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ORIGINAL RESEARCH

Rasch and Confirmatory Factor Analysis of the Community Wellbeing Index: A Multicountry Validation Study

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Abstract
Community wellbeing assessment is of growing interest in governance and policy-making. This study investigated the validity and reliability of the Community Wellbeing Index (CWI), assessing community wellbeing from an individual's perspective, across independent international datasets. The CWI was translated from the original Spanish into English and Setswana and was administered to participants from established research cohorts in Spain ($n=1{,}106$), Australia ($n=677$) and South Africa ($n=400$). The CWI was validated within countries using the Rasch model and confirmatory factor analysis. Differential Item Functioning (DIF) by country and Multigroup Confirmatory Factor Analysis was used to evaluate invariance across the samples. Results indicated a three-dimensional construct, good fit of the data to the model, item local independence, PSI ranging 0.668–0.752, and an absence of DIF by sex, age and country. Configural and metric invariance among the three countries were supported, but not scalar invariance, implying that scale and subscale scores could not be compared across the samples. This could potentially be attributed to sample differences on demographic factors including age, urbanicity and socio-economic status. In conclusion, the CWI performed robustly across geographic, cultural, and linguistic settings, indicating the scale can be used in diverse settings. Continued investigation of the CWI across place and culture is warranted, particularly research using samples more closely matched on demographic factors to explore whether the measure can be used to compare community wellbeing levels across countries.

Keywords Community wellbeing · Community wellbeing index · International psychometric validation · Measurement invariance · Rasch analysis · Wellbeing measurement

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1 Introduction

1.1 Definition of Community Wellbeing

Humans are inherently social and individual, group and community wellbeing are connected (Di Martino et al., 2024, p. 8). In many places across the world, the concept of community wellbeing and its promotion has emerged as a key objective of governance and policy-making (Lee & Kim, 2015) as well as bio-psycho-social health (Wiafe et al., 2021). This movement has led to growing interest in indicators and assessment of community wellbeing and, in particular, how to monitor its progress in the context of community projects (Dluhy & Swartz, 2006). Although there is, at present, no clear consensus in regard to how community wellbeing is best defined, broadly, it encompasses the idea of people in a place living well together (Atkinson et al., 2020). Wiseman and Brasher (2008, p. 358) suggest community wellbeing is a "combination of social, economic, environmental, cultural, and political conditions identified by individuals and their communities as essential for them to flourish and fulfil their potential". Hence, community wellbeing is understood to be a dynamic relationship between the various objective conditions framing community life and the various subjective experiences of those who are collectively living within that frame (McCrea et al., 2014). Accordingly, understanding community members' appraisal of the physical and social conditions they live within is integral to understanding the wellbeing of a community.

1.2 Development of the Community Wellbeing Index

Forjaz and colleagues (2011) developed the Community Wellbeing Index (CWI) with the objective of creating a brief instrument to quantitatively measure community wellbeing from the subjective perspective of a community member. The CWI was intended to be complementary to the previously developed International Wellbeing Index (IWI) (Cummins et al., 2003), which consists of two scales, the Personal Wellbeing (PWI) and National Wellbeing (NWI) Indices. Accordingly, the authors adopted a structure for the CWI that was consistent with both the PWI and NWI. Forjaz and colleagues took an inductive approach to creating the CWI, which involved convening an expert panel to synthesise information about community wellbeing collated from previously undertaken literature reviews and surveys and then formulating an item-pool for the measure. Following this consultation process, a pool of 11 items was selected.

Forjaz and colleagues (2011) then undertook a robust initial validation study of the original Spanish CWI utilising principal component analysis (PCA), exploratory factor analysis (EFA), and Rasch analysis. The validation study was conducted with a nationally representative sample of 1,106 older-aged (≥60 years) people living in Spanish communities. The CWI was found to be multifactorial, with the final version of the measure comprising ten items grouped into three domains identified as "Services", "Attachment", and "Environment". The Services domain encompasses satisfaction with health and social services, support given to families, and leisure facilities in their community. The Attachment domain includes sense of belonging, safety, and trust in people within their community. The Environment domain encompasses satisfaction with the physical environment, and social and economic conditions in their community. The Person Separation Index (PSI) indicated the CWI had good reliability (PSI = 0.82–0.85 across CWI domains). Rasch modelling indi-

cated that the CWI had good internal construct validity, satisfactory known-groups validity, and was free from gender bias. Forjaz and colleagues (2011) concluded that the CWI demonstrated promise as a subjectively-informed assessment of community wellbeing and recommended further exploration of the performance of the measure across a wider diversity of age, culture, and nationality.

1.3 The Community Wellbeing Index in Research

A systematic review of wellbeing tools to evaluate community interventions rated the CWI as "excellent" (Dronavalli & Thompson, 2015). However, to date, few studies have administered the CWI to assess community wellbeing. Studies by Fernandez-Mayoralas et al. (2012) and Giraldez-Garcia et al. (2013) utilised CWI data from the same dataset Forjaz et al. (2011) used in their validation study. Only one published study by Torres-Vallejos et al. (2021) has used the CWI outside Spain, with six of the ten CWI items used in a survey involving participant groups from Chile, Argentina and Venezuela. Internal consistency of the abbreviated CWI that was administered ranged 0.89–0.90 across the three groups. The data from another article, presently under review, that implemented the CWI in an investigation of community wellbeing in the aftermath of a coal mine fire in Australia has been included in the current analysis (Carroll et al. 2023).

1.4 The Present Study

The objective of the present study was to further determine validity and reliability of the CWI by adding datasets from two other countries to the original dataset collected in Spain. The two new datasets were collected as part of ongoing unrelated research projects being undertaken in Australia and South Africa. This provided the opportunity to investigate the performance of the CWI across different cultures and in communities with different socio-economic backgrounds, as well as to assess English (Australia) and Setswana (South Africa) language versions of the original Spanish CWI tool. To ensure a robust investigation, the study implemented Rasch analysis augmented with Differential Item Functioning (DIF) analysis, as well as single and multigroup Confirmatory Factor Analysis (CFA) to evaluate invariance.

2 Method

2.1 Population and Sampling

2.1.1 Spain

The dataset from the original CWI validation study, which comprised responses collected in 2008 from 1,106 community-dwelling adults aged ≥ 60 years residing in Spain (Forjaz et al., 2011), was further utilised in these analyses. A complete description of the sample and data gathering procedure is published elsewhere (Fernandez-Mayoralas et al., 2012). The data collection was approved by the Carlos III Institute of Health Ethics Committee.

2.1.2 Australia

The sample from Australia comprised 677 participants who, between December 2019 and March 2020, completed a survey focused on mental health and wellbeing (Carroll et al., 2022) as part of the wider Hazelwood Health Study (Ikin et al., 2021) assessing the health impacts of the 2014 Hazelwood coal mine fire and associated extended air pollution event. The survey was completed by residents of Morwell, an outer regional town in Victoria, approximately 150 km from the state capital. Since the privatisation of the power industry in the 1990's, Morwell has been characterised as an area of relative socioeconomic and health disadvantage within the state (Duffy et al., 2023). By the time of the follow-up survey, 93% of the sample remained resident in Morwell or nearby localities, so the Australian sample is considered to be outer regional. The majority of participants completed the survey online, with a small number of participants choosing to complete the survey via telephone or paper survey.

2.1.3 South Africa

Data collection in South Africa formed part of the overlap of the longitudinal multidisciplinary Prospective Urban and Rural Epidemiology – South Africa (PURE-SA) study (Teo et al., 2009), North West province leg, and the FORT3 research project (Wilson et al., 2021). The PURE-SA North West study has been tracking the health of a systematically selected sample of participants from low resource urban (Ikageng) and rural (Ganyesa and Tlakgameng) settings in the North West province of South Africa since baseline in 2005. Specifically, at baseline households were systematically selected to be invited to complete a household questionnaire, and eligible participants (adults with no known noncommunicable diseases, tuberculosis, or HIV, using no chronic medication, and not being pregnant or lactating) were identified within households. The PURE-SA/FORT3 overlap study assessed the mental health and wellbeing of the PURE-SA North West cohort, with the CWI administered to a subsample consisting of the first 200 urban and 200 rural participants in the 2017–2019 survey round. Setswana is the most spoken African language in the area (82.5% of the sample indicated Setswana as native language), therefore a Setswana translation of the CWI was administered. Data was collected through interviews conducted by trained fieldworkers as many participants had limited formal schooling (22.1% no formal schooling; 13.5% Grade 1–3; 34.0% Grade 4–7; 17.3% Grade 8–9; 12.9% Grade 10–12; $n = 1$ missing).

Table 1 presents sample characteristics for the three countries.

2.2 Versions of the Community Wellbeing Index

2.2.1 Language Translations

The original CWI Spanish version was first translated into English and then into Setswana using standard forward-backward translation procedures, whereby one translator undertook the forward-translation whilst another translator independently undertook the backward-translation. A research committee comprising native-speaking academics from both languages was then convened to compare the original and back-translated versions of the CWI and further adapt the translations as deemed necessary (Van de Vijver & Leung, 1997).

Table 1 Sociodemographic characteristics of the three samples

	Spain (n=1,106)		Australia (n=677)		South Africa (n=400)		Combined* (n=300)	
	n	%	*n*	%	*n*	%	*n*	%
Sex								
Male	483	43.7	310	45.9	116	29.1	119	39.8
Female	623	56.3	366	54.1	282	70.9	180	60.2
Age (mean, SD)	72.1	7.8	52.7	17.1	61.6	8.9	62.7	14.1
Age (range)	(60–102)		(24–95)		(35–91)		(24–91)	
Age-group								
<60 years	-	-	422	62.3	177	44.8	106	36.2
60–74 years	722	65.3	185	27.3	178	45.1	130	44.4
≥75 years	384	34.7	70	10.3	40	10.1	57	19.5
Location								
Rural	566	51.2	-	-	200	50.0	-	-
Urban	540	48.8	-	-	200	50.0	-	-

*Random subsample of 100 participants per country

SD = standard deviation

Readability of the final CWI translations were verified with a small sample from the target groups.

2.2.2 Subscales

Forjaz and colleagues' [8] initial validation study of the CWI Spanish version identified three factors or subscales: (1) Community Services, comprising four items that assess satisfaction with health and social services, support given to families, and the availability of facilities and services for leisure activities; (2) Community Attachment, comprising three items that assess the level of trust between people, feeling part of the place, and the safety of the area; and (3) Physical and Social Environment, comprising three items that assess satisfaction with the economic situation, the state of the physical environment, and the social conditions.

2.2.3 Item Response Scales

The original CWI Spanish version adopted an 11-point Likert-type response scale (range: 0–10 with anchor points 0 = *completely unsatisfied*, 5 = *neutral*, and 10 = *completely satisfied*). The Australia and South Africa studies each administered the CWI with an alternative 5-point Likert-type response scale (response options 1 = *completely unsatisfied*; 2 = *somewhat unsatisfied*; 3 = *neutral*; 4 = *somewhat satisfied*; 5 = *completely satisfied*). For the purposes of the present study, the CWI responses in the dataset from Spain were rescored into the 5-point format based on response frequencies. Rescoring entailed collapsing the lowest five response-points (0–4) and the highest three response-points (8–10) of the original 11-point response scale into single points bookending the 5-point scale, whilst retaining three inner response-points (5–7). Table 2 presents CWI item response frequencies on the 5-point scale for each country and for all countries combined.

Table 2 CWI item response frequencies presented by country

		Spain (*n*=1,106)	Australia (*n*=677)			South Africa (*n*=400)		Combined* (*n*=300)	
		n	%	*n*	%	*n*	%	*n*	%
Item 1: Economic situation									
1	Completely unsatisfied	138	12.5	132	19.5	139	34.8	60	20.0
2	Somewhat unsatisfied	293	26.5	203	30.0	64	16.0	81	27.0
3	Neutral	252	22.8	244	36.0	58	14.5	74	24.7
4	Somewhat satisfied	242	21.9	58	8.6	105	26.3	57	19.0
5	Completely satisfied	170	15.4	37	5.5	33	8.3	28	9.3
.	Missing	11	1.0	3	0.4	0	0.0	0	0.0
Item 2: Environment									
1	Completely unsatisfied	170	15.4	88	13.0	78	19.5	49	16.3
2	Somewhat unsatisfied	274	24.8	190	28.1	100	25.1	71	23.7
3	Neutral	244	22.1	244	36.0	75	18.8	76	25.3
4	Somewhat satisfied	210	19.0	97	14.3	116	29.1	64	21.3
5	Completely satisfied	204	18.4	57	8.4	30	7.5	40	13.3
.	Missing	4	0.4	1	0.1	0	0.0	0	0.0
Item 3: Social conditions									
1	Completely unsatisfied	122	11.0	136	20.1	59	14.8	46	15.3
2	Somewhat unsatisfied	262	23.7	186	27.5	82	20.6	74	24.7
3	Neutral	270	24.4	205	30.3	74	18.5	72	24.0
4	Somewhat satisfied	249	22.5	98	14.5	137	34.3	73	24.3
5	Completely satisfied	194	17.5	50	7.4	47	11.8	35	11.7
.	Missing	9	0.8	2	0.3	0	0.0	0	0.0
Item 4: Health services									
1	Completely unsatisfied	117	10.6	114	16.8	79	19.8	48	16.0
2	Somewhat unsatisfied	198	17.9	164	24.2	76	19.0	52	17.3
3	Neutral	233	21.1	153	22.6	51	12.8	63	21.0
4	Somewhat satisfied	261	23.6	152	22.5	101	25.3	70	23.3
5	Completely satisfied	293	26.5	93	13.7	93	23.3	67	22.3
.	Missing	4	0.4	1	0.1	0	0.0	0	0.0
Item 5: Social services									
1	Completely unsatisfied	193	17.5	66	9.7	81	20.4	45	15.0

Table 2 (continued)

		Spain (*n*=1,106)	Australia (*n*=677)		South Africa (*n*=400)		Combined* (*n*=300)	
		n	%	*n*	%	*n*	%	*n*	%
2	Somewhat unsatisfied	261	23.6	118	17.4	91	22.9	58	19.3
3	Neutral	234	21.2	293	43.3	68	17.1	88	29.3
4	Somewhat satisfied	228	20.6	131	19.4	112	28.1	59	19.7
5	Completely satisfied	175	15.8	63	9.3	46	11.6	47	15.7
.	Missing	15	1.4	6	0.9	0	0.0	3	1.0
Item 6: Support to families									
1	Completely unsatisfied	232	21.0	62	9.2	60	15.0	41	13.7
2	Somewhat unsatisfied	288	26.0	129	19.1	102	25.5	60	20.0
3	Neutral	227	20.5	308	45.5	77	19.3	94	31.3
4	Somewhat satisfied	195	17.6	120	17.7	117	29.3	70	23.3
5	Completely satisfied	142	12.8	52	7.7	44	11.0	31	10.3
.	Missing	22	2.0	6	0.9	0	0.0	4	1.3
Item 7: Trust in people									
1	Completely unsatisfied	64	5.8	84	12.4	39	9.8	28	9.3
2	Somewhat unsatisfied	183	16.5	177	26.1	89	22.3	73	24.3
3	Neutral	216	19.5	244	36.0	108	27.0	82	27.3
4	Somewhat satisfied	277	25.0	111	16.4	133	33.3	72	24.0
5	Completely satisfied	362	32.7	57	8.4	31	7.8	44	14.7
.	Missing	4	0.4	4	0.6	0	0.0	1	0.3
Item 8: Leisure									
1	Completely unsatisfied	160	14.5	61	9.0	155	38.8	52	17.3
2	Somewhat unsatisfied	250	22.6	129	19.1	66	16.5	60	20.0
3	Neutral	223	20.2	240	35.5	65	16.3	79	26.3
4	Somewhat satisfied	254	23.0	169	25.0	82	20.6	79	26.3
5	Completely satisfied	212	19.2	73	10.8	31	7.8	29	9.7
.	Missing	7	0.6	5	0.7	0	0.0	1	0.3
Item 9: Belonging									
1	Completely unsatisfied	75	6.8	42	6.2	22	5.5	21	7.0
2	Somewhat unsatisfied	173	15.6	91	13.4	47	11.8	46	15.3
3	Neutral	197	17.8	240	35.5	71	17.8	73	24.3

Table 2 (continued)

		Spain (*n*=1,106)		Australia (*n*=677)		South Africa (*n*=400)		Combined* (*n*=300)	
		n	%	*n*	%	*n*	%	*n*	%
4	Somewhat satisfied	290	26.2	185	27.3	168	42.0	98	32.7
5	Completely satisfied	368	33.3	116	17.1	92	23.0	62	20.7
.	Missing	3	0.3	3	0.4	0	0.0	0	0.0
Item 10: Security									
1	Completely unsatisfied	90	8.1	107	15.8	106	26.6	41	13.7
2	Somewhat unsatisfied	192	17.4	187	27.6	56	14.0	58	19.3
3	Neutral	244	22.1	197	29.1	53	13.3	78	26.0
4	Somewhat satisfied	285	25.8	106	15.7	135	33.8	75	25.0
5	Completely satisfied	290	26.2	78	11.5	49	12.3	48	16.0
.	Missing	5	0.5	2	0.3	0	0.0	0	0.0

*Random subsample of 100 participants per country

2.3 Data Analysis

2.3.1 Rasch Analysis

The Rasch model, a one-parameter model which is part of Item Response Theory, purports that the probability of the response to certain items is a functional relationship between the item difficulty (in this case, the level of community wellbeing being measured by the item on the construct continuum) and the person ability (or level of community wellbeing expressed by that person) (Rasch, 1980). In other words, the distribution of person ability and item difficulty are represented in the same linear scale. The model purports that individuals with higher ability are more likely to endorse more difficult items (measuring higher levels of construct). It assumes unidimensionality, item local independence, and it allows assessment of several measurement attributes, such as fit to the Rasch model, reliability, DIF, and adequacy of the response scale. Rasch analysis with large sample sizes can result in small deviations from the Rasch model being statistically significant (Linacre, 1994). Accordingly, separate Rasch analyses were performed for each country using a random sample of 300 participants from each, with DIF by country then tested in a randomly selected subsample of 100 participants per country.

For an adequate fit between the Rasch model and the data, the following attributes are expected: (1) a non-significant person-item interaction chi-squared, with Bonferroni correction for number of items (Tennant & Conaghan, 2007); (2) a normal distribution of person and item locations presenting a mean close to 0 and a standard deviation (*SD*) close to 1; and (3) fit residuals ranging between −2.5 and 2.5 logits. Reliability was measured with the Person Separation Index (PSI), which can be interpreted similarly to Cronbach's alpha.

Thresholds are the point of equal response probability between two adjacent response categories; in the case of disordered thresholds, adjacent categories are collapsed into one.

Rasch analysis was performed using RUMM2030 statistical software. Further information and examples about Rasch analysis using RUMM2030 have been published (Pallant & Tennant, 2007; Tennant & Conaghan, 2007).

To investigate unidimensionality, a principal component analysis (PCA) was performed and items with the lowest and highest loadings on the first residual factor compared using a binomial proportion test. The lower confidence interval was expected to be <0.05 (Smith, 2002). Item local independence was inspected in a correlation matrix of the residuals, where correlation coefficients were expected to be similar (Baghaei, 2008).

DIF analysis enables detection of whether different person-groups answer in similar or dissimilar ways at the same construct level (Tennant & Conaghan, 2007). DIF was analysed by age (categories: <60 years for Australia and South Africa only; 60–74 years for all countries; ≥75 years for all countries), and by sex for all countries; DIF by location (categories: rural vs. urban; rural defined as a locality with $<50{,}000$ inhabitants) was tested only for the Spain and South Africa samples as this categorical distinction was not applicable within the sample from Australia where participants were drawn from a single rural community. To test for DIF by country, a random sample of 300 participants ($n=100$ per country) was taken. When several items present significant DIF, a top-down purification procedure is followed by creating two groups of items, with or without DIF, and comparing the estimates in an ANOVA to observe whether DIF remains.

2.3.2 Cronbach's Alpha and Single and Multigroup Confirmatory Factor Analysis

Using the complete samples, Cronbach's alpha was calculated as an indicator of internal consistency reliability, with values of 0.70 or larger indicative of acceptable reliability (J. Nunnally & Berstein, 1995). Single and multigroup confirmatory factor analysis (CFA; MCFA) were performed using Mplus version 8.2 software. The robust maximum likelihood (MLR) estimator was used. Full information maximum likelihood estimation was used to deal with missing data. The percentage of missing values on an item ranged between 0% and 2% (see Table 2).

The following fit indices are reported to assess the single group CFA model. First, the χ^2 (chi-square) test statistic compares the observed and expected data according to the theorical model. For a good fit, a χ^2 approaching non-significance is expected. However, the χ^2 test is highly sensitive to sample size and tends to be significant (leading to model rejection) when the sample size is large (Byrne, 2012). Therefore, greater consideration was given to other fit indices for decision making. Root Mean Square Error of Approximation (RMSEA) values <0.05 are considered good, 0.05–0.08 acceptable, 0.08–0.1 marginal, and >0.1 poor (MacCallum et al., 1996). Comparative Fit Index (CFI) values can range between 0 and 1, with values >0.90 indicating good fit (Hooper et al., 2008).

MCFA was used to test for measurement invariance. The CFA described above was used to find a baseline model that displayed good fit for each individual sample. Measurement invariance across the three samples was evaluated by comparing a series of nested models each requiring higher levels of invariance as described by Byrne and Van de Vijver (Byrne & van de Vijver, 2010). As a first step, configural invariance was assessed where the number of factors and pattern of loadings are set to be equal across the samples, but parameters are

freely estimated. A well-fitting configural model becomes the baseline with which models requiring higher levels of invariance are compared. The next step was to evaluate metric invariance, that sets factor loadings across the samples to be equal. If metric invariance does not hold for a small number of loadings, these can be allowed free estimation, resulting in partial metric invariance. Lastly, scalar invariance was evaluated, that sets factor loadings and item intercepts to be equal. If this does not hold for all parameters, some can be allowed free estimation to determine whether partial scalar invariance is supported (van de Vijver & Leung, 2011). To assess whether invariance holds, the nested models were compared. This was done using the likelihood ratio test examining the difference between the χ^2 test statistic of the nested models. Due to the χ^2 test's sensitivity to sample size, the hypothesis that invariance holds will mostly be rejected when sample sizes are large (Cheung & Rensvold, 2002). Therefore, the difference between the CFI and RMSEA fit indices of the nested models (ΔCFI and ΔRMSEA, respectively) were used for interpretation, with $\Delta CFI \leq 0.01$ and $\Delta RMSEA \leq 0.015$ indicating support for measurement invariance (Cheung & Rensvold, 2002; Chen, 2007). Furthermore, we report the Akaike's Information Criterion (AIC) and sample size-adjusted Bayesian Information Criterion (BICa), where better fit is indicated by smaller values (Byrne, 2012).

3 Results

3.1 Rasch Analysis

Consistent with the earlier Forjaz et al. (2011) analysis, Rasch analyses by country indicated the ten CWI items measured a three-dimensional construct. Therefore, analyses were run separately for each of the three original CWI dimensions (Forjaz et al., 2011). For the data from Spain, a good fit to the model was observed, with PSI ranging 0.700-0.768. Each of the original CWI dimensions were again confirmed, thresholds were ordered, there was item local independence, and all items were free from DIF by age, sex, and location. Results were similar for the Australia data, with PSI ranging 0.727–0.810; however, item 9 ("Feeling part of the place where you live") showed DIF by age, with adults $\geq$75 years of age overestimating item scores (Fig. 1). Analysis of the South Africa data likewise indicated a good fit to the Rasch model, unidimensionality, and item local independence. PSI was 0.720 for the Physical and Social Environment dimension, 0.651 for the Community Services dimension, and 0.551 for the Community Attachment dimension. All items were free from DIF, except for item 5 ("Social services") and item 9 ("Feeling part of the place where you live"), which each showed DIF by location, with participants living rurally overestimating these items (Fig. 2). Table 3 presents the global fit indices to the Rasch model and Table S1 the individual item fit, each presented by country and for the combined sample. The order of the item thresholds in terms of item difficulty and how it aligns with person ability can be seen in Figure S1.

To investigate for DIF by country, a Rasch analysis was performed on a combined sample consisting of a subsample of 100 participants per country. The analysis indicated good model fit, unidimensionality, item local independence, and PSI ranging 0.668–0.752. Two items of the Community Services dimension (item 2: "The state of the physical environment in the area where you live"; item 3: "The social conditions in the area where you live")

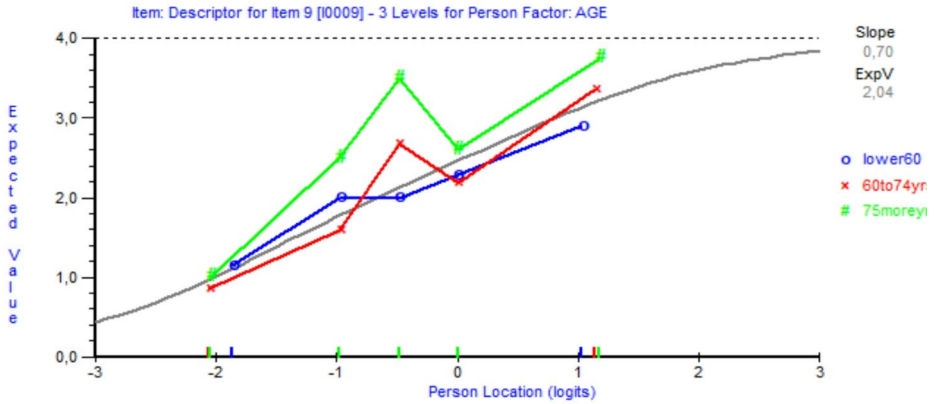

Fig. 1 Differential Item Functioning by Age for CWI Item 9 "Feeling part of the place where you live": Australia Sample

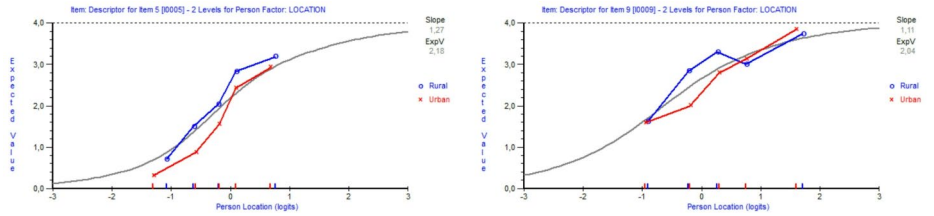

Fig. 2 Differential Item Functioning by Location (Rural vs. Urban) for CWI Items 5 "Social services" (Top) and 9 "Feeling part of the place where you live" (Bottom): South Africa Sample

showed DIF by country in opposite directions, which was cancelled out through a top-down purification procedure. The same was observed for the Physical and Social Environment dimension (item 6: "The support given to families in the area where you live"; item 8: "The availability of facilities and services for leisure activities in the area where you live").

3.2 Cronbach's Alpha, CFA, and MCFA

Cronbach's alpha was above 0.70 in all cases (see Table 4), except for the Community Attachment dimension in the South African dataset, where α was 0.642. Looking deeper, the inter-item correlations among all combinations of the three Community Attachment items, as well as all item-total correlations, were above 0.30, supporting reliability (Field, 2013). The Community Services dimension, which yielded a PSI value below 0.70 in the Rasch analysis, attained an α of 0.728 and all item-total correlations were above 0.30, supporting reliability.

Using single-group CFAs, the three-factor CFA model displayed good fit for all samples. Standardised factor loadings are presented in Table 4. Global fit indices suggested good fit (Table 5) for the three data sets. Configural and metric invariance among the three countries were supported, but not scalar invariance (Table 5). Partial scalar invariance, as indicated by

Table 3 Global fit to the Rasch model

		Criteria	Spain ($n=300$)			Australia ($n=300$)			South Africa ($n=300$)			Combined sample ($n=300$)		
			CS	CA	PSE	CS	CA	PSE	CS	CA	PSE	CS	CA	PSE
Item fit residual	M	0	0.464	0.258	0.206	0.462	0.482	0.356	0.583	0.451	-0.196	0.514	0.404	0.334
	SD	1	1.284	0.914	0.594	1.222	0.771	0.580	1.344	0.691	1.003	1.447	0.546	0.875
Person fit residual	M	0	-0.558	-0.885	-0.994	-0.691	-0.483	-0.731	-0.416	-0.379	-0.508	-0.642	-0.529	-0.571
	SD	1	1.360	1.735	1.784	1.571	1.034	1.378	1.170	0.894	0.921	1.663	1.147	1.202
Item-trait interaction	χ^2	Low	21.622	15.840	17.862	10.384	10.906	7.241	29.481	21.455	20.474	20.784	13.733	23.335
	Prob.	*N*.S.	0.156	0.199	0.120	0.846	0.537	0.841	0.021	0.044	0.059	0.187	0.318	0.025
Person Separation Index		>0.70	0.749	0.700	0.768	0.819	0.727	0.759	0.651	0.551	0.720	0.752	0.668	0.747
Unidimensionality: significant *t*-tests	%	<10%	1.02	0.00	1.01	6.16	2.05	3.08	0.67	1.00	1.67	2.01	0.67	1.00
	(95% CI)	(*)	(-0.02; 0.04)	(-0.03; 0.03)	(-0.02; 0.04)	(0.04; 0.09)	(-0.01; 0.05)	(0.01; 0.06)	(-0.02; 0.03)	(-0.02; 0.04)	(-0.01; 0.04)	(-0.005; 0.045)	(-0.015; 0.035)	(-0.015; 0.035)

Note. *M*=Mean; *SD*=Standard deviation; Prob. = Probability; N.S. non-significant (Bonferroni correction): $p>.0125$ (4 items) or $p>.0167$ (3 items); CI=Confidence interval; CS=Community services; CA=Community attachment; PSE=Physical and social environment

sufficiently small ΔCFI and ΔRMSEA values, was only obtained after allowing free estimation of the intercepts for 40% of the items (items 4, 9, 8, and 2).

4 Discussion

In this study the measurement properties of the CWI were investigated from a cross-cultural perspective in three continents, Europe (Spain), Oceania (Australia), and Africa (South Africa), and three languages: Spanish, English, and Setswana. Overall, the three-dimension structure of the CWI was replicated in each dataset, and good measurement properties were further confirmed. In addition, there was no evidence of bias by country and metric invariance was supported, which together suggest the CWI can be utilised as an appropriate and robust tool for measuring subjective perspectives on community wellbeing across geographically and culturally diverse contexts, but that simple total and subscale scores should not be directly compared across the samples.

4.1 Observations in Relation to the Factor Structure of the CWI

The study confirmed the three-dimension scale structure of the CWI observed in the original 2011 analysis of the dataset from Spain. This structure was evident across the data from three analytic vantage-points: (1) the unidimensionality analysis using the Rasch model, (2) the single group CFAs, and (3) the configural invariance in the MCFA. This multidimensional structure of community wellbeing aligns with other recent findings (Musa et al., 2020; Syhlonyk & Seasons, 2021), suggesting that distinct but linked subdimensions should be measured in parallel. Scale reliability (PSI and Cronbach's alpha) was above 0.70 for all CWI dimensions in both the datasets from Spain and Australia; however, in the South African dataset, the reliability of the Community Attachment dimension was below desirable standard according to both reliability indicators, and for the Community Services dimension, the PSI was below the guideline. For both these subscales, the item-total correlations that were above 0.30 supported internal consistency reliability. Some authors have warned that cut-offs for reliability indicators should not be applied rigidly, and that lower scores can be expected when working with psychological constructs and at early stages of instrument development (Kline, 1999; Nunnally, 1978). Considering all indicators, there is no reason for serious concern regarding the CWI's reliability for the South African dataset, although more research would be beneficial. The findings on the factorial validity and internal consistency reliability of the CWI support use of the scale's three-factor structure across the countries. Again, more research exploring whether this applies in other samples, both similar and diverse to those included in this study, is needed.

4.2 Observations in Relation to CWI Item Functioning and Response Bias

Concerning DIF, consistent with the results of the original validation study in Spain, all CWI items were free of sex biases in the datasets from Australia and South Africa. However, item 9 (belonging) presented DIF by age in Australia. There are contextual considerations that may underlie why older people in the Australian sample appraised community wellbeing more positively than other age-groups. As previously detailed, the Australian sample is

Table 4 Standardised factor loadings for the confirmatory factor analysis model (CFA) of CWI items and Cronbach's alpha values of subscales

	Factor 1 Community services			Factor 2 Community attachment			Factor 3 Physical and social environment		
	Spain	Australia	South Africa	Spain	Australia	South Africa	Spain	Australia	South Africa
Item 4: Health services	0.628	0.701	0.580						
Item 5: Social services	0.820	0.781	0.740						
Item 6: Support to families	0.794	0.796	0.811						
Item 8: Leisure	0.679	0.724	0.473						
Item 7: Trust in people				0.700	0.749	0.624			
Item 9: Belonging				0.768	0.698	0.549			
Item 10: Security				0.771	0.728	0.672			
Item 1: Economic situation							0.766	0.743	0.771
Item 2: Environment							0.764	0.800	0.884
Item 3: Social conditions							0.845	0.788	0.719
Cronbach's alpha	0.814	0.830	0.728	0.792	0.766	0.642	0.834	0.820	0.827

Note. Sample sizes: Spain. $n = 1{,}101$; Australia. $n = 676$; South Africa. $n = 400$

Table 5 Measurement invariance of the CWI across the three countries

Model	Inv model 1	Inv model 2	Inv model 3
χ^2	443.340	516.846	871.585
df	96	110	124
p	<0.001	<0.001	<0.001
CFI	0.951	0.943	0.896
RMSEA	0.071 (0.064; 0.077)	0.071 (0.065; 0.078)	0.091 (0.085; 0.097)
AIC	62078.558	62123.661	62507.033
BICa	62327.043	62337.006	62685.239
Model comparison		2 vs. 1	3 vs. 2
$\Delta\chi^2$		75.942	418.629
df		14	14
p		<0.001	<0.001
ΔCFI		0.008	0.047
ΔRMSEA		<0.001	0.020

Note. Inv model 1 = configural invariance model; Inv model 2 = metric invariance model; Inv model 3 = scalar invariance model; χ^2 = chi-square test statistic; *df* = degrees of freedom; *p* = probability value; CFI = comparative fit index; RMSEA = root mean square error of approximation; AIC = Akaike's information criterion; BIC_a = sample size-adjusted Bayesian information criterion; $\Delta\chi^2$ = likelihood ratio test (difference in chi-square between nested models); ΔCFI = difference in CFI between nested models; ΔRMSEA = difference in RMSEA between nested models

from a community that had recently been exposed to a significant air pollution event due to a mine fire in 2014. The older age group is likely to have lived in the community for longer than their younger counterparts, allowing more time for them to develop links to the community, including family and social connections, resulting in a more enduring connection to place. This likely longer period of tenancy in the community may have also given older residents a more longer-term perspective on the impacts of the mine fire and its place within their community's history, as they are likely to have experienced previous mine fires and other community-wide events, and hence have been better placed to respond with resilience to the 2014 mine fire. This is supported by other research with the cohort indicating that older people typically experienced less distress than younger people as a result of the mine fire event (Broder et al., 2020; Walker et al., 2017).

For the South Africa sample, item 5 (social services) and item 9 (belonging) presented DIF by location, where the rural sample scored higher than expected on the respective items considering their trait levels. In terms of social services (item 5), most of the participants in the South Africa sample were relying on government-funded social grants for subsistence. In the rural context, a mobile service vehicle visits different areas in the rural settlement when social grants are released. Thus, the participants (mostly older people) could get their social grants without the need to travel far or stand in long queues. In contrast, people in the urban setting have to access their grants at places like the postal office or automatic teller machines, which are often far from people's homes, involve long queues, and cause substantial inconvenience. Due to this difference, people from the rural setting may have been inclined to score higher on item 5 than their urban counterparts, even when levels of the underlying trait (community services) were similar. In terms of belonging (item 9), the rural community could be more close-knit and supportive of each other than the urban community, where community members may be more focused on their own needs. This could have contributed to rural participants scoring higher on item 9 compared with urban participants who had similar levels of the underlying trait (community attachment). If these findings are replicated in future research, comparisons by age and location groups at item-level should be interpreted cautiously, as significant differences may reflect an item bias.

4.3 Observations in Relation to the Validity of the CWI Across Countries and Language

Considering comparisons of scale functioning across countries, the absence of DIF by country in the global analysis suggests that the three dimensions of community wellbeing were consistently measured, irrespective of the country where the scale was administered or the language it was presented in. This implies that, where cross-country differences in CWI scoring are detected, they are not due to item biases. This contradicts a previous study that found DIF by world regions in "experienced wellbeing", based on the ladder of life question which measures a different construct than community wellbeing (Rojas-Gualdron, 2017). More research is needed to investigate whether the absence of DIF across country is replicated in studies with data from different and larger groups of countries. MCFA supported configural and metric invariance across countries, but only partial scalar invariance, suggesting that raw total scores should not be directly compared across countries. This aligns with findings on the Personal Wellbeing Index where configural, partial metric, and partial scalar invariance were obtained across 26 countries, and similarly suggested that raw PWI

scores should not be compared across countries (Żemojtel-Piotrowska et al., 2017). The lack of full scalar invariance could potentially be due to age, cultural, linguistic, and socio-economic differences between the samples. Future research incorporating more closely matched samples from different countries is needed to further explore reasons for the lack of full scalar invariance.

4.4 Observations in Relation to the CWI Response Scale Format

The original CWI validation in Spain indicated the 11-point scale showed disordered thresholds and items had to be rescored in different ways (Forjaz et al., 2011). In the current study, the Australian and South African researchers utilised the simpler 5-point response scale, with the dataset from Spain rescored to match. The findings here suggest the revised 5-point response scale performed well across the three samples. In practice, the 5-point response scale may have some advantages relative to the 11-point response scale when administering the CWI. For instance, the simpler 5-point scale demands less time and effort of respondents to comprehend and settle upon their answer, which could prove especially useful when conducting research with populations who have lower education levels, cognitive impairment, or who are older, or otherwise where brevity is important. In addition, the use of labels for each of the five response points might have facilitated the respondents' choice of an appropriate answer.

4.5 Study Strengths and Limitations

This study presents several limitations, but also important strengths. First, samples were established primarily for purposes other than investigating community wellbeing or validate the CWI. Consequently, the studies did not intentionally include a range of other measures to evaluate convergent and discriminant validity, and the designs of the studies did not allow for evaluation of aspects such as test-retest reliability. Also, the Rasch model that was applied in this study is a simple item response theory model that has only one parameter, namely item difficulty. More complex unidimensional or multidimensional item response theory models may give further insight into the functioning of the scale. Despite these limitations, the study used a robust methodology involving different approaches to inspecting various aspects of the performance of the CWI, which is a strength. Further research is needed to provide more information about other psychometric characteristics of the CWI, such as convergent and discriminant validity, test–retest reliability, precision, and responsiveness. The three samples are very diverse to each other in a range of ways (geographically distant; language; culture; socio-economic status). This can be considered a strength since the findings support the use of the scale in diverse settings. However, this can also be seen as a limitation since the samples are not comparable and therefore differences across the samples could potentially be attributed to a wide variety of contextual, linguistic, or other factors.

5 Conclusions

In summary, this multicountry study of the performance of the CWI further supports the validity and reliability of the measure as a brief and easy to administer quantitative assessment of subjective perspectives on community-level wellbeing. Accordingly, the findings here suggest that the CWI is a versatile measure that may have broad utility across geographically, culturally, socio-economically and linguistically diverse populations and contexts. Further investigations involving samples that capture the full range of sociodemographic variation within countries are warranted to better understand the psychometric properties of the CWI and to further explore between-country differences in community wellbeing.

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Declarations

Ethical Approval Approval for this study has been granted by the Carlos III Institute of Health Ethics Committee, the Monash University Human Research Ethics Committee (approval numbers CF15/872 and 21151) and the Health Research Ethics Committee of the North-West University, South Africa (approval numbers NWU-00016-10-A1 and NWU-00002-07-A2).

Consent to Participate Informed consent was obtained from all individual participants included in the study.

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