir⁴⁶, Amir Kabunga⁵¹, Arzu Karakulak⁵²,
Johannes Alfons Karl^{53, 54}, Darko Katović¹⁷, Zhumaly Kauyzbay⁵⁵, Maria Kaźmierczak²⁰, Richa Khanna⁵⁶,
Meetu Khosla⁵⁷, Peter Kisaakye⁵⁸, Martina Klicperova-Baker⁵⁹, Richman Kokera⁶⁰, Ana Kozina⁶¹,
Steven E. Krauss⁶², Rodrigo Landabur⁶³, Katharina Lefringhausen⁶⁴, Aleksandra Lewandowska-Walter²⁰,
Yun-Hsia Liang⁶⁵, Danny Lizarzaburu-Aguinaga⁶⁶, Lorena Cecilia López Steinmetz^{43, 67}, Ana Makashvili⁵⁰,
Sadiah Malik⁶⁸, Denisse Manrique-Millones⁶⁹, Marta Martín-Carbonell⁷⁰, Maria Angela Mattar Yunes⁷¹,
Breeda McGrath⁷², Enkeleint A. Mechili⁷³, Marínés Mejía Alvarez²⁴, Samson Mhizha⁶⁰,
Justyna Michałek-Kwiecień²⁰, Sushanta Kumar Mishra⁷⁴, Mahdi Mohammadi¹¹, Fatema Mohsen⁷,
Rodrigo Moreta-Herrera^{76, 77}, Maria D. Muradyan¹³, Pasquale Musso²³, Andrej Naterer⁷⁸, Arash Nemat⁷⁹,
Félix Neto⁸⁰, Joana Neto⁸¹, Hassan Okati-Aliabad¹¹, Carlos Iván Orellana⁸², Ligia Orellana⁸³, Joonha Park⁸⁴,
Iuliia Pavlova¹⁹, Eddy Alfonso Peralta⁸⁵, Petro Petrytsa⁸⁶, Rasa Pilkauskaitė Valickienė⁸⁷, Saša Pišot⁸⁸,
Iva Poláčková Šolcová⁵⁹, Franjo Prot¹⁷, Gordana Ristevska Dimitrovska⁸⁹, Rita M. Rivera¹⁸,
Benedicta Prihatin Dwi Riyanti⁹⁰, Mohd Saiful Husain Saiful⁹¹, Adil Samekin⁹², Telman Seisembekov¹⁶,
Danielius Serapinas⁸⁷, Zahra Sharafi¹¹, Perna Sharma⁹³, Shanu Shukla^{75, 94}, Fabiola Silletti²³,
Katarzyna Skrzypińska²⁰, Vanessa Smith-Castro⁹⁵, Olga Solomontos-Kountouri⁹⁶, Adrian Stanciu⁹⁷,
Delia Ștefenel⁹⁸, Maria Stogianni⁹⁹, Jaimee Stuart^{100, 101}, Laura Francisca Sudarnoto⁹⁰, Mst Sadia Sultana⁴⁸,
Dijana Sulejmanović¹⁰², Angela Oktavia Suryani⁹⁰, Ergyul Tair¹⁰³, Lucy Tavitian-Elmadjian^{99, 104},
Fitim Uka¹⁰⁵, Guilherme Welter Wendt¹⁰⁶, Pei-Jung Yang¹⁰⁷, Ebrar Yıldırım¹⁰⁸, and Yue Yu^{109, 110}

¹ Department of Psychology, Faculty of Philosophy, University of Novi Sad

² Department of Psychology, University of Waterloo

³ School of Social Sciences and Humanities, Doha Institute for Graduate Studies

⁴ Center for Research in Psychology and Human Well-Being, Universiti Kebangsaan Malaysia

⁵ Department of Pure and Applied Psychology, Adekunle Ajasin University

⁶ Department of Sociology and Social Policy, Lingnan University

⁷ College of Medicine, Syrian Private University

⁸ Islamic Studies, College of Graduate Studies and Scientific Research, Mohamed Bin Zayed University for Humanities

⁹ Departamento de Salud Pública, Universidad del Norte

¹⁰ Department of Physical Education, Lviv Polytechnic National University

¹¹ Health Promotion Research Center, Zahedan University of Medical Sciences

¹² Department of Psychology, De La Salle University

¹³ General Psychology Chair, Yerevan State University

¹⁴ Faculty of Psychology and Education, Universiti Malaysia Sabah

¹⁵ Department of Educational Psychology and Health Psychology, Pavol Jozef Šafárik University in Košice

¹⁶ School of Medicine, Astana Medical University

¹⁷ Faculty of Kinesiology, University of Zagreb

- ¹⁸ Department of Clinical Psychology, Albizu University
- ¹⁹ Department of Theory and Methods of Physical Culture, Lviv State University of Physical Culture
- ²⁰ Institute of Psychology, University of Gdańsk
- ²¹ Department of Psychology, Universidad Central Marta Abreu de Las Villas
- ²² Department of Social Sciences and Communication, Transilvania University of Brasov
- ²³ Department of Education, Psychology, Communication, University of Bari
- ²⁴ Asociación Proyecto Aiglé Guatemala, Ciudad de Guatemala, Guatemala
- ²⁵ Department of Psychology, Universidad del Valle de Guatemala
- ²⁶ Central Department of Psychology, Tribhuvan University
- ²⁷ Department of Psychology, Stockholm University
- ²⁸ Department of Psychology, Ibero-American University
- ²⁹ Faculty of Business Management, National Economics University
- ³⁰ Department of Psychology, Federal University of Bahia
- ³¹ Departamento de Pós-Graduação, Instituto Superior de Ciências de Saúde, Universidade Lúrio
- ³² Department of Sociology, Faculty of the Social Sciences, Adekunle Ajasin University
- ³³ Department of Social Work and Social Administration, Makerere University
- ³⁴ Department of Social Sciences, Islamic University in Uganda
- ³⁵ Department of Life Sciences, College of Health, Medicine and Life Sciences, Brunel University London
- ³⁶ Department of Psychology, Universidad Francisco Marroquín
- ³⁷ Department of Humanities, Universidad Rafael Landívar
- ³⁸ Faculty for Psychology, FernUniversität in Hagen
- ³⁹ Faculty of Education, Universidad de los Andes, Santiago, Chile
- ⁴⁰ Faculty of Education, Beit Berl College
- ⁴¹ Department of Nutrition, Federal University of Parana
- ⁴² Macedonian Academy of Sciences and Arts
- ⁴³ Instituto de Investigaciones Psicológicas, Universidad Nacional de Córdoba, Consejo Nacional de Investigaciones Científicas y Técnicas
- ⁴⁴ Department of General, Experimental, Developmental, and Health Psychology, Sofia University "St. Kliment Ohridski"
- ⁴⁵ Department of Psychology, University of Zambia
- ⁴⁶ Graduate School of Humanities and Social Sciences, Hiroshima University
- ⁴⁷ Faculty of Business Administration, Matsuyama University
- ⁴⁸ Department of Public Health and Informatics, Jahangirnagar University
- ⁴⁹ Centre for Advanced Research Excellence in Public Health, Savar, Dhaka, Bangladesh
- ⁵⁰ Dimitri Uznadze Institute of Psychology, Ilia State University
- ⁵¹ Department of Psychiatry, Lira University
- ⁵² Department of Psychology, MEF University
- ⁵³ School of Psychology, Dublin City University
- ⁵⁴ School of Psychology, Victoria University of Wellington
- ⁵⁵ Department of Family Medicine, South Kazakhstan Medical Academy
- ⁵⁶ School of Human Ecology, Tata Institute of Social Sciences
- ⁵⁷ Daulat Ram College, University of Delhi
- ⁵⁸ Department of Population Studies, Makerere University
- ⁵⁹ Institute of Psychology, Czech Academy of Sciences
- ⁶⁰ Department of Applied Psychology, University of Zimbabwe
- ⁶¹ Evaluation Studies Centre, Educational Research Institute
- ⁶² Institute for Social Science Studies, Universiti Putra Malaysia
- ⁶³ Department of Psychology, University of Atacama
- ⁶⁴ Department of Psychology, Heriot-Watt University
- ⁶⁵ Department of Education, University of Taipei
- ⁶⁶ School of Environmental Engineering, Universidad César Vallejo
- ⁶⁷ Decanato de Ciencias Sociales, Universidad Siglo 21
- ⁶⁸ Department of Psychology, University of Sargodha
- ⁶⁹ Carrera de Psicología, Facultad de Ciencias de la Salud, Universidad Científica del Sur
- ⁷⁰ Faculty of Social and Human Sciences, Cooperative University of Colombia
- ⁷¹ Post Graduation Program of Psychology, Salgado de Oliveira University
- ⁷² Department of Academic Affairs, The Chicago School of Professional Psychology
- ⁷³ Department of Healthcare, Faculty of Health, University of Vlorë
- ⁷⁴ Organizational Behavior and Human Resource Management Area, Indian Institute of Management Bangalore
- ⁷⁵ Organizational Behavior and Human Resource Management Area, Indian Institute of Management Indore
- ⁷⁶ Escuela de Psicología, Pontificia Universidad Católica del Ecuador
- ⁷⁷ Decanato de Investigación y Vinculación, Universidad de Las Américas

- ⁷⁸ Faculty of Arts, University of Maribor
- ⁷⁹ Microbiology Department, Kabul University of Medical Sciences
- ⁸⁰ Department of Psychology, University of Porto
- ⁸¹ Research on Economics, Management and Information Technologies, Universidade Portucalense
- ⁸² Social Sciences Doctoral and Master Program, Don Bosco University
- ⁸³ Departamento de Psicología, Universidad de La Frontera
- ⁸⁴ Department of Management, Nagoya University of Commerce and Business
- ⁸⁵ Medicine School, Mother and Teacher Pontifical Catholic University
- ⁸⁶ Department of Physical Education and Rehabilitation, Ternopil Volodymyr Hnatiuk National Pedagogical University
- ⁸⁷ Institute of Psychology, Mykolas Romeris University
- ⁸⁸ Institute for Kinesiology Research, Science and Research Center Koper
- ⁸⁹ Higher Medical School, University St. Kliment Ohridski Bitola
- ⁹⁰ Faculty of Psychology, Atma Jaya Catholic University of Indonesia
- ⁹¹ Department of Statistics, University Sains Malaysia
- ⁹² School of Liberal Arts, M. Narikbayev KAZGUU University
- ⁹³ Department of Clinical Psychology, Institute of Human Behavior and Allied Sciences
- ⁹⁴ Interdisciplinary Research Team on Internet and Society, Faculty of Social Studies, Masaryk University
- ⁹⁵ Institute for Psychological Research, University of Costa Rica
- ⁹⁶ Theological School, Church of Cyprus
- ⁹⁷ Data and Research on Society, GESIS-Leibniz Institute for the Social Sciences
- ⁹⁸ Faculty of Social Science and Humanities, Lucian Blaga University of Sibiu
- ⁹⁹ Department of Culture Studies, Tilburg University
- ¹⁰⁰ UNU Institute Macau, United Nations University
- ¹⁰¹ School of Applied Psychology, Griffith University
- ¹⁰² Islamic Pedagogic Faculty, University of Bihać
- ¹⁰³ Department of Psychology, Institute for Population and Human Studies, Bulgarian Academy of Sciences
- ¹⁰⁴ Department of Psychology, Faculty of Social and Behavioral Sciences, Haigazian University
- ¹⁰⁵ Department of Psychology, University of Prishtina "Hasan Prishtina"
- ¹⁰⁶ Postgraduate Program in Applied Health Sciences, Western Paraná State University
- ¹⁰⁷ Graduate Institute of Social Work, National Chengchi University
- ¹⁰⁸ Department of Clinical Psychology, Yeditepe University
- ¹⁰⁹ Centre for Research in Child Development, National Institute of Education, Nanyang Technological University
- ¹¹⁰ Singapore Centre for Character and Citizenship Education, National Institute of Education, Nanyang Technological University

Coronavirus Anxiety Scale (CAS) is a widely used measure that captures somatic symptoms of coronavirus-related anxiety. In a large-scale collaboration spanning 60 countries ($N_{\text{total}} = 21,513$), we examined the CAS's measurement invariance and assessed the convergent validity of CAS scores in relation to the fear of COVID-19 (FCV-19S) and the satisfaction with life (SWLS-3) scales. We utilized both conventional exact invariance tests and alignment procedures, with results revealing that the single-factor model fit the data well in almost all countries. Partial scalar invariance was supported in a subset of 56 countries. To ensure the robustness of results, given the unbalanced samples, we employed resampling techniques both with and without replacement and found the results were more stable in larger samples. The alignment procedure demonstrated a high degree of measurement invariance with 9% of the parameters exhibiting noninvariance. We also conducted simulations of alignment using the parameters estimated in the current model. Findings demonstrated reliability of the means but indicated challenges in estimating the latent variances. Strong positive correlations between CAS and FCV-19S estimated with all three different approaches were found in most countries. Correlations of CAS and SWLS-3 were weak and negative but significantly differed from zero in several countries. Overall, the study provided support for the measurement invariance of the CAS and offered evidence of its convergent validity while also highlighting issues with variance estimation.

This article was published Online First November 27, 2023.

Veljko Jovanović  <https://orcid.org/0000-0001-9248-2518>

Maksim Rudnev  <https://orcid.org/0000-0002-2714-3840>

The work of Marta Martín-Carbonell was supported by the Cooperative University of Colombia, Grant INV3092. The work of Jorge Gaete was supported by Agencia Nacional de Investigación y Desarrollo—Millennium Science Initiative Program, Grant NCS2021_081. The work of Adrian Stanciu was supported by GESIS—Leibniz Institute for the Social Sciences. The work of Shanu Shukla, Martina Klicperova-Baker, and Iva Poláčková Šolcová was supported by Národní plán obnovy (NPO) "Systemic Risk Institute," Grant LX22NPO5101, funded by the European Union—Next Generation European

Union (Ministry of Education, Youth, and Sports, NPO: EXCELES). The work of Hrant M. Avanesyan was supported by the financial support of the RA Science Committee, Project 21T-5A203. The work of Breeda McGrath was supported by American Psychological Association Division 48, Small Grants Program. The work of Judyta Borchet was supported by the Foundation for Polish Science, Scholarship START 006.2022. The work of Rubia Carla Formighieri Giordani was supported by the National Council for Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico/CNPq), Project 401749/2022-3. The authors have no known conflicts of interest to disclose.

The data for this study are available by emailing the corresponding author.

continued

Public Significance Statement

We found that the widely used Coronavirus Anxiety Scale is generally suitable for cross-national research. Given that its comparability across contexts was previously questioned, the present study provides evidence for invariance, making international comparisons of coronavirus-related anxiety possible.

Keywords: coronavirus anxiety, measurement invariance, alignment, validity, culture

Supplemental materials: <https://doi.org/10.1037/pas0001270.supp>

The severe acute respiratory syndrome coronavirus 2 (otherwise known as coronavirus or COVID-19) pandemic has had an unprecedented impact on the psychological functioning of people worldwide (Aknin et al., 2022). Notably, fear and anxiety were common responses to the pandemic (Luo et al., 2021), due to its novelty, uncertainty, and unpredictability, and the scope of impact and dramatic consequences of the COVID-19 crisis. Terms “fear of COVID-19” (Ahorsu et al., 2022) and “coronaphobia” (Asmundson & Taylor, 2020) have been used to describe intense fear and discomfort experienced when a person is exposed to COVID-19 information or when they are thinking about the COVID-19 disease. The urgency of understanding mental health aspects of the COVID-19 outbreak has led to the development of a number of questionnaires aimed at assessing fear, anxiety, and stress related to a novel coronavirus (for a review, please see Voitsidis et al., 2021). In the present article, we focus on the five-item Coronavirus Anxiety Scale (CAS; Lee,

2020a), one of the most popular mental health questionnaires to have emerged during the pandemic (e.g., based on Scopus the CAS received more than 100 citations in 2020 and close to 300 during 2021). We evaluate the cross-national measurement invariance of the CAS using samples from 60 countries and examine the convergent validity of CAS scores with fear of COVID-19 and life satisfaction scores.

The Coronavirus Anxiety Scale

The CAS is an instrument that was designed at the onset of the pandemic (in March 2020) to assess coronavirus-related anxiety (i.e., dysfunctional anxiety in the context of the pandemic). It was developed to serve as both a screening instrument and a survey measure, helping health practitioners and researchers alike (Lee, 2020a). Item content shows that the CAS captures exclusively

All the reproduction codes are available in the Open Science Framework directory (<https://osf.io/7gnz9/>). This study was not preregistered.

Veljko Jovanović played a lead role in conceptualization and writing—original draft, a supporting role in formal analysis and methodology, and an equal role in data curation and writing—review and editing. Maksim Rudnev played a lead role in formal analysis and software, a supporting role in conceptualization and writing—original draft, and an equal role in data curation, investigation, methodology, and writing—review and editing. Mohamed Abdelrahman played an equal role in data curation, investigation, and writing—review and editing. Nor Ba'yah Abdul Kadir played an equal role in data curation, investigation, and writing—review and editing. Damilola Fisayo Adebayo played an equal role in data curation, investigation, and writing—review and editing. Plamen Akaliyski played an equal role in data curation, investigation, and writing—review and editing. Rana Alaseel played an equal role in data curation, investigation, and writing—review and editing. Yousuf Abdulqader Alkamali played an equal role in data curation, investigation, and writing—review and editing. Luz Marina Alonso Palacio played an equal role in data curation, investigation, and writing—review and editing. Azzam Amin played an equal role in data curation, investigation, and writing—review and editing. Andrii Andres played an equal role in data curation, investigation, and writing—review and editing. Alireza Ansari-Moghaddam played an equal role in data curation, investigation, and writing—review and editing. John Jamir Benzon Aruta played an equal role in data curation, investigation, and writing—review and editing. Hrant M. Avanesyan played an equal role in data curation, investigation, and writing—review and editing. Norzihan Ayub played an equal role in data curation, investigation, and writing—review and editing. Maria Bacikova-Sleskova played an equal role in data curation, investigation, and writing—review and editing. Raushan Baikanova played an equal role in data curation, investigation, and writing—review and editing. Batoul Bakkar played an equal role in data curation, investigation, and writing—review and editing. Sunčica Bartoluci played an equal role in data curation, investigation, and writing—review and editing.

David Benitez played an equal role in data curation, investigation, and writing—review and editing. Ivanna Bodnar played an equal role in data curation, investigation, and writing—review and editing. Aidos Bolatov played an equal role in data curation, investigation, and writing—review and editing. Judyta Borchet played an equal role in data curation, investigation, and writing—review and editing. Ksenija Bosnar played a lead role in writing—review and editing and an equal role in data curation and investigation. Yunier Broche-Pérez played an equal role in data curation, investigation, and writing—review and editing. Carmen Buzea played an equal role in data curation, investigation, and writing—review and editing. Rosalinda Cassibba played an equal role in data curation, investigation, and writing—review and editing. Maria del Pilar Grazioso played an equal role in data curation, investigation, and writing—review and editing. Sandesh Dhakal played an equal role in data curation, investigation, and writing—review and editing. Radosveta Dimitrova played an equal role in data curation, investigation, and writing—review and editing. Alejandra Dominguez played an equal role in data curation, investigation, and writing—review and editing. Cong Doanh Duong played an equal role in data curation, investigation, and writing—review and editing. Luciana Dutra Thome played an equal role in data curation, investigation, and writing—review and editing. Arune Joao Estavela played an equal role in data curation, investigation, and writing—review and editing. Emmanuel Abiodun Fayankinnu played an equal role in data curation, investigation, and writing—review and editing. Nelli Ferenczi played an equal role in data curation, investigation, and writing—review and editing. Regina Fernández-Morales played an equal role in data curation, investigation, and writing—review and editing. Maria-Therese Friebs played an equal role in data curation, investigation, and writing—review and editing. Jorge Gaete played an equal role in data curation, investigation, and writing—review and editing. Wassim Gharz Edine played an equal role in data curation, investigation, and writing—review and editing. Shahar Gindi played an equal role in data curation, investigation, and writing—review and editing. Rubia Carla Formighieri Giordani played an equal role in data curation,

continued

physical and physiological (i.e., somatic) components of coronavirus anxiety, namely dizziness (Item 1), sleep disturbances (Item 2), tonic immobility (Item 3), appetite changes (Item 4), and nausea and abdominal distress (Item 5). None of the items include cognitive (e.g., worry), behavioral (e.g., avoidance), or emotional (e.g., fear) aspects of anxiety, although items referring to these features of anxiety were included in the initial pool of 20 candidate items. The five somatic items were included in the final version of the CAS because they had the strongest factor loadings on the first component of the principal component analysis, high pattern/structure and communality coefficients, as well as low cross-loadings. As argued by the author of the scale (Lee, 2020b), two CAS items (dizziness and tonic immobility) capture physiological arousal in response to coronavirus-related fear, two items (sleep disturbances and appetite changes) capture the somatic symptoms caused by intense, persistent worry about the coronavirus and are more closely associated with anxiety, and the fifth item (nausea and abdominal distress) captures somatic reactions resulting from either fear (e.g., thoughts of immediate danger) or anxiety (e.g., intense worry). Therefore, the choice of five items included in the final version of the CAS appears to be justified from both psychometric and theoretical perspectives. The original study, which was conducted with an adult sample in the United States (Lee, 2020a), supported high internal consistency of the CAS, a one-factor structure, convergent validity evidence, and measurement invariance across gender and age. However, two items (Item 2: sleep disturbances and Item 4:

appetite changes) operated differently across Whites and non-Whites. More specifically, these two items had stronger loadings on the latent coronavirus anxiety factor among Whites than among the non-Whites (Lee, 2020a). A subsequent psychometric examination in another adult U.S. sample showed that a one-factor structure was invariant across age, gender, and race (Lee et al., 2020).

The favorable psychometric properties in the initial studies and its brevity made the CAS a popular measure of coronavirus-related anxiety during the pandemic. The scale has been translated into dozens of languages and psychometrically evaluated in numerous countries, such as Bangladesh (Ahmed et al., 2022), China (Chen et al., 2021), Cuba (Broche-Pérez et al., 2022), Poland (Skalski et al., 2021), Portugal (Magano et al., 2021), South Korea (Choi et al., 2022), and Turkey (Evren et al., 2022). Furthermore, the scale has been used in several studies examining mental health and well-being during the COVID-19 pandemic around the world, including some cross-national research (e.g., Linehan et al., 2020). In most studies, the results of confirmatory factor analyses have supported the one-factor model of the CAS (Broche-Pérez et al., 2022; Choi et al., 2022; Evren et al., 2022; Lee, 2020c). However, in some countries, modifications have been made (e.g., correlating residuals between a pair of items) to achieve an excellent model fit (see Ahmed et al., 2022; Magano et al., 2021; Vinaccia et al., 2022). Furthermore, in several studies, the upper limit of the 90% confidence interval for the root-mean-square error of approximation (RMSEA) was above the acceptable cutoff (i.e., .10; Chen et al., 2021; Skalski et al., 2021).

investigation, and writing–review and editing. Biljana Gjoneska played an equal role in data curation, investigation, and writing–review and editing. Juan Carlos Godoy played an equal role in data curation, investigation, and writing–review and editing. Camellia Doncheva Hancheva played an equal role in data curation, investigation, and writing–review and editing. Given Hapunda played an equal role in data curation, investigation, and writing–review and editing. Shogo Hihara played an equal role in data curation, investigation, and writing–review and editing. Md. Saiful Islam played an equal role in data curation, investigation, and writing–review and editing. Anna Janovská played an equal role in data curation, investigation, and writing–review and editing. Nino Javakhishvili played an equal role in data curation, investigation, and writing–review and editing. Russell Sarwar Kabir played an equal role in data curation, investigation, and writing–review and editing. Amir Kabunga played an equal role in data curation, investigation, and writing–review and editing. Arzu Karakulak played an equal role in data curation, investigation, and writing–review and editing. Johannes Alfons Karl played an equal role in data curation, investigation, and writing–review and editing. Darko Katović played an equal role in data curation, investigation, and writing–review and editing. Zhumaly Kauyrbay played an equal role in data curation, investigation, and writing–review and editing. Maria Kaźmierczak played an equal role in data curation, investigation, and writing–review and editing. Richa Khanna played an equal role in data curation, investigation, and writing–review and editing. Meetu Khosla played an equal role in data curation, investigation, and writing–review and editing. Peter Kisaakye played an equal role in data curation, investigation, and writing–review and editing. Martina Klicperova-Baker played an equal role in data curation, investigation, and writing–review and editing. Richman Kokera played an equal role in data curation, investigation, and writing–review and editing. Ana Kozina played an equal role in data curation, investigation, and writing–review and editing. Steven E. Krauss played an equal role in data curation, investigation, and writing–review and editing. Rodrigo Landabur played an equal role in data curation,

investigation, and writing–review and editing. Katharina Lefringhausen played an equal role in data curation, investigation, and writing–review and editing. Aleksandra Lewandowska-Walter played an equal role in data curation, investigation, and writing–review and editing. Yun-Hsia Liang played an equal role in data curation, investigation, and writing–review and editing. Danny Lizarzaburu-Aguinaga played an equal role in data curation, investigation, and writing–review and editing. Lorena Cecilia López Steinmetz played an equal role in data curation, investigation, and writing–review and editing. Ana Makashvili played an equal role in data curation, investigation, and writing–review and editing. Sadia Malik played an equal role in data curation, investigation, and writing–review and editing. Denisse Manrique-Millones played an equal role in data curation, investigation, and writing–review and editing. Marta Martín-Carbonell played an equal role in data curation, investigation, and writing–review and editing. Maria Angela Mattar Yunes played an equal role in data curation, investigation, and writing–review and editing. Breeda McGrath played an equal role in data curation, investigation, and writing–review and editing. Enkeleint A. Mechili played an equal role in data curation, investigation, and writing–review and editing. Marinés Mejía Alvarez played an equal role in data curation, investigation, and writing–review and editing. Samson Mhizha played an equal role in data curation, investigation, and writing–review and editing. Justyna Michalek-Kwiecień played an equal role in data curation, investigation, and writing–review and editing. Sushanta Kumar Mishra played an equal role in data curation, investigation, and writing–review and editing. Mahdi Mohammadi played an equal role in data curation, investigation, and writing–review and editing. Fatema Mohsen played an equal role in data curation, investigation, and writing–review and editing. Rodrigo Moreta-Herrera played an equal role in data curation, investigation, and writing–review and editing. Maria D. Muradyan played an equal role in data curation, investigation, and writing–review and editing. Pasquale Musso played an equal role in data curation, investigation, and writing–review and editing. Andrej Naterer played an equal role in data curation, investigation, and

continued

Therefore, the internal structure of the CAS warrants further research, as the simple one-factor solution has been found to not hold in all countries.

The Importance of Testing Cross-National Measurement Invariance of the CAS

Despite the widespread use of the CAS in many countries, to our knowledge, its cross-national measurement invariance has been investigated only in two studies to date (Caycho-Rodríguez et al., 2022; Lieven, 2023), both of which have some important limitations. Caycho-Rodríguez et al. (2022) examined the factor structure and measurement invariance of the Spanish version of the CAS across 12 Latin American countries. The authors found that the original one-factor model fitted poorly in most countries (RMSEA values were above .10 in 11 out of 12 countries), and that residuals of Item 4 (appetite changes) and Item 5 (nausea and abdominal distress) were strongly associated. After removing Item 5, the one-factor model of the abbreviated CAS (CAS-4) provided an excellent fit to the data in most countries. The authors tested the cross-national measurement invariance of the CAS-4 and concluded that both metric and scalar invariance were met, although the large drop in RMSEA between metric and configural model (.04) suggested that the metric invariance was not supported, and that testing for partial metric invariance should have been conducted. Another important limitation of this study is that convergent validity of the CAS scores in relation to other measures was not examined. Lieven (2023)

investigated the measurement invariance of the CAS across 25 countries from six continents, and contrary to Caycho-Rodríguez et al. (2022) found that the original one-factor model provided an acceptable or good fit to the data in all countries, and that this model was fully invariant across countries. However, this study also had some limitations, as the majority of study participants dwelled in high income, Western countries. Furthermore, Lieven's study also did not include convergent measures. To sum up, the cross-cultural applicability of the CAS is still largely unknown, especially in non-Western samples.

There are several issues with the CAS's item content that raise questions as to whether this scale is appropriate for the assessment of coronavirus anxiety in different cultural settings. The CAS was developed in a Western context, that is, with a sample of U.S. adults and relying on the somatic symptoms of fear and anxiety typical for people in Western cultures. For example, the content validity of the CAS items in the original study (Lee, 2020a) has been supported by the relevance of the symptoms captured by the CAS for diagnoses of mental disorders such as panic disorder, generalized anxiety disorder, posttraumatic stress disorder, and major depressive disorder as defined within *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (American Psychiatric Association, 2013), which has been repeatedly criticized as an ethnocentric and culturally insensitive approach to mental disorders (e.g., Bredström, 2019; Marecek & Lafrance, 2021). Although physical and physiological symptoms are common features of anxiety worldwide (Kirmayer, 2001), the presentation, experience,

writing–review and editing. Arash Nemat played an equal role in data curation, investigation, and writing–review and editing. Félix Neto played an equal role in data curation, investigation, and writing–review and editing. Joana Neto played an equal role in data curation, investigation, and writing–review and editing. Hassan Okati-Aliabad played an equal role in data curation, investigation, and writing–review and editing. Carlos Iván Orellana played an equal role in data curation, investigation, and writing–review and editing. Ligia Orellana played an equal role in data curation, investigation, and writing–review and editing. Joonha Park played an equal role in data curation, investigation, and writing–review and editing. Iuliia Pavlova played an equal role in data curation, investigation, and writing–review and editing. Eddy Alfonso Peralta played an equal role in data curation, investigation, and writing–review and editing. Petro Petrytsa played an equal role in data curation, investigation, and writing–review and editing. Rasa Pilkauskaitė Valickienė played an equal role in data curation, investigation, and writing–review and editing. Saša Pišot played an equal role in data curation, investigation, and writing–review and editing. Iva Poláčková Šolcová played an equal role in data curation, investigation, and writing–review and editing. Franjo Prot played an equal role in data curation, investigation, and writing–review and editing. Gordana Ristevska Dimitrovska played an equal role in data curation, investigation, and writing–review and editing. Rita M. Rivera played an equal role in data curation, investigation, and writing–review and editing. Benedicta Prihatin Dwi Riyanti played an equal role in data curation, investigation, and writing–review and editing. Mohd Saiful Husain Saiful played an equal role in data curation, investigation, and writing–review and editing. Adil Samekin played an equal role in data curation, investigation, and writing–review and editing. Telman Seisembekov played an equal role in data curation, investigation, and writing–review and editing. Danielius Serapinas played an equal role in data curation, investigation, and writing–review and editing. Zahra Sharafi played an equal role in data curation, investigation, and writing–review and editing. Prerna Sharma played an equal role in data curation, investigation, and writing–review and editing. Shanu Shukla

played an equal role in data curation, investigation, and writing–review and editing. Fabiola Silletti played an equal role in data curation, investigation, and writing–review and editing. Katarzyna Skrzypińska played an equal role in data curation, investigation, and writing–review and editing. Vanessa Smith-Castro played an equal role in data curation, investigation, and writing–review and editing. Olga Solomontos-Kountouri played an equal role in data curation, investigation, and writing–review and editing. Adrian Stanciu played an equal role in data curation, investigation, and writing–review and editing. Delia Ștefenel played an equal role in data curation, investigation, and writing–review and editing. Maria Stogianni played an equal role in data curation, investigation, and writing–review and editing. Jaimee Stuart played a lead role in writing–review and editing and an equal role in data curation and investigation. Laura Francisca Sudarnoto played an equal role in data curation, investigation, and writing–review and editing. Mst Sadia Sultana played an equal role in data curation, investigation, and writing–review and editing. Dijana Sulejmanović played an equal role in data curation, investigation, and writing–review and editing. Angela Oktavia Suryani played an equal role in data curation, investigation, and writing–review and editing. Ergyul Tair played an equal role in data curation, investigation, and writing–review and editing. Lucy Tavitian-Elmadjian played an equal role in data curation, investigation, and writing–review and editing. Fitim Uka played an equal role in data curation, investigation, and writing–review and editing. Guilherme Welter Wendt played an equal role in data curation, investigation, and writing–review and editing. Pei-Jung Yang played an equal role in data curation, investigation, and writing–review and editing. Ebrar Yıldırım played an equal role in data curation, investigation, and writing–review and editing. Yue Yu played an equal role in data curation, investigation, and writing–review and editing.

Correspondence concerning this article should be addressed to Veljko Jovanović, Department of Psychology, Faculty of Philosophy, University of Novi Sad, 21 000 Novi Sad, Serbia. Email: veljko.jovanovic@ff.uns.ac.rs

and reporting of somatic symptoms of anxiety may vary substantially across cultures (Marques et al., 2011). For example, somatic symptoms appear to have a more central role in anxiety among individuals from non-Western cultures than from Western cultures (Lewis-Fernández et al., 2010). Another potential issue with the CAS is the inclusion of common somatic symptoms of depression, such as problems with sleep and appetite, which may be more frequently endorsed in non-Western cultures (e.g., Ryder et al., 2008). Cross-cultural variations in physical and physiological symptoms of anxiety warrant careful research on the cross-cultural validity of the CAS as a measure of coronavirus-related anxiety.

The Present Study

The main goal of the present study is to investigate the cross-national measurement invariance of the CAS across 60 countries. Measurement invariance is necessary to ensure that a given instrument measures the construct of interest in the same way across different groups (Han et al., 2019). This becomes especially important: (a) when the construct of interest appears to be ubiquitous (as it is related to the pandemic) and does not discriminate between groups and (b) when the groups comprise culturally diverse populations. In this case, the translation of the questionnaire and cultural differences may affect the understanding of the items and could then reveal biased estimates of anxiety. Although unable to guarantee that the instrument's adaptations across languages are parallel, measurement invariance tests can provide evidence for the similarity of its functioning across nations (Leitgöb et al., 2022). In addition, we aimed to expand on previous research by examining the evidence for convergent validity of the CAS scores in relation to an alternative measure of coronavirus-related mental health (i.e., Fear of COVID-19 Scale [FCV-19S]), and in relation to the abbreviated version of the most frequently used measure of subjective well-being (Satisfaction with Life Scale [SWLS]).

Method

Participants and Procedure

The data for the present study were collected as part of a larger project, "International and Multidimensional Perspectives on the Impact of COVID-19 across Generations (IMPACT-C19)," led by the Research Initiatives Working Group of the American Psychological Association Interdivisional Task Force on the pandemic, committed to the advancement of knowledge base through a repository and dissemination of materials and resources on the pandemic (Karakulak et al., 2023). The project aimed at examining the impact and experiences of COVID-19 globally. Due to its exploratory nature, the impact of COVID-19 across generations study was not preregistered. The study was approved by the Chicago School of Professional Psychology institutional review board IRB-20-11-0001.

The samples in most countries were recruited using convenience and snowball sampling methods. Surveys were administered online in the primary language of the local context. The sample characteristics in each country, CAS mean scores and Cronbach α s are listed in online Supplemental Section A, Table S1. In the course of data cleaning, we removed all observations that contained more than two missing responses on the five CAS items which

comprised 0.4% of the total sample. The final sample size included $N = 21,513$ respondents in 60 countries.

Measures

The CAS (Lee, 2020a) consists of the following five items: (1) I felt dizzy, lightheaded, or faint, when I read or listened to news about the coronavirus; (2) I had trouble falling or staying asleep because I was thinking about the coronavirus; (3) I felt paralyzed or frozen when I thought about or was exposed to information about the coronavirus; (4) I lost interest in eating when I thought about or was exposed to information about the coronavirus; and (5) I felt nauseous or had stomach problems when I thought about or was exposed to information about the coronavirus. Participants are asked to rate the frequency of each symptom over the last 2 weeks on a 5-point scale with options *not at all* (1), *rare, less than a day or two* (2), *several days* (3), *more than 7 days* (4), and *nearly every day* (5).

The FCV-19S (Ahorsu et al., 2022) is a seven-item questionnaire (e.g., It makes me uncomfortable to think about coronavirus-19). Items are rated on a 7-point scale (from 1 = *strongly disagree* to 7 = *strongly agree*).

The abbreviated, three-item version of the SWLS (SWLS-3; Kjell & Diener, 2021) was used to assess global life satisfaction. The SWLS-3 is a brief version of the original SWLS (Diener et al., 1985), and it includes the first three items of the original scale (In most ways my life is close to my ideal; The conditions of my life are excellent; I am satisfied with my life). Items are rated on a 7-point scale (from 1 = *strongly disagree* to 7 = *strongly agree*).

Questionnaire Translation

Several translations of the CAS (e.g., Spanish, Japanese, Polish), FCV-19S, and SWLS-3 were already available at the beginning of the project, so where possible, these existing translations were used. In countries where the questionnaires' translations were not identified, a committee approach to translation was used (e.g., van de Vijver, 2019). This approach attempts to decrease the bias by introducing collaborative, consensus-based translation efforts. In each country where there were missing translations at least two individuals with knowledge of the target language, society, and culture, translated the questionnaires independently. These translated versions were then compared and differences were resolved by consensus, with the final version accepted after the discussion on the items' appropriateness.

Data Analysis

Descriptive analysis of the CAS items demonstrated highly skewed distributions in all the groups (for the distributions, see online Supplemental Section B, Figure S1 and Table S2). The response option "*not at all*" was chosen disproportionately more often than all the others (64.5%–83.6% across items), and the second most chosen option was "*rare, less than a day or two*" (9.9%–19.3%), while the other options were chosen only occasionally. The distribution of responses is unsurprising as the CAS measures severe conditions in the general population. However, consequently, the responses could not be treated as a statistically normal continuous distribution, but rather as categorical. Due to low frequencies of several response options combined with the small sample sizes in many groups, the

corresponding contingency tables were sparse (i.e., contained multiple zero frequencies). The sparse response patterns are highly problematic for multiple group latent variable analyses (Forero & Maydeu-Olivares, 2009). Therefore, we could not model this as an ordinal categorical (polytomous) scale. Thus, we decided to dichotomize the responses into 0 for “not at all” and 1 for all the other response options (see DiStefano et al., 2021). Dichotomization did not lead to a substantial loss of information because the crucial meaningful source of variance came from the difference between occurrence and nonoccurrence of the five symptoms.

Measurement Invariance

In order to test measurement invariance of the CAS, we employed multiple approaches because the samples were convenient and diverse, and the study included participants from very different populations. We used both conventional exact invariance tests, as well as a more recent procedure of alignment (Asparouhov & Muthén, 2023; Leitgöb et al., 2022), including weighted least squares and Bayesian versions. The test of the exact invariance with the dichotomous indicators involves comparison of the two models: configural and scalar invariance both estimated with weighted least squares means and variance adjusted (WLSMV). Intermediary metric invariance in the case of binary indicators was not viable (Wu & Estabrook, 2016). The goodness of fit was indicated by comparative fit index (CFI) > .90 and RMSEA < .08 (Hu & Bentler, 1999). The configural model tests for an overall similarity of factor structure across groups, whereas scalar invariance models require equality of the factor loadings and item thresholds across groups. If the difference between the fit of the two models lies within the cutoff values of $\Delta\text{CFI} < .008$ and $\Delta\text{RMSEA} < .05$ (Rutkowski & Svetina, 2017; ΔCFI comes from adding two cutoffs of .004 for factor loadings and threshold constraints), then full scalar invariance is indicated. This would imply comparability of the unstandardized regression coefficients as well as latent means across groups. We also applied the alignment procedure (Asparouhov & Muthén, 2014) because the diverse and large group differences were unlikely to show exact measurement invariance. Alignment is an iterative procedure that estimates a configural model without any group constraints and, similar to the factor loadings rotation in exploratory factor analysis, finds the most invariant set of parameters possible without changing the model fit to the data (Asparouhov & Muthén, 2014, 2023). The alignment procedure established configural invariance model using WLSMV and then rotated parameters to achieve the highest possible invariance. We followed a criterion of the maximum of 25% noninvariant parameters to establish a sufficient level of measurement invariance. In addition, we considered R^2 , its higher values reflect the degree to which group differences in loadings and thresholds are explained by corresponding differences in factor variances and means. Higher values indicate a higher degree of invariance. At first, we ran a free mode alignment, identified a group with a latent mean close to zero (which happened to be Malaysia), and then ran a fixed mode alignment using the identified group as a baseline.

Resampling Analysis

The sample sizes of groups were very different (see online Supplemental Table S1). This might have caused unequal influence

of different groups on the overall result of the measurement invariance tests (Yoon & Lai, 2018). Therefore, another robustness check was implemented. Specifically, we employed a resampling technique described by Yoon and Lai (2018). Resampling included (a) drawing random samples of equal size from each group and (b) fitting multiple group factor analysis using this new sample. Points 1 and 2 were repeated a large number of times (500 runs), and finally, the fit statistics and estimated parameters were summarized across all the runs of the resampled models. The resampling technique was applied both to the conventional tests and to the alignment. One important limitation of this technique is that the resampled N gets as small as the smallest group in the data. Since our data set contains groups with as little sample sizes as 48, we first dropped all the groups with sample sizes below 99 observations. It resulted in 52 groups for the resampling analysis. The resampling was performed in two ways. First, we precisely followed the instructions given by Yoon and Lai (2018) and sampled every group with the same number of observations, where N was equal to the smallest sample in the data. Second, we opted to use resampling with replacement, so that the group sample sizes can be larger. This enabled the models to be estimated using indefinitely large samples, so we chose to use 500 and 1,000 observations per group. Finally, led by the inconclusive results of the planned tests, we ran a follow-up analysis applying several alternative methods of measurement invariance testing. The details are discussed in the corresponding section.

Convergent Validity

Following invariance testing we sought to test the convergent validity of the CAS scores in relation to FCV-19S and SWLS-3 scores. A strong, positive association between the CAS and FCV-19S, and a negative, but weak association between CAS and SWLS-3, were expected in every country. Before testing the associations of the CAS with the other scales, measurement invariance of these scales was also assessed. Therefore, we utilized the abovementioned methods of exact, approximate (alignment) invariance, and a resampling technique for the convergent validity measures as well. Finally, we computed correlations between these latent variables.

Most analyses were conducted using Mplus 8.8 (Muthén & Muthén, 1998–2022), preparation of data, integration of results, and visualizations were conducted in R (R Core Team, 2022), in particular, using “MplusAutomation” (Hallquist & Wiley, 2018), “Measurement Invariance Explorer” (Rudnev, 2022), “lavaan” (Rosseel, 2012), and other packages. The data for the present study are available upon request from the corresponding author. All the reproduction codes and the full list of R packages are available in the Open Science Framework directory (<https://osf.io/7gnz9/>).

Results

Exact Invariance

We tested a simple one-factor model of CAS without any correlated residuals. Before checking for measurement invariance, we tested the model in each country separately using confirmatory factor analyses. The results are listed in online Supplemental Section C, Table S3. The model fit the data sufficiently well in almost all the

countries—the χ^2 tests p values were higher than .05 in all but seven countries. Five of those had relatively large sample sizes (>300) and good model fit in terms of CFI and RMSEA, which made significant χ^2 values less relevant. The samples from Uganda and Taiwan showed an unacceptable fit in terms of both RMSEA and χ^2 values. Also, despite the model showing a good fit to the data, the estimated factor's variance was negative in the Czech Republic. These three countries were dropped from further analysis. In addition, Mozambique was dropped because the preliminary multiple group models persistently estimated a negative variance of the CAS factor in this sample. The model using the pool of 56 remaining samples revealed a very good fit to the data, CFI/Tucker–Lewis index (TLI) = .998/.996, RMSEA = .042 (90% CI [.037, .047]), standardized root-mean-square residual, SRMR = .018.

Next, we tested the exact measurement invariance. Table 1 lists the results of the configural and scalar multigroup confirmatory factor analysis (MGCFA) model fit in 56 countries. The results showed that the configural invariance model had a very good fit to the data. Scalar invariance showed acceptable CFI and SRMR values, RMSEA was .085, which is higher than recommended upper cutoff value of .08 (Hu & Bentler, 1999). The examination of parameter estimates in the configural model demonstrated that thresholds of Item 1 (dizziness) and Item 3 (tonic immobility) showed the largest differences across groups. Therefore, we fitted a partial scalar invariance model (Byrne et al., 1989), removing the equality constraints on these two items' thresholds. The partial invariance model included relaxed constraints on the two thresholds, at the same time the corresponding “scales” were fixed at 1. This way, the model had the same number of degrees of freedom as the scalar model, but was less constrained.¹ The resulting partial invariance model had a good fit to the data across all fit indices. The differences in CFI and RMSEA between the configural and partial scalar invariance models were within the recommended range (i.e., $\Delta\text{CFI} = .003$, $\Delta\text{RMSEA} = .009$). Other than that, scalar invariance model estimated nonsignificant variances of the latent factor in approximately half of the samples, which signals a problematic solution. Nevertheless, we can conclude that partial invariance could be supported and the means and regression coefficients of the COVID-19 anxiety factor can be compared across cultural groups.

Resampling of the Exact Invariance Tests

As already mentioned, we applied two resampling approaches—without replacement and with replacements. To make these resampling solutions comparable to the nonresampled models, we further excluded four countries with the smallest samples (Costa Rica, Bosnia and Herzegovina, Nigeria, and Qatar, all $n < 99$); therefore, the number of countries was reduced to 52 (see Table 2). Several notable points arose from this analysis. The conventional invariance tests on the slightly reduced sample showed almost identical results. Every resampling supported well-fitting configural models, rejected full scalar models, and confirmed partial invariance as its fit was only slightly worse than the fit of the configural models. In resampling runs with $n = 500$ and $n = 1,000$, the partial invariance model had marginal RMSEA values of .083 and .084, respectively. These results imply that if we had balanced and large samples in each country partial invariance would probably not be supported. This adds some ambiguity to the results

and asks for further robustness tests. Therefore, we turned to an approximate invariance testing using the alignment procedure.²

Measurement Invariance Testing Using Alignment

The model fit in the alignment procedure was the same as applied in the configural model (see Table 1). The results of the alignment procedure are listed in Table 3. All the factor loadings were approximately invariant across all 56 countries. Only 9% of the parameters were noninvariant, which is substantially lower than the recommended upper cutoff of 25%. The most noninvariant parameter was the threshold of Item 1 (dizziness), which was noninvariant in 21 countries. Also, the threshold of Item 3 (tonic immobility) was noninvariant in 14 countries. This coincides with the results of the partial invariance analysis. The other thresholds had negligible numbers of noninvariant countries. Even in countries with the weakest invariance, namely, Brazil and Romania, only three thresholds were noninvariant whereas the other thresholds and all the five-factor loadings were invariant. Overall, the alignment demonstrated a high degree of approximate measurement invariance.

Next, we ran simulations of alignment with parameters estimated in the current model (Asparouhov & Muthén, 2014). Simulations can demonstrate whether the current model is able to correctly estimate latent means and variances. We ran simulations for different numbers of observations per group—100, 500, and 1,000. The general approach assumes a balanced design (equal sample sizes in each group). This is not the case in our data which may produce overly optimistic estimates of the reliability of alignment. Therefore, given the unbalanced nature of our data, actual sample sizes were used in the simulation as well. There were two measures of replication. For the first one, each set of estimated means is correlated with the (true) means found in the original alignment, and then these correlations are averaged across all samples. Another way to aggregate the results is to compute average estimates across all the generated samples, and only after that correlate these average estimates to the true means. Both approaches should arrive at correlation equal to or greater than .98 to support reliability of the alignment results. The results for different sample sizes are listed in online Supplemental Section D, Table S4. The simulations with actual n and $n = 100$ had a large proportion of nonpositive definite (NPD) solutions (which is not necessarily problematic, see Footnote 2). It was not the case for balanced and larger samples though. The correlations of true and estimated means were acceptable ($r > .98$) in balanced sample condition with $n = 500$ and higher. It follows that the latent means would be reliable if the sampling was balanced, and the samples were at least 500 per group. But for the current sampling approach, the model might have slightly misestimated the latent means of the

¹ In the delta parameterization for confirmatory factor analysis with categorical indicators, scales are additional parameters replacing residuals which are normally not identified.

² Many resampled solutions had a high number of NPD matrices (namely negative variances of observed variables), which were more common in smaller samples and less common in larger samples. Sparse contingency tables likely caused this, as some cross-tabulations had frequencies close to zero, and resampling reproduced this issue. Given that residuals of binary observed indicator estimated with delta parameterization are not typical parameters and do not necessarily point to a problem, we considered the results of the resampling solutions sufficiently reliable.

Table 1
Fit Indices of the Exact Invariance Tests of the CAS

Model	CFI	Δ CFI	TLI	Δ TLI	RMSEA	Δ RMSEA	SRMR	Δ SRMR
Configural	.998		.995		.047		.033	
Full scalar	.988	.010	.984	.011	.085	.038	.048	.015
Partial scalar	.995	.003	.993	.002	.056	.009	.043	.010

Note. In the partial scalar model, threshold of items Item 1 (dizziness) and Item 3 (tonic immobility) are free. CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual; CAS = Coronavirus Anxiety Scale.

anxiety factor. In contrast, the correlations between true and estimated variances were extremely small, the highest estimated correlation for a balanced sample and $n = 1,000$ was only .736. This result implies that the variances of the latent variables could not be reliably estimated by the current alignment model. Yet, the other measure of reliability of variances, correlation of average estimated variance with the population values, showed higher reliability, but again reaches an acceptable level only at $n = 500$.

Finally, we also applied resampling to the alignment. We successfully computed 491 resampled alignments ($n = 500$ for each group, with replacement),³ which resulted in 500 sets of means for each of the 52 groups. The replication rates were high. The average correlation was $r = .991$ and its $SD = .002$. The correlation of average estimates with the true values was $r = .999$. As mentioned above, a similar method, but for simulations rather than resampling, was suggested by Asparouhov and Muthén (2014), who also provided a cutoff of $r = .98$ as a measure of successful replication. Although there are no correlation guidelines for the resampling, the correlations seem high enough to suggest that the results of alignment might have revealed the unbiased means. The correlations between the estimated variances in resampling and true variances were also very high ($r = .999$).

Overall, the results of the invariance tests were inconclusive. On one hand, both exact invariance tests and alignment suggested a high degree of (approximate) invariance. On the other hand, however, the solutions contained many NPDs, means and variances differed across methods. In order to add more certainty, we also ran a more flexible Bayesian alignment, maximum likelihood alignment, and Bayesian approximate invariance tests (Bayesian structural equation modeling [BSEM]—see details in van de Schoot et al., 2013). The details of these analyses are listed in online Supplemental Section D, Tables S5–S7. The correlations between latent means and variances estimated with six different methods are listed in Table 4. The means, including a simple group mean score, converged. The correlation between WLSMV alignment and partial exact invariance is $r = .96$. Online Supplemental Figure S2 demonstrates similarity of means estimated by these two methods and their similarity to average summative scores. The other methods estimated means that correlated with each other $r = .90$ or higher, except the means estimated by the full scalar model. The latter is expected as the model was rejected due to its poor fit to the data and estimation problems.

Unlike the means, the estimation of variances produced very different results (see Table 4, above the diagonal). The variances of the summative index demonstrated the weakest correlations with

variances estimated by the other methods. Nevertheless, partial invariance model and different methods of alignment estimated factor variances that correlate around $r = .90$ which is sufficient for most practical purposes. Overall, all the nonexact invariance methods estimated highly consensual means and variances, and arrived at similar conclusions of a high level of approximate/partial invariance of the CAS. For further analysis of convergent validity, we opted to use WLSMV alignment because it seems to represent the most consensual pattern of means and variances compared to all the other methods.

Convergent Validity Evidence

Before examining the relations between CAS with FCV-19S and SWLS-3 scales, the latter also needed to be tested for invariance across countries. Although both scales have been shown to be invariant across various countries in other studies (e.g., Sawicki et al., 2022), it was necessary to demonstrate it with the current data to ensure that the within-country correlations were not biased (requires metric invariance) and that country-level correlations can be interpreted (requires scalar invariance). The results listed in online Supplemental Section E demonstrate that both scales had a sufficient level of approximate invariance.

Given the inconsistent results of the tests of invariance and also to test the relations between CAS and the two convergent measures, we used methodological triangulation. That is, we applied three different strategies. The first strategy used predicted individual factor scores and then computed correlations. The second strategy involved merging MGCFA models with established levels of invariance into a single MGCFA model and estimating covariances between latent variables simultaneously. Finally, we made use of the possibility of conducting alignment for the entire model with factors for CAS, SWLS-3, and FCV-19S. The results are summarized in Table 5 (for details see online Supplemental Section F). The correlations between the two factors of the FCV-19S (physiological arousal and psychological distress) and CAS were positive and significant at the country level as well as at the individual level in all countries except Pakistan (in Nepal, only the correlation between CAS and psychological distress factor was nonsignificant). The exclusion of Pakistan, however, barely changed the results, which supported the convergent validity of CAS. Correlations of CAS with

³ Resampling using $n = 99$ without replacement resulted in 91% solutions with NPD, yet the correlations of true and replicated means were relatively high; correlation of averages with the true means was $r = .999$ (and $r = .994$ for variances), average of correlations with true means was $r = .972$ and $SD = .007$.

Table 2
Exact Measurement Invariance Tests With the Full and Resampled Data (Number of Runs Is 500; Number of Groups Is 52)

Model	χ^2 (SD)	CFI (SD)	TLI (SD)	RMSEA [90% CI] (SD)	SRMR (SD)	N converged replications	NPD matrix (% of replications)
Not resampled, reduced sample of groups							
Configural	502.1	.997	.995	.049 [.042, .055]	.032	Converged	0
Partial	945.4	.994	.993	.057 [.053, .062]	.042	Converged	0
Scalar	1631.1	.987	.984	.087 [.082, .091]	.047	Converged	0
Δ Configural and scalar	1128.9	.010	.011	.038	.015		
Δ Configural and partial	443.2	.003	.002	.008	.010		
Resampling without replacement, N per group = 99							
Configural	284.9 (20.1)	.999 (.001)	.998 (.001)	.028 (.014)	.055 (.003)	485	93
Partial	529.0 (27.7)	.996 (.001)	.995 (.001)	.053 (.006)	.070 (.003)	488	93
Scalar	653.7 (32.7)	.992 (.001)	.990 (.002)	.077 (.005)	.070 (.003)	477	93
Δ Configural and scalar	368.8	.007	.008	.049	.015		
Δ Configural and partial	244.1	.003	.003	.025	.015		
Resampling with replacement, N rep per group = 500							
Configural	928.6 (52.3)	.995 (.000)	.990 (.001)	.072 (.003)	.044 (.002)	500	71
Partial	1831.5 (74.7)	.990 (.001)	.987 (.001)	.083 (.002)	.057 (.002)	500	59
Scalar	2511.2 (92.3)	.984 (.001)	.980 (.001)	.101 (.002)	.058 (.002)	500	77
Δ Configural and scalar	1582.6	.011	.010	.029	.014		
Δ Configural and partial	902.9	.005	.003	.011	.013		
Resampling with replacement, N rep per group = 1,000							
Configural	1633.2 (72.7)	.995 (.000)	.989 (.001)	.073 (.002)	.041 (.001)	500	42
Partial	3316.0 (101.2)	.989 (.001)	.986 (.001)	.084 (.001)	.053 (.001)	500	56
Scalar	4692.8 (122.8)	.983 (.001)	.979 (.001)	.102 (.001)	.055 (.001)	500	77
Δ Configural and scalar	3059.6	.012	.010	.029	.014		
Δ Configural and partial	1682.6	.006	.003	.011	.012		

Note. Degrees of freedom for configural, partial, and scalar models are 260, 413, and 413, respectively. NPD = nonpositive definite model-implied covariance matrix (e.g., negative variances of observed variables); CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual; CI = confidence interval.

Table 3*The Results of the Fixed-Mode WLSMV Alignment of the CAS*

Parameter	Aligned estimated parameter	R^2	N nonvariant	List of countries with noninvariant parameters
Thresholds				
Dizziness	1.08	0.76	21	Afghanistan, Armenia, Bangladesh, Bulgaria, Colombia, Cyprus, Georgia, Germany, Indonesia, Iran, Israel, Lebanon, Malaysia, Nepal, Philippines, Poland, Romania, Singapore, Syria, Ukraine, Zambia
Sleep disturbances	0.55	0.82	7	Afghanistan, Brazil, Honduras, Lebanon, Philippines, Portugal, United States
Tonic immobility	1.33	0.74	14	Bosnia and Herzegovina, Brazil, Colombia, Cuba, Ecuador, Georgia, Germany, Honduras, Poland, Romania, Serbia, Singapore, Slovenia, Turkey
Appetite changes	0.88	0.93	3	Brazil, India, Japan
Nausea and abdominal distress	0.81	0.89	4	Kosovo ^a , Romania, Slovakia, Vietnam
Loadings				
Dizziness	0.87	0.59	0	
Sleep disturbances	0.90	0.29	0	
Tonic immobility	0.91	0.52	0	
Appetite changes	0.91	0.61	0	
Nausea and abdominal distress	0.93	0.42	0	

Note. As of December 2022, out of 193 United Nations member states, 117 countries recognize Kosovo as an independent state, whereas 76 countries, including Serbia, do not. WLSMV = weighted least squares means and variance adjusted; CAS = Coronavirus Anxiety Scale

^a Kosovo declared its independence from Serbia in 2008, but there is no consensus on its status as a state.

SWLS-3 were much weaker and less stable across countries. The average correlation across different methods was between $-.10$ and $-.14$, with large standard deviations pointing to their marginal difference from zero. Indeed, the correlation was significantly different from zero only in a small fraction of countries. However, in almost all groups, this correlation was consistently negative.

Finally, we checked how consistent the correlations were between different methods. Consistency (correlation of Fisher-standardized correlations estimated by different methods) of within-country correlations estimated with factor scores versus MGCFA was $r = .97$ (psychological distress factor), $r = .97$ (physiological arousal factor), and $r = .95$ (life satisfaction). Likewise, metacorrelations based on estimates from a general alignment model and MGCFA were $.99$, $.99$, $.99$; and the ones based on factor scores and the common alignment were $.98$, $.97$, $.96$, respectively. Mean

differences between values of correlation coefficients were $.06$ and $.07$ for physiological arousal and psychological distress factors, respectively, and $.03$ for life satisfaction.

Discussion

The present study is the largest cross-national investigation of CAS conducted to date, examining the factor structure, measurement invariance, and convergent validity evidence of the scale with a sample of 21,513 respondents from five continents and 60 countries. From a methodological standpoint, this is the first study to apply both exact and approximate approaches to testing measurement invariance of the CAS and to examine cross-national associations between the CAS and two concurrent measures of mental health and well-being. The CAS is a new measure designed

Table 4

Pearson Correlations Between the Latent Means (Below the Diagonal) and Variances (Above the Diagonal) Estimated by Different Methods, $N = 56$

Method	1	2	3	4	5	6	7	8	9	10
1. Mean score	—	.22	.28*	.28*	.33*	.34*	.37**	.22	.17	.35**
2. Configural	NA	—	.77***	.45***	.72***	.65***	.68***	.59***	.54***	.63***
3. Partial	.96***	NA	—	.58***	.94***	.92***	.92***	.82***	.80***	.78***
4. Scalar	.73***	NA	.85***	—	.55***	.49***	.51***	.51***	.53***	.55***
5. Alignment WLSMV	.98***	NA	.96***	.74***	—	.97***	.98***	.89***	.86***	.87***
6. Alignment MLR	.90***	NA	.93***	.81***	.91***	—	.98***	.91***	.87***	.86***
7. Alignment Bayes	.89***	NA	.92***	.82***	.89***	.93***	—	.90***	.87***	.86***
8. BSEM approximate (configural)	.91***	NA	.93***	.81***	.90***	.97***	.94***	—	.94***	.88***
9. BSEM approximate (scalar)	.94***	NA	.95***	.82***	.92***	.95***	.94***	.97***	—	.85***
10. Alignment BSEM	.93***	NA	.95***	.83***	.92***	.96***	.94***	.98***	.99***	—

Note. NA = means are not available in exact configural model because they are fixed to zero for identification purposes; WLSMV = weighted least squares means and variance adjusted; MLR = robust maximum likelihood; BSEM = Bayesian structural equation modeling. Fit indices and other details of each model are provided in the [online Supplemental Section D](#).

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 5*Summary of Relations Between CAS, FCV-19S, and SWLS-3*

Estimation method	Correlations between the CAS and the convergent measures		
	Psychological distress (FCV-19S)	Physiological arousal (FCV-19S)	Life satisfaction (SWLS-3)
Factor scores (estimated with three separate alignments) correlations			
Average individual-level correlation (<i>SD</i>)	.42 (.13)	.44 (.13)	-.10 (.09)
Correlation of means	.23**	.43***	.03
<i>N</i> ^a	52	52	50
MGCFA (<i>N</i> = 49) ^b			
Average individual-level correlation (<i>SD</i>)	.51 (.18)	.55 (.15)	-.14 (.12)
Common alignment (<i>N</i> = 43) ^c			
Average individual-level correlations (<i>SD</i>)	.49 (.14)	.54 (.11)	-.13 (.11)
Correlation of means	.52***	.71**	-.08

Note. MGCFA = multigroup confirmatory factor analysis; CAS = Coronavirus Anxiety Scale; FCV-19S = Fear of COVID-19 Scale; SWLS-3 = Satisfaction with Life Scale; CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root-mean-square error of approximation; SRMR = standardized root-mean-square residual.

^a For models with FCV-19S, we excluded Dominican Republic, Ecuador, Lebanon, and Nigeria because of the issues with the model fit; for models with SWLS-3, we further reduced sample by excluding Qatar and Syria due to inadmissible solutions of the model. ^b Latent means were not available for FCV-19S and SWLS-3 since the established models were metric, and thus the means were fixed to 0 in all groups. In addition to previously excluded countries, we dropped India as well because it caused a nonpositive definite matrix in the model. Fit indices for the MGCFA are $\chi^2 = 6509.9$ ($df = 4,353$), CFI = .973, TLI = .968, RMSEA = .035, SRMR = .055. ^c Due to multiple inadmissible solutions, we reduced sample to 43 countries.

** $p < .01$. *** $p < .001$.

to assess COVID-19-related anxiety, but its content can easily be adapted for other health crises and negative life experiences. Furthermore, the CAS's brevity and ease of administration make it a promising tool for large surveys and cross-national research. Therefore, testing its measurement invariance across a large set of countries can offer valuable insights for future cross-national research.

Overall, the scale demonstrated the theoretically expected single-factor structure in the vast majority of countries included in this research and showed consistent strong, positive associations with fear of COVID-19 and negative (albeit less consistent) links with satisfaction with life. The one-factor model of the CAS had a poor fit to the data only in a few samples, whereas an excellent fit was observed in the vast majority of countries. This is in line with the findings by [Lieven \(2023\)](#) that were drawn from 10,232 respondents across 25 countries. Low RMSEA values of the single-factor model observed in most countries in the present study were not in accordance with the results of [Caycho-Rodríguez et al.'s \(2022\)](#) study, who found large RMSEA values in 11 out of 12 Latin American countries. Although RMSEA values can be overestimated in models with small degrees of freedom ([Kenny et al., 2015](#)), such is the case with the one-factor model of the CAS ($df = 5$), these discrepancies in RMSEA values in our and [Caycho-Rodríguez et al.'s \(2022\)](#) study suggest that the single-factor model might operate differently across samples and languages, thus warranting further research on the CAS's structure. However, it is also important to note that our results are not directly comparable to previous research due to several methodological and statistical differences. Namely, [Lieven \(2023\)](#) and [Caycho-Rodríguez et al. \(2022\)](#) used maximum likelihood and robust maximum likelihood estimation method, respectively, whereas we relied on the WLSMV. The data collection in two previous cross-cultural studies was restricted to March 2021 ([Lieven, 2023](#)) and February–March 2021 ([Caycho-Rodríguez et al., 2022](#)). Whereas, we used data that were collected from the beginning until the end of 2021. Most

importantly, we dichotomized the data and treated them as binary, whereas the earlier cross-national studies relied on the original five response options in their analyses.

The results of our study showed that cross-national measurement invariance of the CAS needs to be approached with caution and that alternative methods of assessing invariance should be considered when evaluating this scale across a wide range of countries. There were several important details that we explored in depth. First, the results of various approaches to testing the measurement invariance of CAS resulted in generally optimistic but unstable results. Despite good fit of the models, they often arrived at inadmissible solutions and, depending on the method, varied in the estimated levels of COVID-19-related anxiety. In order to arrive at a stable result, we applied a methodological triangulation which involves the application of several methods to analyze the same data ([Heesen et al., 2019](#)). The results suggested that the most stable solution was found in Bayesian alignment.

Virtually all methods pointed to the lower invariance of thresholds for items relating to dizziness (Item 1) and tonic immobility (Item 3). These results indicate that these two symptoms appear across samples to different degrees regardless of the overall anxiety. In other words, it might imply that culture moderates the expression of anxiety through dizziness (feeling dizzy, lightheaded, faint) and tonic immobility (feeling paralyzed, frozen) or at least regulates the self-reports of these conditions. Contrary to the other items (sleep disturbances, appetite changes, nausea/abdominal distress) capturing somatic symptoms caused primarily by intense worry about the coronavirus, dizziness, and tonic immobility refer to physiological arousal in response to intense fear. Both dizziness (and other dissociative symptoms; [Schalinski et al., 2015](#)) and tonic immobility (e.g., [Abrams et al., 2012](#)) might occur in situations of perceived inescapability, threat of death, and in the context of panic attacks. Although both dizziness and tonic immobility are involuntary, automatically activated defense behaviors ([Kozłowska et al., 2015](#)), they were assessed via self-report in the present study, which might bring out some cross-cultural

differences in the interpretation of these symptoms (see Hinton & Pollack, 2009) and provoke culture-specific meanings of these bodily symptoms (Hofmann & Hinton, 2014). Furthermore, the linguistic meaning of dizzy/lightheaded/faint (Item 1) and paralyzed/frozen (Item 3) probably varies more across languages compared to sleeping (Item 2) and eating problems (Item 4), which refer to basic physiological needs essential for human survival. Thus, items referring to eating and sleeping can be expected to have higher translatability and a more similar meaning across languages, as they capture motivational states with a high level of universality across languages (e.g., Saucier et al., 2014). In addition, nausea/stomach problems (Item 5) are closely associated with an affective state of disgust also essential for survival (Panksepp, 2007) and thus also can be expected to have less variation across languages than terms related to dizziness and tonic immobility.

The triangulated analysis of CAS association with fear of COVID-19 and satisfaction with life did not show exactly the same strength of correlation coefficients in every studied country, but these correlations' directions were consistent with our expectations. As expected, the coronavirus anxiety (as measured by the CAS) had strong positive correlations with physiological arousal and psychological distress factors of the FCV-19S and weak negative correlations with satisfaction with life. The findings support the convergent validity of the CAS scores, as it has been shown that somatic symptoms of coronavirus anxiety are more closely associated with psychological and somatic aspects of COVID-19-related fear (i.e., FCV-19S) than with a measure of people's overall evaluation of their life. Life satisfaction judgments are relatively stable and strongly influenced by objective conditions and chronically accessible information (Pavot & Diener, 2008), thus weak correlations with context-specific fears and anxiety are expected. The magnitude of correlations between CAS and two FCV-19S factors found in the present research is comparable to those observed in only a few previous studies that adopted a two-factor structure of the FCV-19S (e.g., Magano et al., 2021) and suggests that the CAS and FCV-19S measure related, yet distinct constructs. The CAS focuses exclusively on somatic aspects of anxiety, whereas the FCV-19S includes items covering somatic symptoms of fear (insomnia, heart palpitations, and clammy hands), but also psychological aspects (being afraid, uncomfortable, afraid to die, and nervous/anxious), thus their relatively modest intercorrelation is as expected.

Based on our results and some previous findings on the structure of the FCV-19S (e.g., Sawicki et al., 2022) and the CAS (Lieven, 2023) across cultures, it can be concluded that the CAS is a better alternative for cross-cultural research than FCV-19S. However, it has to be noted that the CAS is limited in its scope (no psychological, cognitive, or social dimensions of anxiety are included), so it would be preferable to complement this scale with measures that capture other aspects of anxiety beyond somatic symptoms.

Constraints on Generality

Several important limitations of the present study should be noted. First, although we covered a wide range of countries across the globe, the participants were recruited using convenience sampling and, in most countries, included mostly young adults. This limits the generalizability of our findings as anxiety symptoms might differ substantially across age groups (e.g., Carlucci et al., 2018; Teachman & Gordon, 2009). Second, the sample sizes varied

greatly across countries, which poses a challenge for testing cross-national measurement invariance. Previous studies have shown that unequal sample sizes across groups might jeopardize the results of invariance testing and lead to biased invariance findings (Yoon & Lai, 2018). Although we applied a resampling strategy (i.e., random samples of balanced groups), future studies should aim to recruit more balanced samples across cultures in terms of gender, age, and socioeconomic status and further evaluate the CAS's utility for cross-national research. Third, the need for dichotomization of the CAS items means that the findings are limited to indications of the presence or absence of anxiety conditions. A future study targeted at the affected populations could focus on the viability of the scale for indicating the severity. Fourth, none of the CAS items were reverse-coded which can introduce issues concerning response styles, which in turn are known to boost reliability and unidimensionality. On one hand, our conclusions on the comparability of CAS across nations might indicate the invariance of response style in addition to invariance of the COVID-19 anxiety; on the other hand, there is no reason to expect close relations between response style and anxiety, hence, the confusion is unlikely. Additionally, dichotomization of items could partially mitigate the response style bias, removing the scale use variance. Fifth, the convergent validity evidence of the CAS scores was evaluated only in relation to life satisfaction and fear of COVID-19. Future studies should strive to examine the relationships between the CAS and other well-established measures of anxiety (for a review of self-report anxiety scales, see Wall & Lee, 2022). Finally, we did not explore potential factors that might have influenced the measurement invariance results, that is, source of noninvariance of Items 1 and 3. A recently developed procedure for disentangling different sources of item bias—the culture, comprehension, and translation bias procedure (Bader et al., 2021)—might be a useful resource for future studies aimed at understanding whether the lack of invariance on certain CAS items results from translation bias or from systematic differences in social and cultural contexts between groups. The present study suggests that the CAS is not only a valid measure of somatic symptoms of health-related anxiety for purposes of cross-national research but also underscores the need for thorough examination of CAS's measurement invariance prior to conducting meaningful cross-national comparisons.

References

- Abrams, M. P., Carleton, R. N., & Asmundson, G. J. G. (2012). Tonic immobility does not uniquely predict posttraumatic stress symptom severity. *Psychological Trauma: Theory, Research, Practice, and Policy*, 4(3), 278–284. <https://doi.org/10.1037/a0023272>
- Ahmed, O., Faisal, R. A., Sharkey, T., Lee, S. A., & Jobe, M. C. (2022). Adaptation of the bangla Version of the COVID-19 anxiety scale. *International Journal of Mental Health and Addiction*, 20(1), 284–295. <https://doi.org/10.1007/s11469-020-00357-2>
- Ahorsu, D. K., Lin, C. Y., Imani, V., Saffari, M., Griffiths, M. D., & Pakpour, A. H. (2022). The fear of COVID-19 scale: Development and initial validation. *International Journal of Mental Health and Addiction*, 20(3), 1537–1545. <https://doi.org/10.1007/s11469-020-00270-8>
- Aknin, L. B., De Neve, J.-E., Dunn, E. W., Fancourt, D. E., Goldberg, E., Helliwell, J. F., Jones, S. P., Karam, E., Layard, R., Lyubomirsky, S., Rzepa, A., Saxena, S., Thornton, E. M., VanderWeele, T. J., Whillans, A. V., Zaki, J., Karadag, O., & Ben Amor, Y. (2022). Mental health during the first year of the COVID-19 pandemic: A review and recommendations

- for moving forward. *Perspectives on Psychological Science*, 17(4), 915–936. <https://doi.org/10.1177/17456916211029964>
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.).
- Asmundson, G. J. G., & Taylor, S. (2020). Coronaphobia: Fear and the 2019-nCoV outbreak. *Journal of Anxiety Disorders*, 70, Article 102196. <https://doi.org/10.1016/j.janxdis.2020.102196>
- Asparouhov, T., & Muthén, B. (2014). Multiple-Group factor analysis alignment. *Structural Equation Modeling: A Multidisciplinary Journal*, 21(4), 495–508. <https://doi.org/10.1080/10705511.2014.919210>
- Asparouhov, T., & Muthén, B. (2023). Multiple group alignment for exploratory and structural equation models. *Structural Equation Modeling: A Multidisciplinary Journal*, 30(2), 169–191. <https://doi.org/10.1080/10705511.2022.2127100>
- Bader, M., Jobst, L. J., Zettler, I., Hilbig, B. E., & Moshagen, M. (2021). Disentangling the effects of culture and language on measurement noninvariance in cross-cultural research: The culture, comprehension, and translation bias (CCT) procedure. *Psychological Assessment*, 33(5), 375–384. <https://doi.org/10.1037/pas0000989>
- Bredström, A. (2019). Culture and context in mental health diagnosing: Scrutinizing the DSM-5 revision. *The Journal of Medical Humanities*, 40(3), 347–363. <https://doi.org/10.1007/s10912-017-9501-1>
- Broche-Pérez, Y., Fernández-Castillo, E., Fernández-Fleites, Z., Jiménez-Puig, E., Vizcaíno-Escobar, A., Ferrer-Lozano, D., Martínez-Rodríguez, L., & Martín-González, R. (2022). Adaptation of the Cuban version of the Coronavirus Anxiety Scale. *Death Studies*, 46(3), 603–607. <https://doi.org/10.1080/07481187.2020.1855610>
- Byrne, B. M., Shavelson, R. J., & Muthén, B. (1989). Testing for the equivalence of factor covariance and mean structures: The issue of partial measurement invariance. *Psychological Bulletin*, 105(3), 456–466. <https://doi.org/10.1037/0033-2909.105.3.456>
- Carlucci, L., Watkins, M. W., Sergi, M. R., Cataldi, F., Saggino, A., & Balsamo, M. (2018). Dimensions of anxiety, age, and gender: Assessing dimensionality and measurement invariance of the state-trait for cognitive and somatic anxiety (STICSA) in an Italian sample. *Frontiers in Psychology*, 9, Article 2345. <https://doi.org/10.3389/fpsyg.2018.02345>
- Caycho-Rodríguez, T., Valencia, P. D., Vilca, L. W., Carbajal-León, C., Vivanco-Vidal, A., Saroli-Aranibar, D., Reyes-Bossio, M., White, M., Rojas-Jara, C., Polanco-Carrasco, R., Gallegos, M., Cervigni, M., Martino, P., Palacios, D. A., Moreta-Herrera, R., Samaniego-Pinho, A., Lobos-Rivera, M. E., Figares, A. B., Puerta-Cortés, D. X., ... Flores-Mendoza, C. (2022). Cross-cultural validation of the new version of the Coronavirus Anxiety Scale in twelve Latin American countries. *Current Psychology*. Advance online publication. <https://doi.org/10.1007/s12144-021-02563-0>
- Chen, J. H., Tong, K. K., Su, X., Yu, E. W.-Y., & Wu, A. M. S. (2021). Measuring COVID-19 related anxiety and obsession: Validation of the Coronavirus Anxiety Scale and the Obsession with COVID-19 Scale in a probability Chinese sample. *Journal of Affective Disorders*, 295, 1131–1137. <https://doi.org/10.1016/j.jad.2021.08.104>
- Choi, E., Lee, J., & Lee, S. A. (2022). Validation of the Korean version of the obsession with COVID-19 scale and the Coronavirus anxiety scale. *Death Studies*, 46(3), 608–614. <https://doi.org/10.1080/07481187.2020.1833383>
- Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment*, 49(1), 71–75. https://doi.org/10.1207/s15327752jpa4901_13
- DiStefano, C., Shi, D., & Morgan, G. B. (2021). Collapsing categories is often more advantageous than modeling sparse data: Investigations in the CFA framework. *Structural Equation Modeling: A Multidisciplinary Journal*, 28(2), 237–249. <https://doi.org/10.1080/10705511.2020.1803073>
- Evren, C., Evren, B., Dalbudak, E., Topcu, M., & Kutlu, N. (2022). Measuring anxiety related to COVID-19: A Turkish validation study of the Coronavirus Anxiety Scale. *Death Studies*, 46(5), 1052–1058. <https://doi.org/10.1080/07481187.2020.1774969>
- Forero, C. G., & Maydeu-Olivares, A. (2009). Estimation of IRT graded response models: Limited versus full information methods. *Psychological Methods*, 14(3), 275–299. <https://doi.org/10.1037/a0015825>
- Hallquist, M. N., & Wiley, J. F. (2018). MplusAutomation: An R package for facilitating large-scale latent variable analyses in Mplus. *Structural Equation Modeling: A Multidisciplinary Journal*, 25(4), 621–638. <https://doi.org/10.1080/10705511.2017.1402334>
- Han, K., Colarelli, S. M., & Weed, N. C. (2019). Methodological and statistical advances in the consideration of cultural diversity in assessment: A critical review of group classification and measurement invariance testing. *Psychological Assessment*, 31(12), 1481–1496. <https://doi.org/10.1037/pas0000731>
- Heesen, R., Bright, L. K., & Zucker, A. (2019). Vindicating methodological triangulation. *Synthese*, 196(8), 3067–3081. <https://doi.org/10.1007/s11229-016-1294-7>
- Hinton, D. E., & Pollack, M. H. (2009). Introduction to the special issue: Anxiety disorders in cross-cultural perspective. *CNS Neuroscience & Therapeutics*, 15(3), 207–209. <https://doi.org/10.1111/j.1755-5949.2009.00097.x>
- Hofmann, S. G., & Hinton, D. E. (2014). Cross-cultural aspects of anxiety disorders. *Current Psychiatry Reports*, 16(6), Article 450. <https://doi.org/10.1007/s11920-014-0450-3>
- Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1–55. <https://doi.org/10.1080/10705519909540118>
- Karakulak, A., Rivera, R., Dimitrova, R., Carballea, D., Chen, B.-B., Kittiteerasack, P., Rios González, C. M., Yildirim, E., & Yu, Y. (2023). International advancements on COVID-19 scholarship through the research initiatives working group at the APA interdivisional task force on the pandemic. In C. R. Figley, L. E. Walker, & I. A. Serlin (Eds.), *Pandemic providers* (pp. 241–322). Springer. https://doi.org/10.1007/978-3-031-27580-7_11
- Kenny, D. A., Kaniskan, B., & McCoach, D. B. (2015). The performance of RMSEA in models with small degrees of freedom. *Sociological Methods & Research*, 44(3), 486–507. <https://doi.org/10.1177/0049124114543236>
- Kirmayer, L. J. (2001). Cultural variations in the clinical presentation of depression and anxiety: Implications for diagnosis and treatment. *The Journal of Clinical Psychiatry*, 62(Suppl. 13), 22–28.
- Kjell, O. N. E., & Diener, E. (2021). Abbreviated three-item versions of the Satisfaction with Life Scale and the Harmony in Life Scale yield as strong psychometric properties as the original scales. *Journal of Personality Assessment*, 103(2), 183–194. <https://doi.org/10.1080/00223891.2020.1737093>
- Kozłowska, K., Walker, P., McLean, L., & Carriev, P. (2015). Fear and the defense cascade: Clinical implications and management. *Harvard Review of Psychiatry*, 23(4), 263–287. <https://doi.org/10.1097/HRP.0000000000000065>
- Lee, S. A. (2020a). Coronavirus Anxiety Scale: A brief mental health screener for COVID-19 related anxiety. *Death Studies*, 44(7), 393–401. <https://doi.org/10.1080/07481187.2020.1748481>
- Lee, S. A. (2020b). Measuring coronaphobia: The psychological basis of the Coronavirus Anxiety Scale. *Dusumen Adam: The Journal of Psychiatry and Neurological Sciences*, 33(2), 107–108. <https://doi.org/10.14744/DAJPNS.2020.00069>
- Lee, S. A. (2020c). Replication analysis of the Coronavirus Anxiety Scale. *Dusumen Adam: The Journal of Psychiatry and Neurological Sciences*, 33, 203–205. <https://doi.org/10.14744/DAJPNS.2020.00079>
- Lee, S. A., Mathis, A. A., Jobe, M. C., & Pappalardo, E. A. (2020). Clinically significant fear and anxiety of COVID-19: A psychometric examination of the Coronavirus Anxiety Scale. *Psychiatry Research*, 290, Article 113112. <https://doi.org/10.1016/j.psychres.2020.113112>
- Leitgöb, H., Seddig, D., Asparouhov, T., Behr, D., Davidov, E., De Roover, K., Jak, S., Meitinger, K., Menold, N., Muthén, B., Rudnev, M., Schmidt,

- P., & van de Schoot, R. (2022). Measurement invariance in the social sciences: Historical development, methodological challenges, state of the art, and future perspectives. *Social Science Research*, 110, Article 102805. <https://doi.org/10.1016/j.ssresearch.2022.102805>
- Lewis-Fernández, R., Hinton, D. E., Laria, A. J., Patterson, E. H., Hofmann, S. G., Craske, M. G., Stein, D. J., Asnaani, A., & Liao, B. (2010). Culture and the anxiety disorders: Recommendations for DSM-V. *Depression and Anxiety*, 27(2), 212–229. <https://doi.org/10.1002/da.20647>
- Lieven, T. (2023). Global validation of the Coronavirus Anxiety Scale (CAS). *Current Psychology*, 42, 17384–17394. <https://doi.org/10.1007/s12144-021-02583-w>
- Linehan, C., Araten-Bergam, T., Baumbusch, J., Beadle-Brown, J., Bigby, C., Birkbeck, G., Bradley, V., Brown, M., Bredewold, F., Chirwa, M., Cui, J., Godoy Gimenez, M., Gomiero, T., Kanova, S., Kroll, T., MacLachlan, M., Mirfin-Veitch, B., Narayan, J., Nearchou, F., ... Tossebro, J. (2020). COVID-19 IDD: A global survey exploring family members' and paid staff's perceptions of the impact of COVID-19 on individuals with intellectual and developmental disabilities and their caregivers. *HRB Open Research*, 3, Article 39. <https://doi.org/10.12688/hrbopenres.13077.2>
- Luo, F., Ghanei Gheshlagh, R., Dalvand, S., Saedmoucheshi, S., & Li, Q. (2021). Systematic review and meta-analysis of fear of COVID-19. *Frontiers in Psychology*, 12, Article 661078. <https://doi.org/10.3389/fpsyg.2021.661078>
- Magano, J., Vidal, D. G., Sousa, H. F. P. E., Dinis, M. A. P., & Leite, Â. (2021). Validation and psychometric properties of the Portuguese version of the Coronavirus Anxiety Scale (CAS) and Fear of COVID-19 Scale (FCV-19S) and associations with travel, tourism and hospitality. *International Journal of Environmental Research and Public Health*, 18(2), Article 427. <https://doi.org/10.3390/ijerph18020427>
- Marecek, J., & LaFrance, M. N. (2021). Editorial introduction: The politics of psychological suffering. *Feminism & Psychology*, 31(1), 3–18. <https://doi.org/10.1177/0959353521989537>
- Marques, L., Robinaugh, D. J., LeBlanc, N. J., & Hinton, D. (2011). Cross-cultural variations in the prevalence and presentation of anxiety disorders. *Expert Review of Neurotherapeutics*, 11(2), 313–322. <https://doi.org/10.1586/ern.10.122>
- Muthén, L. K., & Muthén, B. O. (1998–2022). *Mplus user's guide* (8th ed.). Panksepp, J. (2007). Criteria for basic emotions: Is DISGUST a primary “emotion”? *Cognition and Emotion*, 21(8), 1819–1828. <https://doi.org/10.1080/02699930701334302>
- Pavot, W., & Diener, E. (2008). The Satisfaction With Life Scale and the emerging construct of life satisfaction. *The Journal of Positive Psychology*, 3(2), 137–152. <https://doi.org/10.1080/17439760701756946>
- R Core Team. (2022). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. <https://www.R-project.org/>
- Rossee, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software*, 48(2), 1–36. <https://doi.org/10.18637/jss.v048.i02>
- Rudnev, M. (2022). *Measurement invariance explorer* (MIE R package). <https://github.com/MaksimRudnev/MIE.package>
- Rutkowski, L., & Svetina, D. (2017). Measurement invariance in international surveys: Categorical indicators and fit measure performance. *Applied Measurement in Education*, 30(1), 39–51. <https://doi.org/10.1080/08957347.2016.1243540>
- Ryder, A. G., Yang, J., Zhu, X., Yao, S., Yi, J., Heine, S. J., & Bagby, R. M. (2008). The cultural shaping of depression: Somatic symptoms in China, psychological symptoms in North America? *Journal of Abnormal Psychology*, 117(2), 300–313. <https://doi.org/10.1037/0021-843X.117.2.300>
- Saucier, G., Thalmayer, A. G., & Bel-Bahar, T. S. (2014). Human attribute concepts: Relative ubiquity across twelve mutually isolated languages. *Journal of Personality and Social Psychology*, 107(1), 199–216. <https://doi.org/10.1037/a0036492>
- Sawicki, A. J., Żemojtel-Piotrowska, M., Balcerowska, J. M., Sawicka, M. J., Piotrowski, J., Sedikides, C., Jonason, P. K., Maltby, J., Adamovic, M., Agada, A. M. D., Ahmed, O., Al-Shawaf, L., Appiah, S. C. Y., Ardi, R., Babakr, Z. H., Bălăţescu, S., Bonato, M., Cowden, R. G., Chobthamkit, P., ... Zand, S. (2022). The fear of COVID-19 scale: Its structure and measurement invariance across 48 countries. *Psychological Assessment*, 34(3), 294–310. <https://doi.org/10.1037/pas0001102>
- Schalinski, I., Schauer, M., & Elbert, T. (2015). The shutdown dissociation scale (shut-d). *European Journal of Psychotraumatology*, 6(1), Article 25652. <https://doi.org/10.3402/ejpt.v6.25652>
- Skalski, S., Uram, P., Dobrakowski, P., & Kwiatkowska, A. (2021). The link between ego-resiliency, social support, SARS-CoV-2 anxiety and trauma effects. Polish adaptation of the Coronavirus Anxiety Scale. *Personality and Individual Differences*, 171, Article 110540. <https://doi.org/10.1016/j.paid.2020.110540>
- Teachman, B. A., & Gordon, T. (2009). Age differences in anxious responding: Older and calmer, unless the trigger is physical. *Psychology and Aging*, 24(3), 703–714. <https://doi.org/10.1037/a0016813>
- van de Schoot, R., Kluytmans, A., Tummers, L., Lugtig, P., Hox, J., & Muthén, B. (2013). Facing off with Scylla and Charybdis: A comparison of scalar, partial, and the novel possibility of approximate measurement invariance. *Frontiers in Psychology*, 4, Article 770. <https://doi.org/10.3389/fpsyg.2013.00770>
- van de Vijver, F. J. R. (2019). Cross-cultural research. In J. Edlund & A. Nichols (Eds.), *Advanced research methods and statistics for the behavioral and social sciences* (pp. 274–286). Cambridge University Press.
- Vinaccia, S., Bahamón, M. J., Trejos-Herrera, A. M., Lee, S. A., Quiceno, J. M., Gómez, C. A., Vega DoLugar, S., & Pelaez, E. C. (2022). Validating the Coronavirus Anxiety Scale in a Colombian sample. *Death Studies*, 46(10), 2366–2375. <https://doi.org/10.1080/07481187.2021.1944401>
- Voitsidis, P., Kerasidou, M. D., Nikopoulou, A. V., Tsalikidis, P., Parlapani, E., Holeva, V., & Diakogiannis, I. (2021). A systematic review of questionnaires assessing the psychological impact of COVID-19. *Psychiatry Research*, 305, Article 114183. <https://doi.org/10.1016/j.psychres.2021.114183>
- Wall, A. D., & Lee, E. B. (2022). What do anxiety scales really measure? An item content analysis of self-report measures of anxiety. *Journal of Psychopathology and Behavioral Assessment*, 44(4), 1148–1157. <https://doi.org/10.1007/s10862-022-09973-9>
- Wu, H., & Estabrook, R. (2016). Identification of confirmatory factor analysis models of different levels of invariance for ordered categorical outcomes. *Psychometrika*, 81(4), 1014–1045. <https://doi.org/10.1007/s11336-016-9506-0>
- Yoon, M., & Lai, M. H. (2018). Testing factorial invariance with unbalanced samples. *Structural Equation Modeling: A Multidisciplinary Journal*, 25(2), 201–213. <https://doi.org/10.1080/10705511.2017.1387859>

Received January 15, 2023

Revision received June 2, 2023

Accepted July 17, 2023 ■