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Psychometric properties of the sense of coherence scale: a cross-sectional study in Spain and Latin America

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Antonovsky postulates that the Sense of Coherence (SOC) is key to managing stress and maintaining well-being. He developed the Sense of Coherence Scale, used in different languages, although research has yielded heterogeneous results on its internal structure. This study analyzed the psychometric properties of the SOC-13 scale in adults from 11 Spanish-speaking countries, paying special attention to the influence of negatively worded items. Data from 22,844 participants (66.1% women) were collected between March and August 2020. Participants completed the SOC-13, the General Health Questionnaire (GHQ-12), and a self-perceived health item. Results indicated that traditional models of the scale did not show adequate fit. However, when the method effect associated with negatively worded items was considered, the expected three-factor structure showed good model fit across countries. Higher SOC scores were associated with lower psychological distress and better self-perceived health. This is the first multinational study to examine the psychometric properties of the SOC-13 scale across 11 Spanish-speaking countries, providing new evidence supporting the adequacy of its internal structure. Furthermore, the findings highlight the importance of systematically accounting for the method effect when evaluating the dimensionality of psychological scales.

Keywords Sense of coherence, Psychometric properties, Validity, Reliability, Method effect

The promotion and protection of health enable the improvement of healthy behaviors in the population[1]. Therefore, for the optimal development of a country and its citizens, it is necessary to promote healthy lifestyles that bring them benefits and well-being.

Antonovsky[2] proposed the term "salutogenesis" to refer to the origin of health and developed a salutogenic model to investigate the origin of health. He focused on the health of individuals rather than on the origin of diseases. The model is based on the premise that stress and difficulties are inherent elements of people's existence[3]. Antonovsky[4] proposed understanding health as a health-illness continuum, using the dichotomous well-being/discomfort classification. In doing so, he investigated health factors that actively promoted individual health rather than focusing on risk factors, investigating people's characteristics to successfully manage stressful events.

One of the central concepts of the salutogenic model is the Sense of Coherence (SOC) which is defined as a personal predisposition to understand and manage life events[4]. SOC is a cognitive motivational pattern that enables a person to cope with stressful situations and protect themselves from negative effects[1], and it can be understood as part of a person's resilience[3]. It also refers to the degree to which a person perceives that they can handle and cope with situations at different times in their lives. Therefore, it is considered to be an important variable for managing stress and maintaining physical and psychological health[5]. Consequently, ensuring the

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validity and reliability of instruments assessing SOC is fundamental for both research and population-based assessment and public health intervention planning.

According to this background, a person with a high level of SOC will face a stressful situation with desire and motivation (i.e., *meaningfulness*), perceiving that he or she understands the circumstances (i.e., *comprehensibility*) and has resources available to cope with it (i.e., *manageability*)[4]. It is therefore considered one of the most influential models for understanding the variables that explain human health[6].

SOC has been widely related to health variables. A systematic review of 32 studies found a positive correlation between SOC and quality of life[7]. In addition, it has been found that SOC has an important negative influence on anxiety, depression, post-traumatic stress disorder, burnout, anger, demoralization, hostility, hopelessness, and perceived stress[8]. The General Health Questionnaire (GHQ-12) is widely used as an external indicator of psychological distress in SOC research, with previous studies reporting significant negative associations between SOC and GHQ-12 scores[9–11]. Similarly, it was found that SOC was strongly and positively associated with positive mental health-related outcomes such as optimism, hardiness, control, and coping[8,12]. Additionally, a recent systematic review showed that SOC was positively associated with other health outcomes such as higher levels of physical activity, better compliance with healthy behaviors such as oral health and eating habits, and lower substance abuse (tobacco, alcohol, and illegal substances)[13]. Previous studies have also related SOC to a lower COVID-19 pandemic impact and healthier strategies to cope with it[14–19].

The most used measurement instrument for the assessment of SOC is the Sense of Coherence Scale[20]. The instrument has been translated into more than 33 languages and has been used in multiple countries and is considered a cross-culturally usable measure of SOC[5,21]. The original version of the scale consists of 29 items (SOC-29) which assesses aspects related to the three dimensions that originally comprise the construct[20,22]. Later, shorter versions composed of 13 (SOC-13)[22], nine[23] and three items (SOC-3)[24,25] were tested for their use in different samples. However, according to Eriksson and Lindström[21], there are at least 15 versions of the scale.

In addition, the results regarding the internal structure of the SOC scale are heterogeneous. The original version created by Antonovsky[22] opted for an unifactorial structure. Since then, some studies support the unidimensionality of the scale[26], while others defend a three-component structure composed of the meaningfulness, comprehensibility and manageability dimensions[27,28], a two-factor model[29] and a five-dimensional model[30].

SOC has been widely used in the Spanish context, however, studies exploring its psychometric properties are scarce[29,31,32] and none of these previous studies have explored the psychometric properties of the SOC-13 scale in the general population (examined in samples of older adults over 70 years, in patients with cardiovascular risk factors, and in non-university adult education students). To our knowledge, only five validation studies have been conducted in the Latin American Spanish-speaking context, but they were mainly focused on university students[33–37]. Taken together, previous studies indicate that the SOC-13 presents adequate reliability, with total scores comparable to those reported in other languages. However, findings regarding its internal structure are diverse, and several studies have shown that negatively worded items (items 1, 2, 3, 7, and 10) affect model fit[23,31], suggesting that the lack of control of these items may contribute to the discrepant structural results found in the literature[38,39].

Therefore, this study aimed to analyze the psychometric properties of the SOC-13 for its use in the general population using cross-sectional data from Spain and Latin America (Argentina, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Mexico, Nicaragua, Paraguay, and Peru). Based on previous literature reporting heterogeneous findings regarding the internal structure of the SOC-13 and the influence of negatively worded items on model fit, we compared alternative factorial models, including unidimensional and multidimensional structures, both with and without controlling for wording-related method effects. We expected that models accounting for the method effect would demonstrate superior fit compared to traditional models. Additionally, consistent with previous research, we anticipated that higher SOC scores would be negatively associated with psychological distress and positively associated with self-perceived health, providing evidence of convergent validity.

Method

Participants

To participate in this study, the following inclusion criteria were established: (i) age ≥ 18 years and (ii) signed informed consent form. Between March and August 2020, 34,890 people from Argentina ($n = 1,592$), Chile ($n = 3,090$), Colombia ($n = 1,564$), Costa Rica ($n = 1,680$), Ecuador ($n = 4,497$), El Salvador ($n = 3,979$), Mexico ($n = 2,580$), Nicaragua ($n = 1,289$), Paraguay ($n = 1,512$), Peru ($n = 2,924$), and Spain ($n = 10,183$), accessed the questionnaire link and signed an informed consent form. Of these, 99 (0.28%) were excluded because they were under 18 years of age, and 7,662 (21.96%) due to extremely incomplete questionnaires. Data from 27,130 (77.75%) participants were considered valid. In this study, missing values were not imputed, so participants who did not complete the main dependent variables (Sense of Coherence Scale– SOC-13, General Health Questionnaire – GHQ-12 and self-perceived health) were also excluded from the analyses ($n = 4,286$; 12.28%). Given the large initial sample size, a complete-case approach was considered appropriate, as the exclusion of these cases did not compromise statistical power and allowed the analyses to be conducted using fully observed data. The final sample consisted of 22,844 participants (see Figure S1, Supplementary Material).

The sociodemographic characteristics of this final sample are shown in Table S1 (Supplementary Material). Most of participants were female (66.1%). The mean age was 37.3 years ($SD = 13.7$), and the most common marital status was single (46.8%), followed by married or cohabiting (44.4%).

Instruments

Sense of Coherence Scale (SOC-13)[20,22]. A self-administered scale that assesses the sense of coherence through 13 semantic differential items using a Likert-type response scale ranging from 1 (least frequent) to 7 (most frequent). The 13 items are grouped into three dimensions: *meaningfulness* (items 1, 4, 7 and 12); *comprehensibility* (items 2, 6, 8, 9 and 11) and *manageability* (items 3, 5, 10 and 13). The total score can range from 13 to 91 points and can be used as a single dimension or broken down into the three dimensions above. In both cases, a higher score indicates a higher level of sense of coherence. Before data collection, each country team reviewed the Spanish SOC-13 version to ensure that all items were clearly understood in their local context. No lexical or semantic discrepancies requiring adaptation were identified, allowing the same version to be administered consistently across all 11 countries.

General Health Questionnaire (GHQ-12)[40]. Self-administered scale consisting of 12 items that assess the level of psychological distress of the person with a Likert-type scale with four response options (0-1-2-3). The total score ranged from 0 to 36, with higher scores indicating higher levels of psychological distress. The internal consistency index obtained in this study was $\alpha = 0.84$ (Argentina $\alpha = 0.83$; Chile $\alpha = 0.86$; Colombia $\alpha = 0.86$; Costa Rica $\alpha = 0.85$; Ecuador $\alpha = 0.82$; El Salvador $\alpha = 0.87$; Spain $\alpha = 0.83$; Mexico $\alpha = 0.85$; Nicaragua $\alpha = 0.83$; Paraguay $\alpha = 0.80$ and Peru $\alpha = 0.84$).

Self-perceived health; To assess the participants' perceived health at the time of participation in the study, an ad-hoc item was included with five response options (very bad, bad, fair, good, and very good).

Procedure

Data were collected from Spain between March 26 and August 31, 2020, using an online questionnaire via the Qualtrics® XM survey platform. Participants were recruited using a non-probability snowball sampling method. Researchers in each participating country disseminated the questionnaire via social media and email lists to professional groups that were invited to participate (e.g. professional schools and associations, universities, and scientific societies, and the Latin American and Caribbean Teachers Network (RedDOLAC), among others). However, this strategy, although it facilitated access to participants across different countries, may have introduced self-selection bias and limited the representativeness of the sample.

Once the participants accessed the link from their mobile phone or other devices, such as a tablet or computer, they were presented with the study information and an informed consent form. The participants had to accept it to be able to access the questions in the questionnaire, declare that they were of legal age, and agree to participate in the research. The voluntary nature of their participation and the possibility of leaving the study without penalty, simply by closing the browser window, were always made clarified. Likewise, the confidentiality and protection of the collected data were guaranteed.

Data analysis

All statistical analyses were performed with R Studio 2021.09.01. Based on the Mahalanobis distance ($p < .001$), 518 cases were identified as multivariate outliers, so these cases were not included in subsequent analyses, reducing the sample of 22,844 participants to 22,326. Univariate and multivariate normality were studied using Kolmogorov–Smirnov and Mardia's test (Mardia skewness and kurtosis = 35085.42 and 114.61, respectively). For descriptive analysis of the items of the SOC-13 scale, the statistical mean, standard deviation, percentiles, skewness, kurtosis and floor and ceiling effects were provided.

In the study of the factor structure of the SOC-13 scale, Confirmatory Factor Analysis (CFA) was carried out using the Lavaan library. Given the non-normal nature of the data, the robust Maximum Likelihood method (MLR) was used. The following structures were studied: (i) a unidimensional model with all items forming a single factor; (ii) a model of three correlated factors; (iii) a unidimensional model with all items forming a single factor with method effect (items 1, 2, 3, 7, and 10) and (iv) a model of three correlated factors with method effect (items 1, 2, 3, 7, and 10). Following the recommendations of Alavi[41], the indices used to assess the fit of the models were: the Chi Square statistic (χ^2), the Comparative Fit Index (CFI), the Non-Normalized Fit Index (NNFI), the Root Mean Square Error of Approximation (RMSEA) and the Standardized Root Mean Square Residual (SRMR). CFI and NNFI values above 0.90 are considered adequate[42] However, Hu and Bentler[43] recommend values ≥ 0.95. Similarly, RMSEA and SRMR values close to 0.06 and 0.08, respectively, are also indicative of a good fit. To provide evidence of validity through the relationship with other variables, Pearson´s correlations between the SOC-13 and GHQ-12 scores and self-perceived health were provided. Finally, to study the internal consistency of the scale, item-test correlation, Cronbach´s alpha, and McDonald´s omega coefficients were calculated.

Results

Item analysis

The descriptive statistics of the participants´ responses to the 13 items of the SOC-13 scale are presented in Table S2 (Supplementary Material). In the pooled sample, the item with the highest score was item 4 ($M = 6.0$; $SD = 1.3$) while the item with the lowest score was item 2 ($M = 3.7$; $SD = 1.7$). The analyses by country showed similar results except in Spain where item 4 ($M = 5.8$; $SD = 1.2$) and item 1 ($M = 5.8$; $SD = 1.7$) share the highest score and item 2 ($M = 3.7$; $SD = 1.5$) share the lowest score with the item 11 ($M = 3.7$; $SD = 1.9$).

The pooled sample showed skewness values of the score distribution between −1.5 and 0.3 and kurtosis values between −1.3 and 2. In addition, 11 of the 13 items showed a ceiling effect, while a floor effect was only detected for item 11.

Evidence of validity based on internal structure

The CFA results for the different models are presented in Table 1. The unidimensional and three correlated factors models did not provide good fit indices in any of the countries. However, when the same structures were analyzed by adding a latent factor derived from the method effect of the negatively worded items, the fit indices improved considerably (min. CFI and NNFI = 0.911 and 0.884, max. RMSEA and SRMR = 0.076 and 0.045 (Ecuador); min. CFI and NNFI = 0.929 and 0.903 (Paraguay), max. RMSEA and SRMR = 0.068 (Ecuador and Paraguay) and 0.044, respectively). The standardized factor loadings of these two models are listed in Tables S3 and S4 (Supplementary Material). The best results for all the analyzed structures were provided by the three correlated factors model with the method effect for the total sample (X^2 (57) = 3747.1; $p < .001$; CFI = 0.962; NNFI = 0.948; RMSEA = 0.054 [95% CI (0.052 – 0.055)]; SRMR = 0.031) and for all the individual countries analyzed (CFI values between 0.929 (Paraguay) and 0.976 (Chile); NNFI values between 0.903 (Paraguay) and 0.967 (Chile); RMSEA values between 0.045 [95% CI (0.040 – 0.050)] in Chile and 0.068 [95% CI (0.059 – 0.077)] in Paraguay and 0.068 [95% CI (0.064 – 0.072)] in Ecuador; SRMR values between 0.029 (Chile) and 0.044 (Paraguay)). The ten largest modification indices for the total sample and each country are reported in Supplementary Table S5.

Regarding the total score and dimensions of the SOC-13 scale (Table S6, Supplementary Material), the results of the analysis of variance (ANOVA) showed significant differences by country (total score: F = 55.7; $p < .001$; $\eta^2_p = 0.02$; *comprehensibility*: F = 68.5; $p < .001$; $\eta^2_p = 0.03$; *manageability*: F = 22.9; $p < .001$; $\eta^2_p = 0.01$ and *meaningfulness*: F = 51.0; $p < .001$; $\eta^2_p = 0.02$). Although these differences reached statistical significance, the effect sizes were small, indicating that the magnitude of between-country differences was limited. This information is shown in further detail in Figures S2-S5 (Supplementary Material).

Overall, these findings indicate that traditional unidimensional and correlated-factor models did not provide adequate fit across countries. In contrast, incorporating a wording-related method factor substantially improved model fit, with the three correlated factors model including the method effect providing the best overall fit. Differences between countries in the SOC-13 total score and its dimensions were statistically significant but small in magnitude, suggesting limited practical variability across national contexts.

Evidence of validity based on the relationship with other variables

In terms of validity evidence in relation to other variables (Table 2), the total score of the SOC-13 scale correlated negatively and with a large effect size with the GHQ-12 ($p < .001$ in all countries; r value between −0.54 (Ecuador) and −0.70 (Chile)). Similar results were obtained for the different dimensions of the SOC-13, with correlations ranging from moderate (min. $r = -.39$ in Paraguay, $p < .001$) to high (max. $r = -.65$ in Chile, $p < .001$). In contrast, SOC-13 total and dimensional scores were positively associated with self-perceived health, with effect sizes between small (min. $r = .18$ in Paraguay, $p < .001$) and medium (max. $r = .32$ in Chile, $p < .001$).

These findings provide additional evidence of the construct validity of the SOC-13, as higher SOC scores were consistently associated with lower psychological distress and better self-perceived health.

Reliability

Cronbach´s alpha and McDonald´s omega coefficient for the total score of the scale were 0.850 and 0.856 in the pooled sample, respectively (Table 3), ranging between α = 0.819, ω = 0.821 (Paraguay) and α = 0.874, ω = 0.880 (El Salvador), suggesting good reliability across all countries. For the scale dimensions, values of α = 0.624/ω = 0.644 were obtained for meaningfulness, α = 0.721/ω = 0.752 for comprehensibility and α = 0.649/ω = 0.652 for manageability. The item-test correlations ranged from 0.268 (item 1) to 0.715 (item 8). Finally, the internal consistency of the scale based on Cronbach´s alpha increased by a maximum of 0.006 with the removal of item 1. The estimated reliability coefficients for each country are detailed in Table 3.

Percentiles

Table S7 (Supplementary Material) shows the percentile equivalences of the SOC-13 total scores for each country that participated in the study.

Discussion

To the best of our knowledge, this study is the first to explore the psychometric properties of the SOC-13 scale for its use in the Spanish, Argentinian, Chilean, Colombian, Costa Rican, Ecuadorian, Salvadoran, Mexican, Nicaraguan, Paraguayan, and Peruvian general population.

The results showed that the unidimensional and three correlated factors models considering the method effect presented good fit indices for all countries. These results support the internal structures of the SOC-13 scale. However, the three correlated factors model considering the method effect presented the best fit results for all structures analyzed. These results align with two prior studies that showed an improvement in model fit when controlling for the method effect[21,31]. The unidimensional and three correlated factors models, without considering the method effect, did not present good fit indices for any of the countries. These results are not congruent with other previous studies. However, it must be noted that previous studies have yielded heterogeneous results regarding the internal structure of the SOC-13 scale[20,22,29,33,34,36,44–47]. The enhancement of fit indices upon incorporating the method effect in the unidimensional and three correlated factors models may indicate that the use of negatively worded items contributes to inconsistent findings related to the internal structure of the SOC-13 scale. It is important to highlight that although the confirmatory factor analysis supported the three-factor model, the substantial correlations between factors could indicate that these are closely related and may reflect aspects of a broader underlying construct that are somehow similar. In practice, the dimensions may not be entirely independent of each other. As guidance for assessment in both research and professional settings, interpretation of scores should be conducted on both dimension-specific concepts and in terms of the

Factorial models	Country	X^2	df	*p*	CFI	NNFI	RMSEA [95% CI]	SRMR	Correlations between factors
Unidimensional model	Total	16461.1	65	< 0.001	0.830	0.796	0.106 [0.105 – 0.108]	0.070	--
	Argentina	882.3	65	< 0.001	0.810	0.772	0.107 [0.100 – 0.114]	0.073	--
	Chile	1256.2	65	< 0.001	0.860	0.833	0.101 [0.096 – 0.106]	0.067	--
	Colombia	762.9	65	< 0.001	0.865	0.837	0.099 [0.092 – 0.106]	0.066	--
	Costa Rica	863.0	65	< 0.001	0.852	0.823	0.101 [0.094 – 0.107]	0.066	--
	Ecuador	3089.4	65	< 0.001	0.780	0.736	0.115 [0.112 – 0.119]	0.081	--
	El Salvador	1848.6	65	< 0.001	0.858	0.830	0.105 [0.100 – 0.109]	0.064	--
	Mexico	1490.8	65	< 0.001	0.839	0.807	0.106 [0.101 – 0.111]	0.069	--
	Nicaragua	564.1	65	< 0.001	0.834	0.801	0.103 [0.095 – 0.111]	0.069	--
	Paraguay	626.2	65	< 0.001	0.796	0.756	0.108 [0.100 – 0.116]	0.073	--
	Peru	1163.0	65	< 0.001	0.846	0.815	0.102 [0.096 – 0.108]	0.072	--
	Spain	4336.9	65	< 0.001	0.807	0.768	0.106 [0.103 – 0.109]	0.070	--
Three correlated factors	Total	14509.4	62	< 0.001	0.851	0.812	0.102 [0.101 – 0.104]	0.068	$r_{12} = 0.84$; $r_{13} = 0.91$; $r_{23} = 0.91$
	Argentina	766.7	62	< 0.001	0.836	0.794	0.101 [0.095 – 0.108]	0.071	$r_{12} = 0.85$; $r_{13} = 0.83$; $r_{23} = 0.84$
	Chile	1333.8	62	< 0.001	0.879	0.847	0.096 [0.092 – 0.101]	0.065	$r_{12} = 0.87$; $r_{13} = 0.91$; $r_{23} = 0.93$
	Colombia	712.7	62	< 0.001	0.874	0.841	0.098 [0.091 – 0.105]	0.065	$r_{12} = 0.90$; $r_{13} = 0.92$; $r_{23} = 0.94$
	Costa Rica	770.2	62	< 0.001	0.869	0.835	0.097 [0.091 – 0.104]	0.065	$r_{12} = 0.85$; $r_{13} = 0.91$; $r_{23} = 0.94$
	Ecuador	2805.7	62	< 0.001	0.800	0.749	0.112 [0.109 – 0.116]	0.080	$r_{12} = 0.83$; $r_{13} = 0.93$; $r_{23} = 0.90$
	El Salvador	1626.0	62	< 0.001	0.876	0.844	0.100 [0.096 – 0.105]	0.063	$r_{12} = 0.87$; $r_{13} = 0.93$; $r_{23} = 0.93$
	Mexico	1279.2	62	< 0.001	0.852	0.813	0.104 [0.099 – 0.011]	0.069	$r_{12} = 0.88$; $r_{13} = 0.92$; $r_{23} = 0.93$
	Nicaragua	500.8	62	< 0.001	0.854	0.817	0.099 [0.090 – 0.108]	0.070	$r_{12} = 0.82$; $r_{13} = 0.90$; $r_{23} = 0.91$
	Paraguay	589.1	62	< 0.001	0.809	0.759	0.107 [0.099 – 0.116]	0.075	$r_{12} = 0.86$; $r_{13} = 0.96$; $r_{23} = 0.90$
	Peru	1077.9	62	< 0.001	0.857	0.820	0.101 [0.095 – 0.106]	0.071	$r_{12} = 0.88$; $r_{13} = 0.93$; $r_{23} = 0.94$
	Spain	3595.23	62	< 0.001	0.840	0.799	0.099 [0.096 – 0.102]	0.066	$r_{12} = 0.77$; $r_{13} = 0.88$; $r_{23} = 0.90$
Unidimensional model with method effect (ME)	Total	5840.7	60	< 0.001	0.940	0.922	0.066 [0.064 – 0.067]	0.036	
	Argentina	317.6	60	< 0.001	0.941	0.924	0.062 [0.054 – 0.069]	0.040	--
	Chile	513.1	60	< 0.001	0.957	0.944	0.058 [0.053 – 0.063]	0.033	--
	Colombia	261.6	60	< 0.001	0.962	0.951	0.054 [0.047 – 0.062]	0.034	--
	Costa Rica	321.8	60	< 0.001	0.952	0.938	0.060 [0.053 – 0.067]	0.037	--
	Ecuador	1289.1	60	< 0.001	0.911	0.884	0.076 [0.073 – 0.080]	0.045	--
	El Salvador	729.7	60	< 0.001	0.947	0.931	0.067 [0.062 – 0.071]	0.035	--
	Mexico	570.1	60	< 0.001	0.943	0.926	0.066 [0.060 – 0.071]	0.037	--
	Nicaragua	246.70	60	< 0.001	0.939	0.921	0.065 [0.056 – 0.074]	0.039	--
	Paraguay	297.7	60	< 0.001	0.915	0.890	0.073 [0.064 – 0.082]	0.043	--
	Peru	423.4	60	< 0.001	0.950	0.935	0.061 [0.055 – 0.067]	0.035	--
	Spain	1754.4	60	< 0.001	0.924	0.901	0.069 [0.066 – 0.072]	0.042	--
Three correlated factors with method effect (ME)	Total	3747.1	57	< 0.001	0.962	0.948	0.054 [0.052 – 0.055]	0.031	$r_{12} = 0.84$; $r_{13} = 0.92$; $r_{23} = 0.92$
	Argentina	214.8	57	< 0.001	0.965	0.952	0.049 [0.041 – 0.057]	0.035	$r_{12} = 0.84$; $r_{13} = 0.86$; $r_{23} = 0.86$
	Chile	313.3	57	< 0.001	0.976	0.967	0.045 [0.040 – 0.050]	0.029	$r_{12} = 0.87$; $r_{13} = 0.93$; $r_{23} = 0.94$
	Colombia	198.80	57	< 0.001	0.974	0.964	0.046 [0.038 – 0.055]	0.032	$r_{12} = 0.90$; $r_{13} = 0.92$; $r_{23} = 0.93$
	Costa Rica	217.17	57	< 0.001	0.971	0.961	0.047 [0.040 – 0.055]	0.031	$r_{12} = 0.84$; $r_{13} = 0.90$; $r_{23} = 0.94$
	Ecuador	974.0	57	< 0.001	0.934	0.909	0.068 [0.064 – 0.072]	0.041	$r_{12} = 0.82$; $r_{13} = 0.93$; $r_{23} = 0.91$
	El Salvador	486.73	57	< 0.001	0.966	0.954	0.055 [0.050 – 0.059]	0.031	$r_{12} = 0.86$; $r_{13} = 0.94$; $r_{23} = 0.94$
	Mexico	438.05	57	< 0.001	0.958	0.942	0.058 [0.053 – 0.064]	0.034	$r_{12} = 0.87$; $r_{13} = 0.92$; $r_{23} = 0.93$
	Nicaragua	174.4	57	< 0.001	0.962	0.948	0.052 [0.043 – 0.062]	0.036	$r_{12} = 0.81$; $r_{13} = 0.90$; $r_{23} = 0.92$
	Paraguay	255.8	57	< 0.001	0.929	0.903	0.068 [0.059 – 0.077]	0.044	$r_{12} = 0.85$; $r_{13} = 0.97$; $r_{23} = 0.90$
	Peru	328.4	57	< 0.001	0.963	0.949	0.054 [0.047 – 0.060]	0.033	$r_{12} = 0.88$; $r_{13} = 0.92$; $r_{23} = 0.94$
	Spain	981.93	57	< 0.001	0.958	0.943	0.053 [0.049 – 0.056]	0.033	$r_{12} = 0.77$; $r_{13} = 0.90$; $r_{23} = 0.91$

Table 1. Fit indices for the confirmatory factor analyses of the SOC-13 scale (N = 22326). Note: r_{12} = correlation between Factor 1 (Meaningfulness) and Factor 2 (Comprehensibility); r_{13} = correlation between Factor 1 (Meaningfulness) and Factor 3 (Manageability); r_{23} = correlation between Factor 2 (Comprehensibility) and Factor 3 (Manageability).

Variables	GHQ-12	Self-related Health
Total score		
Total sample	−0.62*	0.28*
Argentina	−0.62*	0.31*
Chile	−0.70*	0.36*
Colombia	−0.63*	0.31*
Costa Rica	−0.62*	0.26*
Ecuador	−0.54*	0.23*
El Salvador	−0.67*	0.31*
Mexico	−0.61*	0.24*
Nicaragua	−0.61*	0.27*
Paraguay	−0.56*	0.25*
Peru	−0.62*	0.31*
Spain	−0.57*	0.27*
Meaningfulness		
Total sample	−0.51*	0.23*
Argentina	−0.51*	0.27*
Chile	−0.60*	0.32*
Colombia	−0.54*	0.29*
Costa Rica	−0.53*	0.19*
Ecuador	−0.46*	0.19*
El Salvador	−0.58*	0.28*
Mexico	−0.52*	0.20*
Nicaragua	−0.49*	0.19*
Paraguay	−0.39*	0.20*
Peru	−0.51*	0.24*
Spain	−0.41*	0.20*
Comprehensibility		
Total sample	−0.57*	0.25*
Argentina	−0.59*	0.27*
Chile	−0.65*	0.32*
Colombia	−0.59*	0.28*
Costa Rica	−0.57*	0.24*
Ecuador	−0.46*	0.19*
El Salvador	−0.62*	0.29*
Mexico	−0.56*	0.22*
Nicaragua	−0.54*	0.24*
Paraguay	−0.52*	0.25*
Peru	−0.58*	0.29*
Spain	−0.54*	0.23*
Manageability		
Total sample	−0.52*	0.25*
Argentina	−0.47*	0.24*
Chile	−0.58*	0.32*
Colombia	−0.54*	0.26*
Costa Rica	−0.53*	0.25*
Ecuador	−0.47*	0.20*
El Salvador	−0.57*	0.26*
Mexico	−0.51*	0.23*
Nicaragua	−0.53*	0.25*
Paraguay	−0.51*	0.18*
Peru	−0.53*	0.27*
Spain	−0.48*	0.24*

Table 2. Correlations between SOC-13 and related constructs (N = 22,326). Note: *$p < .001$; Effect size ($r < .30$ small; $0.30 \leq r \leq .50$ medium; $r > 0.50$ large).

Variables	Total	Argentina	Chile	Colombia	Costa Rica	Ecuador	El Salvador	Mexico	Nicaragua	Paraguay	Peru	Spain
Cronbach´s alpha/McDonald´s omega												
Total score	0.850/0.856	0.837/0.842	0.865/0.874	0.865/0.870	0.857/0.861	0.827/0.830	0.874/0.880	0.861/0.866	0.846/0.852	0.819/0.821	0.847/0.851	0.834/0.842
Meaningfulness	0.624/0.644	0.601/0.637	0.684/0.720	0.656/0.677	0.650/0.663	0.577/0.587	0.674/0.692	0.637/0.652	0.581/0.612	0.470/0.498	0.609/0.629	0.605/0.622
Comprehensibility	0.721/0.752	0.702/0.733	0.737/0.774	0.719/0.744	0.715/0.738	0.682/0.716	0.757/0.784	0.732/0.759	0.704/0.736	0.666/0.692	0.716/0.746	0.710/0.744
Manageability	0.649/0.652	0.639/0.641	0.644/0.651	0.686/0.690	0.680/0.681	0.607/0.612	0.691/0.696	0.665/0.667	0.684/0.685	0.632/0.632	0.624/0.627	0.638/0.639
Item – test correlation												
1	0.268	0.229	0.297	0.321	0.353	0.27	0.341	0.306	0.238	0.175	0.272	0.249
2	0.36	0.359	0.32	0.382	0.419	0.317	0.414	0.409	0.457	0.328	0.335	0.363
3	0.413	0.381	0.405	0.448	0.48	0.373	0.469	0.467	0.477	0.417	0.372	0.427
4	0.43	0.423	0.444	0.472	0.426	0.394	0.494	0.476	0.368	0.323	0.448	0.356
5	0.463	0.457	0.435	0.462	0.538	0.442	0.446	0.492	0.49	0.488	0.435	0.461
6	0.566	0.544	0.595	0.57	0.586	0.547	0.587	0.583	0.546	0.538	0.607	0.514
7	0.525	0.533	0.626	0.577	0.533	0.462	0.53	0.522	0.537	0.461	0.523	0.476
8	0.715	0.673	0.754	0.74	0.717	0.667	0.735	0.735	0.686	0.651	0.72	0.695
9	0.692	0.658	0.715	0.69	0.713	0.651	0.738	0.689	0.667	0.617	0.685	0.673
10	0.586	0.601	0.635	0.638	0.547	0.525	0.633	0.54	0.577	0.523	0.582	0.574
11	0.334	0.346	0.36	0.358	0.272	0.291	0.397	0.351	0.238	0.35	0.337	0.289
12	0.67	0.633	0.722	0.692	0.644	0.631	0.724	0.677	0.663	0.615	0.673	0.619
13	0.611	0.514	0.597	0.66	0.621	0.601	0.677	0.635	0.631	0.599	0.621	0.561
Cronbach´s alpha/McDonald´s omega if item is deleted												
1	0.856/0.862	0.844/0.849	0.869/0.878	0.868/0.874	0.858/0.862	0.832/0.837	0.877/0.884	0.865/0.870	0.854/0.860	0.833/0.835	0.853/0.858	0.839/0.847
2	0.849/0.857	0.834/0.842	0.866/0.876	0.863/0.870	0.853/0.859	0.826/0.832	0.872/0.880	0.858/0.865	0.838/0.847	0.817/0.823	0.847/0.854	0.830/0.840
3	0.846/0.854	0.832/0.841	0.862/0.873	0.860/0.867	0.849/0.856	0.822/0.828	0.869/0.877	0.855/0.862	0.837/0.846	0.810/0.816	0.845/0.852	0.826/0.837
4	0.845/0.850	0.830/0.835	0.860/0.869	0.859/0.864	0.853/0.856	0.820/0.823	0.869/0.875	0.855/0.859	0.843/0.848	0.817/0.816	0.840/0.844	0.831/0.838
5	0.843/0.850	0.828/0.835	0.861/0.871	0.859/0.865	0.845/0.850	0.817/0.820	0.871/0.878	0.854/0.859	0.836/0.843	0.805/0.807	0.841/0.846	0.824/0.834
6	0.836/0.842	0.821/0.827	0.851/0.861	0.852/0.858	0.842/0.846	0.809/0.812	0.863/0.870	0.848/0.853	0.832/0.839	0.801/0.802	0.829/0.833	0.820/0.829
7	0.839/0.846	0.823/0.829	0.850/0.860	0.853/0.859	0.846/0.851	0.816/0.820	0.866/0.873	0.852/0.857	0.833/0.840	0.807/0.808	0.835/0.840	0.823/0.832
8	0.825/0.831	0.812/0.817	0.840/0.849	0.842/0.847	0.834/0.839	0.800/0.803	0.854/0.860	0.838/0.842	0.822/0.828	0.793/0.797	0.821/0.825	0.806/0.814
9	0.826/0.831	0.811/0.815	0.843/0.851	0.844/0.848	0.833/0.836	0.800/0.801	0.853/0.858	0.840/0.844	0.823/0.828	0.793/0.795	0.822/0.825	0.807/0.814
10	0.835/0.842	0.818/0.824	0.849/0.860	0.849/0.855	0.845/0.850	0.811/0.815	0.861/0.868	0.851/0.856	0.830/0.838	0.802/0.804	0.831/0.836	0.817/0.826
11	0.853/0.859	0.837/0.843	0.866/0.875	0.868/0.873	0.867/0.870	0.831/0.833	0.875/0.882	0.865/0.869	0.855/0.860	0.817/0.818	0.850/0.854	0.839/0.846
12	0.829/0.835	0.814/0.820	0.843/0.852	0.845/0.851	0.839/0.843	0.803/0.805	0.855/0.861	0.842/0.846	0.824/0.831	0.795/0.795	0.825/0.829	0.813/0.821
13	0.833/0.840	0.824/0.830	0.851/0.862	0.848/0.853	0.841/0.845	0.805/0.808	0.858/0.865	0.845/0.850	0.827/0.834	0.797/0.796	0.829/0.833	0.817/0.826

Table 3. Item-Test Correlations and Cronbach´s Alpha and McDonald´s Omega Coefficients (N = 22,326).

overall construct. While dimensional scores may be useful for identifying specific aspects of SOC or evaluating the impact of interventions on particular components, the total score may provide a more parsimonious and psychometrically stable global indicator when a general assessment is sufficient. Therefore, the choice between dimensional and total scores should be guided by the specific research or clinical objective. However, caution is warranted to avoid over-interpreting small differences between highly correlated dimensions. From a practical perspective, reliable assessment of SOC may facilitate the identification of population groups with lower coping resources and therefore greater vulnerability to stress-related health problems. In this context, the SOC-13 could be used as an assessment and evaluation tool in salutogenic interventions aimed at strengthening psychological resources such as resilience, stress management, and adaptive coping strategies. These interventions may be implemented in community, educational, or occupational settings as part of broader health promotion programs. Future research could also explore alternative structural solutions, such as bifactor or two-factor models, to further clarify the dimensionality of SOC. Such approaches may provide additional insight into the extent to which the construct reflects a general underlying factor alongside more specific components, thereby contributing to the ongoing discussion about its underlying structure.

Regarding validity evidence based on relationships with other variables, theoretically expected relationships were found. The SOC-13 scale, and its dimension were negatively and significantly correlated with the GHQ-12, and positively and significantly correlated with participants´ self-perceived level of health. These results are congruent with previous studies exploring GHQ and SOC-13 relationships[9–11] and with previous studies exploring the relationship between SOC and self-perceived level of health[8,31,48,49] conducted in different countries and samples. Although the correlations with self-perceived health were small to moderate, this pattern is theoretically expected, as SOC reflects a relatively stable psychosocial resource whereas perceived health is more sensitive to contextual and behavioral influences.

In terms of reliability, evaluated as internal consistency, the total score of the SOC-13 scale showed adequate and high internal consistency with Cronbach´s alpha values ranging from 0.819 (Paraguay) to 0.874 (El Salvador). Thus, the total SOC-13 score appears to be precise for evaluating SOC in the general population. These results are consistent with the conclusions found in the systematic review by Eriksson & Lindström[7] based on 127 studies, which found that the alpha values of the SOC-13 scale ranged from 0.70 to 0.92 and with the results derived from studies conducted in Spain and Latin America[29,31,33–36].

For the meaningfulness, comprehensibility and manageability dimensions, Cronbach´s alpha values were lower, compared with the total score, ranging from 0.470 (Paraguay) to 0.684 (Chile), from 0.666 (Paraguay) to 0.757 (El Salvador) and from 0.607 (Ecuador) to 0.686 (Colombia), respectively. Again, these results are consistent with previous studies conducted in several countries and samples[29,31,33]. However, it must be noted that for the Meaningfulness and the Manageability dimensions, Cronbach´s alpha values were lower than the established optimal cut-off point ($\alpha \geq 0.70$) across all countries suggesting low reliability. This pattern may reflect both the short length of these subscales—given that reliability coefficients are sensitive to the number of items—and the heterogeneous nature of the content domains, which may reduce internal homogeneity even when items function adequately.

This study has several strengths. First, it provides the first psychometric evidence regarding the use of SOC-13 scale to assess SOC in the general population of 11 Spanish-speaking countries. Second, the results derived from this study were based on a large and heterogeneous general population sample, which could support its external validity. Third, it explored the effect of negatively worded items (method effect) on the internal factor structure of the SOC-13 scale, which may have contributed to inconsistent findings related to the internal factor structure found in previous studies.

Despite the strengths of these results, this study had several limitations. First, to obtain evidence of validity based on relationships with other variables, we included a few related variables. In addition, participants´ self-perceived level of health was assessed using a single item. Second, data were collected during the COVID-19 pandemic, a contextual factor that may have influenced participants' responses. This period likely affected psychological stress and coherence processes in the population and should therefore be considered when interpreting levels of coherence and psychological distress. Third, only cross-sectional data were available in the present study, therefore, longitudinal studies are needed to examine the test-retest reliability and predictive validity of the scale. In addition, given that SOC has been conceptualized as a relatively stable psychological resource, the absence of longitudinal data limits our ability to determine the extent to which SOC remains stable over time or changes in response to life events or interventions. Fourth, a non-probability snowball sampling method was used, which may have introduced self-selection bias and consequently limits the generalizability of the findings. Finally, although all participating countries share the Spanish language, cultural and contextual differences between countries may influence how individuals interpret and respond to questionnaire items. These potential sources of cultural heterogeneity should be considered when interpreting the psychometric findings across different national contexts. In addition, factorial invariance across countries was not examined. Establishing multinational measurement invariance represents an important next step to further examine whether the SOC-13 operates equivalently across countries. Demonstrating such invariance would enable more robust cross-national comparisons and strengthen the interpretability of cross-cultural findings. Therefore, future research should prioritize large-scale multinational studies to evaluate the cross-cultural robustness of the instrument.

Conclusions

The results of this study show that the SOC-13 scale is a valuable tool for assessing SOC in the general population of different Spanish-speaking countries. This study provides an important methodological contribution by explicitly controlling for the method effect associated with negatively worded items, which may help explain inconsistencies in the internal structure of the SOC-13 reported in previous research. The SOC-13 may serve as a

useful instrument for the design and evaluation of salutogenic public health interventions aimed at strengthening coping resources and psychological well-being in Spanish-speaking populations.

Data availability

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

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References

1. Escobar-Castellanos, B., Cid, P., Juvinyà, D. & Sáez, K. Estilo de vida promotor de salud y sentido de coherencia en adultos jóvenes universitarios. *Hacia la. Promoc Salud*. **24**, 107–122. https://doi.org/10.17151/hpsal.2019.24.2.9 (2019).
2. Antonovsky, A. *Health, stress and coping* (Jossey-Bass, 1979).
3. Olsson, M., Hansson, K., Lundblad, A. M. & Cederblad, M. Sense of coherence: definition and explanation. *Int. J. Soc. Welf.* **15**, 219–229. https://doi.org/10.1111/j.1468-2397.2006.00410.x (2006).
4. Antonovsky, A. The salutogenic model as a theory to guide health promotion. *Health Promot Int.* **11**, 11–18. https://doi.org/10.1093/heapro/11.1.11 (1996).
5. Bowman, B. Cross-cultural validation of Antonovsky's sense of coherence scale. *J. Clin. Psychol.* **52**, 547–549. https://doi.org/10.1002/(SICI)1097-4679(199609)52:5%3C547::AID-JCLP8%3E3.0.CO;2-K (1996). https://onlinelibrary.wiley.com/doi/10.1002/(SICI)1097-4679(199609)52:5%3C547::AID-JCLP8%3E3.0.CO;2-K
6. Rivera de los Santos, F., Valverde, R., Moreno, P. & Rodríguez, C. Hernán García, M. Análisis del modelo salutogénico en España: aplicación en salud pública e implicaciones para el modelo de activos en salud. *Rev. Esp. Salud Publica*. **85**, 129–139 (2011).
7. Eriksson, M. & Lindström, B. Antonovsky's sense of coherence scale and its relation with quality of life: a systematic review. *J. Epidemiol. Community Health*. **61**, 938–944. https://doi.org/10.1136/jech.2006.056028 (2007).
8. Eriksson, M. & Lindström, B. Antonovsky's sense of coherence scale and the relation with health: a systematic review. *J. Epidemiol. Community Health*. **60**, 376–381. https://doi.org/10.1136/jech.2005.041616 (2006).
9. Balajti, I., Vokó, Z., Ádány, R. & Kósa, K. Validation of the Hungarian versions of the abbreviated sense of coherence (SOC) scale and the General Health Questionnaire (GHQ-12). *Mentálhigiéné Pszichoszomatika*. **8**, 147–161. https://doi.org/10.1556/Mental.8.2007.2.4 (2007).
10. Kuwato, M. & Hirano, Y. Sense of coherence, occupational stressors, and mental health among Japanese high school teachers in Nagasaki prefecture: a multiple regression analysis. *BMC Public. Health*. **20**, 1355. https://doi.org/10.1186/s12889-020-09475-x (2020).
11. Nilsson, K. W., Leppert, J., Simonsson, B. & Starrin, B. Sense of coherence and psychological well-being: improvement with age. *J. Epidemiol. Community Health*. **64**, 347–352. https://doi.org/10.1136/jech.2008.081174 (2010).
12. Bauer, G. F. & Jenny, G. J. Applying salutogenesis in organisations. In The handbook of salutogenesis. Second edition (ed (eds Mittelmark, M. et al.) https://doi.org/10.1007/978-3-030-79515-3_28 (Springer, (2022).
13. Da Silva-Domingues, H. et al. Relationship between sense of coherence and health-related behaviours in adolescents and young adults: a systematic review. *BMC Public. Health*. **22**, 12816. https://doi.org/10.1186/s12889-022-12816-7 (2022).
14. Barni, D. et al. Facing the COVID-19 pandemic: the role of sense of coherence. *Front. Psychol.* **11**, 578440. https://doi.org/10.3389/fpsyg.2020.578440 (2020).
15. Dadaczynski, K., Okan, O., Messer, M. & Rathmann, K. University students' sense of coherence, future worries and mental health: findings from the German COVID-HL-survey. *Health Promot Int.* **37**, daab070. https://doi.org/10.1093/heapro/daab070 (2022).
16. Dymecka, J. et al. Fear of COVID-19 and life satisfaction: the role of health-related hardiness and sense of coherence. *Front. Psychiatry*. **12**, 712103. https://doi.org/10.3389/fpsyt.2021.712103 (2021).
17. Mana, A. et al. Order out of chaos: sense of coherence and the mediating role of coping resources in explaining mental health during COVID-19 in 7 countries. *SSM Ment Health*. **1**, 100001. https://doi.org/10.1016/j.ssmmh.2021.100001 (2021).
18. Misamer, M., Signerski-Krieger, J., Bartels, C. & Belz, M. Internal locus of control and sense of coherence decrease during the COVID-19 pandemic: a survey of students and professionals in social work. *Front. Sociol.* **6**, 705809. https://doi.org/10.3389/fsoc.2021.705809 (2021).
19. Stoyanova, K. & Stoyanov, D. S. Sense of coherence and burnout in healthcare professionals in the COVID-19 era. *Front. Psychiatry*. **12**, 709587. https://doi.org/10.3389/fpsyt.2021.709587 (2021).
20. Antonovsky, A. *Unravelling the mystery of health: how people manage stress and stay well* (Jossey-Bass, 1987).
21. Eriksson, M. & Lindström, B. Validity of Antonovsky's sense of coherence scale: a systematic review. *J. Epidemiol. Community Health*. **59**, 460–466. https://doi.org/10.1136/jech.2003.018085 (2005).
22. Antonovsky, A. The structure and properties of the sense of coherence scale. *Soc. Sci. Med.* **6**, 725–733 (1993). 10.1016/0277–9536(93)90033-Z.
23. Lin, M., Bieda, A. & Margraf, J. Short form of the sense of coherence scale (SOC-L9) in the US, Germany, and Russia. *Eur. J. Psychol. Assess.* **36**, 796–804. https://doi.org/10.1027/1015-5759/a000561 (2020).
24. Lundberg, O. Nyström Peck, M. A simplified way of measuring sense of coherence. *Eur. J. Public. Health*. **5**, 56–59. https://doi.org/10.1093/eurpub/5.1.56 (1995).
25. Žilinskas, E. et al. Mental health among higher education students during the COVID-19 pandemic: a cross-sectional survey from Lithuania. *Int. J. Environ. Res. Public. Health*. **18**, 12737. https://doi.org/10.3390/ijerph182312737 (2021).
26. Callahan, L. F. & Pincus, T. The sense of coherence scale in patients with rheumatoid arthritis. *Arthritis Rheum.* **8**, 28–35. https://doi.org/10.1002/art.1790080108 (1995).
27. Feldt, T. *Sense of coherence: structure, stability and health promoting role in working life.* Doctoral thesis, Univ. Jyväskylä (2000).
28. Paredes-Carbonell, J. J., Agulló-Cantos, J. M., Vera-Remartínez, E. J. & Hernán-García, M. Sentido de coherencia y activos para la salud en jóvenes internos en centros de menores. *Rev. Esp. Sanid Penit*. **15**, 87–97 (2013).
29. Virués-Ortega, J., Martínez-Martín, P., del Barrio, J. L. & Lozano, L. M. Validación transcultural de la Escala de Sentido de Coherencia de Antonovsky (OLQ-13) en ancianos mayores de 70 años. *Med. Clin.* **128**, 486–492 (2007).
30. von Bothmer, M. I. & Fridlund, B. Self-rated health among university students in relation to sense of coherence and other personality traits. *Scand. J. Caring Sci.* **17**, 347–357. https://doi.org/10.1046/j.0283-9318.2003.00234.x (2003).
31. Domínguez-Salas, S. et al. Analysis of the psychometric properties of the sense of coherence scale (SOC-13) in patients with cardiovascular risk factors: a study of the method effects associated with negatively worded items. *Health Qual. Life Outcomes*. **20**, 8. https://doi.org/10.1186/s12955-021-01914-6 (2022).
32. Moreno, B., Alonso, M. & Álvarez, E. Sentido de coherencia, personalidad resistente, autoestima y salud. *Rev. Psicol. Salud*. **9**, 115–137. https://doi.org/10.21134/pssa.v9i2.820 (1997).
33. Saravia, J. C., Iberico, C. & Yearwood, K. Validation of sense of coherence (SOC) 13-item scale in a Peruvian sample. *J. Behav. Health Soc. Issues*. **6**, 35–44. https://doi.org/10.5460/jbhsi.v6.2.43847 (2014).

34. Mafla, A. C. et al. Psychometric properties of the SOC-13 scale in Colombian adults. *Int. J. Environ. Res. Public. Health*. **18**, 13017. https://doi.org/10.3390/ijerph182413017 (2021).
35. Barraza, A. Validación psicométrica de una versión reformulada de la Escala de Sentido de Coherencia de trece ítems (SOC-13) en una población estudiantil mexicana. *J. Bus. Entrepreneurial*. **4**, 1–14. https://doi.org/10.37956/jbes.v4i2.114 (2020).
36. Velázquez-Jurado, H. et al. Comparación de dos formas de una escala de sentido de coherencia. *Rev. Intercont Psicol. Educ.* **16**, 51–70 (2014).
37. Sánchez-Palacio, N., Vélez-Álvarez, C. & Betancurth-Loaiza, D. P. Content validation and adaptation of the 29-item sense of coherence scale for the Colombian population. *Rev. Fac. Nac. Salud Publica*. **39**, e342827. https://doi.org/10.17533/udea.rfnsp.e342827 (2021).
38. Cronbach, L. J. Studies of acquiescence as a factor in the true-false test. *J. Educ. Psychol.* **33**, 401–415. https://doi.org/10.1037/h0054677 (1942).
39. Lance, C. E., Dawson, B., Birkelbach, D. & Hoffman, B. J. Method effects, measurement error, and substantive conclusions. *Organ. Res. Methods*. **13**, 435–455. https://doi.org/10.1177/1094428109352528 (2010).
40. Goldberg, D. P. et al. The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychol. Med.* **27**, 191–197. https://doi.org/10.1017/S0033291796004242 (1997).
41. Alavi, M. et al. Chi-square for model fit in confirmatory factor analysis. *J. Adv. Nurs.* **76**, 9. https://doi.org/10.1111/jan.14399 (2020).
42. McDonald, R. P. & Ho, M. H. R. Principles and practice in reporting structural equation analyses. *Psychol. Methods*. **7**, 64–82. https://doi.org/10.1037/1082-989X.7.1.64 (2002).
43. Hu, L. T. & Bentler, P. M. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct. Equ Model.* **6**, 1–55 (1999).
44. Bernabé, E. et al. Structure of the sense of coherence scale in a nationally representative sample: the Finnish Health 2000 survey. *Qual. Life Res.* **18**, 629–636. https://doi.org/10.1007/s11136-009-9469-z (2009).
45. Flannery, R. B., Perry, J. C., Penk, W. E. & Flannery, G. J. Validating Antonovsky's sense of coherence scale. *J. Clin. Psychol.* **50**, 575–577. https://doi.org/10.1002/1097-4679(199407)50:4%3C575::AID-JCLP2270500412%3E3.0.CO;2-8 (1994).
46. Hittner, J. B. Factorial invariance of the 13-item sense of coherence scale across gender. *J. Health Psychol.* **12**, 273–280. https://doi.org/10.1177/1359105307074256 (2007).
47. Klepp, O. M. et al. Structure analysis of Antonovsky's sense of coherence from an epidemiological mental health survey with a brief nine-item sense of coherence scale. *Int. J. Methods Psychiatr Res.* **16**, 11–22. https://doi.org/10.1002/mpr.197 (2007).
48. Nilsson, B., Holmgren, L. & Westman, G. Sense of coherence in different stages of health and disease in northern Sweden: gender psychosocial differences. *Scand. J. Prim. Health Care*. **18**, 14–20. https://doi.org/10.1080/02813430050202497 (2000).
49. Surtees, P., Wainwright, N., Luben, R., Khaw, K. T. & Day, N. Sense of coherence and mortality in men and women in the EPIC-Norfolk United Kingdom prospective cohort study. *Am. J. Epidemiol.* **158**, 1202–1209. https://doi.org/10.1093/aje/kwg272 (2003).

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SD-S : Conceptualization, Methodology, Investigation, Software, Data curation, Formal analysis, Writing- original draft, Writing - review and editing, Visualization. CR-D : Conceptualization, Methodology, Investigation, Software, Formal analysis, Writing- original draft, Writing - review and editing, Visualization. KE-S : Methodology, Investigation, Writing – original draft, Writing – review and editing. AIA-R : Writing- original draft, Writing - review and editing, Visualization. IG-G : Writing- original draft, Writing - review and editing, Visualization. JG-S : Conceptualization, Methodology, Investigation, Supervision, Writing - review and editing, Visualization. All authors reviewed the manuscript and approved the submitted version.

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Declarations

Competing interests

The authors declare no competing interests.

Ethical considerations

As data were collected from Spain, the project was approved by the Research Ethics Committee of Huelva, which belong to the Regional Ministry of Health of Andalusia, Spain (PI 036/20). The study was also approved by the following Ethics Committees: Universidad de Aconcagua (Santiago, Chile), University of Cartagena (Colombia), Universidad San Gregorio de Portoviejo (Ecuador), Benemérita Universidad Autónoma de Puebla

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Additional information

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