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Rasch analysis of the sense of coherence scale in a sample of people with morbid obesity – a cross-sectional study

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Abstract

Background: The prevalence of morbid obesity is an increasing health problem in most parts of the world and is related to lower quality of life. Sense of coherence, or the perception that the world is meaningful and predictable, is considered a promising health resource for changing behaviour and adopting a healthier lifestyle. Thus, a valid and reliable instrument for measuring sense of coherence is needed to further research and clinical efforts in this area. The purpose of the study was to examine the psychometric properties of the 13-item Sense of Coherence scale and its sub-dimensions (Comprehensibility, Manageability, and Meaningfulness) in a sample of people with morbid obesity using a Rasch analysis approach.

Methods: Data were collected cross-sectionally in Norway in 2009 from 142 patients attending a mandatory patient education course for patients with morbid obesity on a waiting list for treatment. Participants completed a socio-demographic questionnaire and the 13-item Sense of Coherence scale at the beginning of the course. Evidence of rating scale functioning, internal scale validity, person-response validity, person-separation reliability and differential item functioning of the 13-item version were explored. The scale's three sub-dimensions were also evaluated.

Results: A 12-item version of the scale demonstrated the best fit to the Rasch model and increased the variance explained without reducing the separation index. The three sub-dimensions demonstrated good fit but lacked unidimensionality and person-separation reliability. The Meaningfulness sub-dimension showed better psychometric properties than the Comprehensibility and Manageability sub-dimensions.

Conclusion: A 12-item version of the Sense of Coherence scale has better psychometric properties than the original 13-item version among persons with morbid obesity. Further studies should explore whether these questionable validity findings for the 13-item scale generalize to other populations and examine whether including other items from the longer 29-item version may improve the psychometric properties of an abbreviated Sense of Coherence measure.

Keywords: Sense of coherence, Rasch analysis, Psychometrics, Obesity, Health education, Life style, Quality of life, Validity, Reliability

Background

Obesity is an increasing global health problem (World Health Organization 2010), as well as a significant risk factor for numerous chronic illnesses and co-morbid conditions, such as diabetes, stroke, obstructive sleep apnoea, cancer, musculoskeletal pain, hypertension and heart disease (James 1998; National Task Force on the Prevention and Treatment of Obesity 2000; Dixon 2010). Morbid obesity is also associated with lower physiological and psychological well-being (Abiles et al. 2010). In a previously published study of people with morbid obesity, health-related quality of life was found to be directly related to one's sense of coherence (SOC), or their perception that the world is meaningful and predictable, even after controlling for socio-demographic variables, health behaviour, environmental and other personal factors (Lerdal et al. 2011a). Given its relationship to quality of life outcomes, SOC is often assessed in studies aimed at modifying

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participants' views and management of their health problems (Eriksson and Lindstrom 2006) and evaluating the effectiveness of health education.

SOC is a concept in the salutogenic theory introduced by Antonovsky (1987). He argued SOC to be "a major determinant of maintaining one's position on the health ease/dis-ease continuum and of movement toward the health end." (Antonovsky 1987, p. 18). A systematic review on SOC-related research concluded that it may be a promising health promoting resource to strengthen resilience and to develop positive subjective health. According to Antonovsky, SOC is comprised of three dimensions: a cognitive one (*comprehensibility),* an instrumental one (*manageability)*, and a motivational one (*meaningfulness*). The participants in our study attended a patient education course that was grounded in salutogenic theory and cognitive behavior theory and that emphasized the participants' work in uncovering hidden resources, strengthening their self-concept and social skills, and raising their consciousness about lifestyle choices. To measure changes in SOC among participants after attending such a course, a valid and reliable measure of SOC and its sub-dimensions is needed. Thus, both SOC in general and each sub-dimension were analyzed in this study.

SOC is typically measured using the 29-item Orientation to Life Questionnaire, also known as the SOC-29, developed by Antonovsky (1987). Initially the instrument was constructed to test the core hypothesis from the salutogenic theory, i.e. the causal relationship between persons' SOC and health status (Antonovsky 1987). It has been used in several intervention and longitudinal studies to describe changes in SOC and their relationship to other health-related variables (Langeland et al. 2006; Bergman et al. 2009; Forsberg et al. 2010).

The SOC-13 (see Table 1) is a widely used short form of the original SOC-29, and includes items from each the three sub-dimensions of SOC: Meaningfulness (4 items), Manageability (4 items), and Comprehensibility (5 items). Although the psychometric properties of the SOC-13 have not been evaluated among people with morbid obesity, several prior studies have evaluated the SOC-13 in other populations using both classical and modern test theory approaches.

A recent study of healthy people older than 65 years evaluated the psychometric properties of the SOC-13 in The Netherlands (Naaldenberg et al. 2011). Responses were analyzed using inter-item correlation, Cronbach's alpha, cluster analysis and exploratory factor analyses. The study showed that items #2 and #4 performed poorly. Item #2 asks '*Has it happened in the past that you were surprised by the behaviour of people whom you thought you knew well?*', with response alternatives ranging from: 1= '*never happened*' to 7= '*always happened.*' Item #4 states '*Until now your life has had:*' with response alternatives ranging from: 1 = '*no clear goals or purpose at all*' to 7 = '*very clear goals or purpose.*' The study reported that excluding these two items in an 11-item version resulted in better psychometric properties than the SOC-13. The SOC-13 was also evaluated in a group of college undergraduates in the US using confirmatory factor analyses (Hittner 2007). The author reported that the SOC-13 had a good fit to a common factor model with a single latent SOC construct. Hagquist and Andrich (2004) evaluated the SOC-13 using Rasch analysis in a Swedish sample of 868 eighteen-year-old students in upper secondary school. The study revealed uniform differences between girls and boys, i.e., the girls scored relatively higher on item #1 ('*Do you have the feeling that you don't really care about what goes on around you?'*) and the boys scored relatively higher on item #3 (*'Has it happened that people whom you counted on disappointed you?'*) and item #10 ('*Many people—even those with a strong character — sometimes feel like sad sacks (losers) in certain situations. How often have you felt this way in the past?'*). Furthermore, the study showed that the separation index increased when item #11 ('*When something happened, have you generally found that:*' [response alternative ranging from 1: *you over-estimated or underestimated its importance* to 7: *you saw things in the right proportion*]) was deleted from the analysis.

These prior studies suggest that certain items may pose threats to the reliability and validity of the SOC-13 and highlight the need for it to be evaluated among persons with chronic health conditions, such as morbid obesity as well. Furthermore, none of the prior studies have evaluated the psychometric properties of the subdimensions, which may yield valuable information about the SOC construct as well as the utility of using the subdimension scores.

In 2001, the World Health Organization launched a theoretical framework (World Health Organization 2001) describing multiple domains, i.e. personal factors, which are considered important for understanding peoples' health and for performing health research. In order to estimate aspects of these domains in a valid manner, it is crucial to ensure that the measures generated from instruments such as the SOC scale are not multidimensional or biased in other ways. To our knowledge, the SOC-13 scale has not been assessed using a Rasch analysis approach in a sample other than healthy adolescents (Hagquist and Andrich 2004). Given its application in the field of health education, further psychometric evaluation is warranted among adults and persons with chronic illness or other health problems. Furthermore, the sub-dimensions of the SOC-13 have never been analyzed using a Rasch analysis approach.

Thus, the aim of this study was to examine the psychometric properties of the SOC-13 total scale and its

Table 1 Example of items from the Sense of Coherence scale 13-item version (SOC-13), its sub-dimensions and coding

Item	Dimension	Coding	Question						
1	ME	Rev	Do you have the feeling that you don't really care about what goes on around you?						
			1	2	3	4	5	6	7
			Seldom or never						Very often
2	CO	Rev	Has it happened in the past that you were surprised by the behavior of people whom you thought you knew well?						
			1	2	3	4	5	6	7
			Never happened						Always happened
3	MA	Rev	Has it happened that people whom you counted on disappointed you?						
			1	2	3	4	5	6	7
			Never happened						Always happened
4	ME		Until now your life has had:						
			1	2	3	4	5	6	7
			No clear goals or purpose at all						Very clear goals and purpose
8	CO		Do you have very mixed-up feelings and ideas?						
			1	2	3	4	5	6	7
			Very often						Very seldom or never
10	MA	Rev	Many people—even those with a strong character— sometimes feel like sad sacks (losers) in certain situations. How often have you felt this way in the past?						
			1	2	3	4	5	6	7
			Never						Very often
11	CO		When something happened, have you generally found that:						
			1	2	3	4	5	6	7
			You overestimated or underestimated its importance						You saw things in the right proportion

Note: CO = Comprehensability, MA = Manageability, ME = Meaningfulness, Rev = reversed coding.

three sub-dimensions in a sample of people with morbid obesity. The specific objectives were to assess: 1) the functioning of the rating scales used in the SOC-13 items, 2) the fit of the SOC-13 items to the Rasch model, 3) unidimensionality, 4) person-response validity, and 5) person-separation reliability, as demonstrated by the scale's ability to separate a sample into distinct levels of SOC.

Methods

This article reports findings from a prospective longitudinal study in which questionnaire data were collected at six time points: at the beginning of a patient education course, 2 weeks after the course, and 3, 6, 12 and 24 months after course completion. Only cross-sectional data from the first time point are analysed in this article.

Sample and procedures

A convenience sample of participants was recruited at three different sites on the first or second day of 10 mandatory courses held in the spring of 2009. All 185 participants attending the courses were given verbal and written information about the study and invited to participate. Of these, 142 (76.8%) gave their written consent to participate, completed the questionnaire in a secluded room on-site and returned it in a sealed envelope. The project representative collected the envelopes.

Instruments

This study used the Norwegian language version of the previously described SOC-13 (Antonovsky 1987). The translation from English into Norwegian was conducted using standard back and forth translation procedures (Guillemin et al. 1993). Responses are recorded on a 7-point Likert-type scale with varying response anchors. A person's SOC-13 total score is calculated by summing all item scores (range 13–91), with higher scores indicating a stronger SOC. For the purpose of this analysis, separate sub-dimension scores were based on the 4 meaningfulness items, the 4 manageability items, and the 5 comprehensibility items. The SOC-13 has been reported as a reliable and valid instrument (Eriksson and Lindstrom 2005).

Ethics

The Regional Medical Research Ethics Committee of Norway (REK S-08662c 2008/17575; NCT 01336725), and the Norwegian Data Inspectorate and the Ombudsman of Oslo University Hospital approved the study. All participants signed an informed consent form.

Statistical analysis

The SOC-13 was analyzed using a Rasch model for several reasons. First, the SOC-13 items represent different dimensions of SOC that are assumed to vary in their degree of challenge. Rasch models adjust the final person measures based on relative differences in item challenge, thereby providing more precise estimates of a person's SOC. Rasch models are also suitable for evaluating data that have items missing at random. Even though 12 item scores out of 1846 (0.7%) were missing among the 142 participants, all available data could be used with the Rasch model, and no data were excluded (Linacre 2011; Bond and Fox 2001; Wright and Stone 1979).

The Rasch analysis converts the SOC-13 raw item scores into measures with equal intervals using a logarithmic transformation of the odds probabilities of each response. The transformation provides both an estimation/measure of a person's SOC as well as estimates of item challenge along a calibrated continuum (from low to high SOC). But before using the measures for further statistical analyses, it is crucial that the response patterns on persons and items demonstrate acceptable levels of validity. For this project, a Rasch partial credit model was applied in the analysis because it is designed for scales where ratings may differ across items, as the anchors in the SOC-13 items are formulated differently and may not function in a similar manner across all items (e.g. item #1 '*Do you have the feeling that you don't really care about what goes on around you?*' with response anchors: '*Seldom or never*' versus '*Very often*', and item #4 '*Until now your life has had:*' with response anchors: '*No clear goals or purpose at all*' versus '*Very clear goals and purpose*'). The analyses were conducted using a seven-step approach, which has also been used in previous studies (Lerdal et al. 2010; Lerdal and Kottorp 2011; Lerdal et al. 2011b). The steps are shown in Table 2. The WINSTEPS analysis software program, version 3.69.1.16 was used to analyze the data (Linacre 2009).

In the first step, the psychometric properties of the rating scales used in the SOC-13 were evaluated according to the following criteria: a) the average calibration for each step category on each item should advance monotonically, and b) outfit mean square *(MnSq)* values for each step category calibration should be less than 2.0 (Linacre 2004). In the second step, the fit of the item responses to the Rasch model assertions was analysed. The third step evaluated evidence of unidimensionality by conducting a principal component analysis. The fourth step evaluated aspects of person-response validity, and the fifth step estimated the ability of the SOC-13 to reliably separate the participants into distinct groups (i.e., person-separation reliability). The sixth step explored the internal consistency in the SOC-13, and the seventh step assessed uniform differential item functioning (DIF) within the SOC-13 items.

Item and person goodness-of-fit statistics were used to assess *internal-scale validity* (step 2) and *person-response*

Table 2 Overview of the analytic process using a Rasch model approach

Steps	Psychometric property	Measuring	Statistical approach
1	Rating scale functioning	Does the rating scale function consistently across items?	
2	Internal scale validity	How well do the actual item responses match the expected responses from the Rasch model?	Item goodness-of-fit statistics
3	Internal scale validity	Is the scale unidimensional?	Principal component analysis
4	Person-response validity	How well do the actual individual responses match the expected responses from the Rasch model?	Person goodness-of-fit statistics
5	Person-separation reliability	Can the scale distinguish at least two distinct levels of sense of coherence in the sample tested?	Person-separation index
6	Internal consistency	Are item responses consistent with each other?	Cronbach's alpha coefficient
7	Differential item functioning (DIF)	Are item difficulty calibrations stable in relation to demographic and clinical variables?	Mantel-Haenszel statistics

validity (step 4). These statistics were based on mean square *(MnSq)* residuals and standardized *z*-values for all items and persons and indicate the degree of match between actual responses on the SOC-13 items and the expected responses based on the Rasch model. Goodness-of-fit statistics can be evaluated using *infit* and/or *outfit* statistics. Because *infit* statistics are more informative when exploring the fit of items and persons (Bond and Fox 2007; Wright and Masters 1982), we chose to focus on *infit* statistics for this analysis. For assessing *item goodness-of-fit* in step 2, we used a sample-size adjusted Rasch analysis of the sense of coherence scale in a sample of people with morbid obesity – a cross-sectional study criterion of infit *MnSq* values between 0.7 and 1.3 logits (Smith et al. 2008). The criterion for evaluating *person goodness-of-fit* was to accept infit *MnSq* values ≤ 1.4 logit and/or an associated *z* value < 2 (Nilsson and Fisher 2006; Patomella et al. 2006). It is generally accepted that, by chance, 5% of the sample may fail to demonstrate acceptable goodness-of-fit without a serious threat to person-response validity (Kottorp et al. 2003; Patomella et al. 2006).

To assess unidimensionality in step 3, a *principal component analysis* (PCA) of residuals was performed to identify the presence of additional explanatory dimensions in the data (Linacre 2009). The two criteria were: 1) the first latent dimension should explain at least 50% of the total variance, and, 2) any additional dimension should explain < 5% of the remaining variance of residuals (Linacre 2011). In step 5, a *person-separation index* of 1.5 was required to ensure that the SOC scale could differentiate people with at least two different levels of SOC. For the purpose of comparison to more traditional reliability estimates, the Rasch-equivalent Cronbach's alpha statistic was also reported (Fisher 1992).

The SOC scale is based upon Antonovsky's theory, and he initially suggested that only the SOC total score should be used. Thus, we first evaluated the SOC-13 total scale according to the process described above. However, because findings based on the three sub-scales have also been reported (Madarasova et al. 2010; Veenstra et al. 2005), we then evaluated each of the SOC-13 sub-dimensions (Meaningfulness, Comprehensibility and Manageability) in the same manner. If the rating scale did not function according to the criterion set, we followed Linacre's recommendation to collapse scale steps (Linacre 2004). If any of the items did not demonstrate acceptable goodness-of-fit to the model according to the set criteria, one item at a time was removed and psychometric properties were re-analyzed with the remaining items. This procedure was then repeated until all items demonstrated acceptable goodness-of-fit. After each item removal, unidimensionality, person-response validity, and reliability of the SOC measures were re-evaluated as described above. The process above was first used to evaluate the SOC-13 total scale because it is typically used to generate a single total score, but the process was also repeated for each sub-dimension of the SOC-13 to generate additional understanding of the three component concepts.

Finally, DIF analyses were performed to evaluate the stability of SOC-13 response patterns across different socio-demographic groups (step 7). The magnitude of DIF was evaluated based on Mantel-Haenszel statistics for polytomous scales using log-odds estimators (Mantel 1963, Mantel & Haenzel 1959) as reported by the WINSTEPS program, ($p < .01$ with Bonferroni correction).

PASW Statistics Version 18.0.1 software was used to describe demographic data.

Results

Sample characteristics

Mean age of the 142 participants in the study sample was 42.5 years (SD = 10.4) and 100 (70.4%) were women. Seventy-three (51.4%) lived in a paired relationship (missing responses = 2). Among the participants, 123 (87.9%) had Norwegian ethnic background (missing = 2).

Rating scale functioning for each SOC-13 item (step 1)

When evaluating rating scale function, items #2, #3, #4, #7 and #11 did not meet the set criteria. The average step calibration measures did not advance monotonically in these items, although all items were associated with acceptable outfit *MnSq* values for all category step calibrations in these items. The other eight items demonstrated acceptable values. We therefore collapsed the category steps that were problematic in these items (category steps 1–2 in items #2, #3 and #7; category steps 1–3 in #11; and category steps 6–7 in items #2, #3 and #4) before proceeding to the other analyses.

Item fit (step 2), unidimensionality (step 3), person-response validity (step 4), reliability (step 5), and internal consistency (step 6) for the SOC-13 total scale

In the analysis of the SOC-13 total scale, all items but one (item #1) demonstrated acceptable goodness-of-fit to the Rasch model. The Rasch model explained 39.0% of the total variance in the dataset. The secondary dimension explained an additional 10.0% of the remaining variance, which was higher than expected (See Table 3). Therefore, evidence of unidimensionality was mixed for the SOC-13 total scale. The proportion of participants that did not demonstrate acceptable goodness-of-fit to the Rasch model was 7.0% in the SOC-13 total scale. None of the participants demonstrated maximum and minimum scores (ceiling and floor effects) across the SOC-13 scale, as shown in Table 3. The separation index was 2.05 with an associated Cronbach's alpha coefficient of 0.81.

Since item #1 did not meet the criteria for item fit, we excluded this item and re-analysed the remaining 12 items. The outcomes changed only marginally in the reduced version (See Table 3), so we concluded that the SOC-12 improved item fit and did not decrease the separation index of the tool. In Figure 1 we present the items of the SOC-12 along a linear continuum. The items in the Meaningfulness sub-dimension are at the lower end of the continuum, indicating that these items are easier to agree with in general and, therefore, more fundamental to increasing SOC, as compared to the other sub-dimensions.

Differential item functioning (DIF) of the SOC-12 (step 7)

We then analyzed the presence of DIF in relation to socio-demographic variables in the SOC-12. There was no significant DIF in any of the items in relation to age group or cohabitant status. Only item #8 (*'Do you have very mixed-up feelings and ideas?')* demonstrated DIF in relation to gender, with the women scoring higher than expected by the Rasch model. As only one item demonstrated uniform DIF across all iterations of the SOC-12, we concluded that the presence of DIF in the SOC-12 was minimal.

Relationships between SOC-12 total scores and Rasch-based measures

We also evaluated the bivariate relationship between the SOC-12 total scores and the Rasch-based SOC-12 measures generated from WINSTEPS. We decided to use the 12-item version of the SOC scale because it did not demonstrate any item misfit, which is considered a threat to validity. The correlation coefficient between the two measures was 0.98 ($p < .001$), supporting the concurrent validity between the total scores (sum of raw scores) and the Rasch-based SOC-12 measures. Next, we proceeded to evaluate each of the SOC sub-dimensions in the same manner to see if we could establish a higher level of sensitivity with an acceptable level of evidence of item and person-response validity.

Table 3 Evaluation of psychometric properties of the SOC total scale and its three sub-dimensions (N = 142)

Step		SOC Total scale		SOC Sub-dimensions		
		Original (13 items)	Reduced (12 items)	Meaningfulness (4 items)	Comprehensibility (5 items)	Manageability (4 items)
2	Item misfit	#1	None	None	None	None
3	Variance explained					
	1st dimension %	39.0%	39.1%	58.4%	43.4%	52.3%
	2nd dimension %	10.0%	10.5%	15.8%	18.3%	20.0%
4	Person misfit, n (%)	10 (7.0)	11 (7.7)	8 (5.6)	9 (6.3)	7 (4.9)
	Maximum score, n (%)	None	None	None	None	None
	Minimum score, n (%)	None	None	None	None	None
5	Person-separation index (without extremes)	2.05	2.01	1.71	1.30	1.46
6	Cronbach's alpha	0.81	0.80	0.74	0.63	0.74

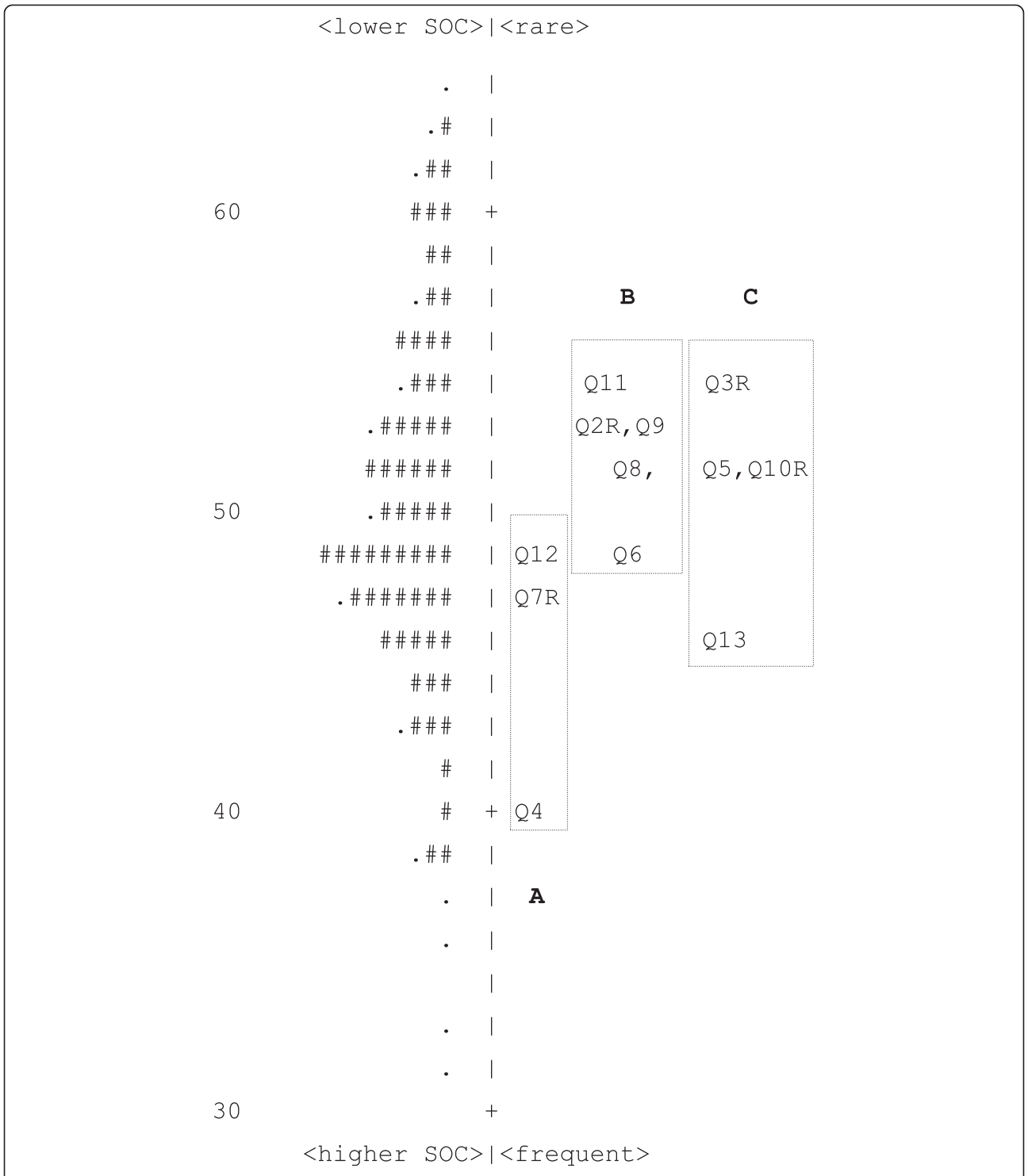

Figure 1 Item hierarchy for the SOC sub-dimensions: A) Meaningfulness (items: Q4, Q7R and Q12), B) Comprehensibility (items: Q6, Q8, Q2R, Q9 and Q11R), and C) Manageability (items: Q13, Q5, Q10R and Q3R). Note: Each "#" = 2 people, each "." = 1 person. R = items that are reverse-coded.

Item fit to the Rasch model and unidimensionality (steps 2 and 3) for the SOC sub-dimensions

All items demonstrated acceptable goodness-of-fit to the Rasch model in the SOC sub-dimensions. The PCA for the SOC sub-dimensions is presented in Table 3. The Rasch model explained between 43.4% and 58.4% of the total variance in each of the sub-dimensions, which was generally higher than the variance explained in the full

scale. These proportions met the criterion of at least 50% for Meaningfulness and Manageability, but not for the Comprehensibility sub-dimension. In addition, the secondary component, which was expected to be < 5%, explained an additional 15.8% to 20.0% of the variance, thereby suggesting some degree of multidimensionality in all three of the sub-dimensions. Therefore, as with the full SOC-13 scale, evidence of unidimensionality was mixed for the SOC sub-dimensions.

Person-response validity and reliability (steps 4 and 5) and internal consistency (step 6) for the SOC sub-dimensions

Of the 142 SOC-13 surveys, between 4.9% and 6.3% of the participants did not demonstrate acceptable goodness-of-fit to the Rasch model on the three SOC sub-dimensions. As the number of participants not demonstrating acceptable fit was small ($6 < n < 10$), we did not perform any statistical comparisons of the participants with and without misfit. None of the participants demonstrated maximum and minimum scores (ceiling and floor effects) across the SOC sub-dimensions (Table 3).

The person-separation index in the SOC sub-dimensions ranged from 1.30 to 1.71, where the sub-dimension Meaningfulness was the only subscale sensitive enough to detect the minimum of two distinct levels of SOC in the sample. The Rasch-equivalent Cronbach's alpha coefficients for the SOC sub-dimensions ranged from 0.63 to 0.74.

The results of the SOC sub-dimensions generated mixed evidence of validity and reliability. Because the separation index of the SOC sub-dimensions Comprehensibility and Manageability was lower than 1.5, these sub-dimensions were not able to distinguish any distinct levels of SOC in the sample and, therefore, were not functioning as reliable scales.

Discussion

This is the first study to assess the SOC-13 scale using Rasch analysis in a sample of persons with health problems, in this case persons with morbid obesity. The results of the unidimensionality analyses indicated that a 12-item version of the SOC with item #1 deleted improved item fit to the Rasch model and increased the explained variance of the first factor without reducing the separation index. Thus, an optimal measure of SOC among persons with morbid obesity would best be generated from a SOC-12 scale rather than from the original 13-item scale.

The sub-dimensions did not have any items with poor fit to the Rasch model, but demonstrated lack of unidimensionality in our sample. However, this may be related to the theoretical definitions of the sub-dimensions, which cover relatively abstract subjective phenomena that are difficult to operationalize and measure clearly. It is always a balance between theory and empirical findings when these perspectives do not fit: Do we find the source of the observed discrepancy in the empirical data or in the theory? We therefore suggest further studies with other samples using Rasch models to explore whether the findings in this study are generic findings or related to this specific sample.

Among the sub-dimensions, Meaningfulness showed the best psychometric properties with a large proportion of explained variance for the first factor, but still with an imprecision in the generated measures, indicated by the low separation index. Antonovsky described Meaningfulness as the most important SOC sub-dimension (Antonovsky 1987). We have not found any study that has examined the separation index of the different SOC sub-dimensions.

Similar to Hagquist and Andrich's study (2004), our study indicated that the responses on items #2, #4, #7 and #11 did not advance monotonically. In contrast to their study, item #3 also did not advance monotonically in the present study while responses on items #5, and #6 did advance monotonically in our study. A possible explanation for the differences between the studies may be related to differences in the characteristics of the study samples, i.e. healthy persons versus persons with morbid obesity. Furthermore, other studies have shown that responses on scales with as many as seven categories may not advance monotonically as assumed and intended (van Nes et al. 2009). Antonovsky recommended which 13 items from the SOC-29 should be included in a SOC short form (Antonovsky 1987), but the rationale for selecting these specific items is unclear. Perhaps other items from the original SOC-29 would be psychometrically more suitable for inclusion in an SOC short form?

Findings from our study indicate that the SOC-12 total scale was able to separate persons into three groups while none of the sub-dimensions were able to separate the persons into more than two groups. Except for the Comprehensibility sub-dimension, which had a medium low Cronbach's alpha value, the other sub-dimensions showed acceptable reliability consistent with other studies reporting Cronbach's alpha values ranging from 0.68 to 0.92 (Eriksson and Lindstrom 2005). All three sub-dimensions demonstrated a high level of imprecision in the generated measures, as indicated by the low separation index. Therefore we should be cautious when using the sum scores from the sub-dimensions as absolute measures of the individual since the imprecision of the analyses of the Comprehensibility and Manageability sub-dimensions do not adequately distinguish persons with different levels of these constructs. Using the SOC-12 total score may provide a higher degree of precision, at least for group-level comparisons. A method to improve precision in measurement may also be to add valid items to a short scale that are spread out along the

continuum. As the SOC-13 was derived from the longer SOC-29, and the items for each sub-dimension are not perfectly matched to cover the sample distribution (See Figure 1), there may be good options for adding items from the larger pool of items to improve the precision of the sub-dimension measures.

All three SOC sub-dimensions and the SOC-12 showed acceptable person-response validity with a relatively low proportion of persons whose responses failed to demonstrate acceptable goodness-of-fit values. This suggests that the measures generated were not biased or invalid in this sample, and could therefore be used as valid measures. The DIF on item #8 between male and female participants showed that relative to other items, females scored highly more easily, i.e. that they were less likely to '*…have mixed-up feelings and ideas*' than the men. Nonetheless, DIF on this single item was not considered a serious threat to validity.

The study has several limitations. A larger sample would have allowed us to conduct more in-depth analysis of subgroups, e.g. item DIFs in relation to relevant clinical factors such as body mass index. Furthermore, disease-specific information, such as BMI and comorbid conditions, was not collected from participants. These factors may be useful to evaluate in relation to SOC in future studies. In addition, this study did not include a comparison group of normal weight individuals, and therefore, it is not clear whether the findings are specific to those with morbid obesity or to the Norwegian version of the SOC. Finally, this study uses a Norwegian translation of the SOC, and although it was translated using a standard approach, it has not been previously described or validated. To our knowledge, this is the first study assessing the psychometric properties of the Norwegian version of the SOC.

Conclusion

This study showed that a 12-item version of the SOC scale has better psychometric properties than the original SOC-13 in a sample of persons with morbid obesity. The study revealed psychometric weaknesses with the SOC sub-dimensions, in particular Comprehensibility and Manageability, which indicate that further development of these sub-dimensions is needed. Using a Rasch analysis approach to evaluate scores from the SOC-29 in a large sample may be helpful in identifying additional items for the different sub-dimensions with better psychometric properties.

Abbreviations

DIF: Differential item functioning; PCA: Principal components analysis; SOC: Sense of coherence.

Competing interests

No conflicts of interest to declare.

Authors' contribution

AL participated in designing the study, interpreting the data and drafting the manuscript. MSF was the principal investigator, was responsible for designing the study and data collection, and also drafted and revised the manuscript. TB participated in the acquisition of data and analysed the data. CLG participated in analysing and interpreting the data and revised the manuscript, AK analysed and interpreted the data, and drafted the manuscript. All authors read and approved the final manuscript.

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References

Abiles, V, Rodriguez-Ruiz, S, Abiles, J, Mellado, C, Garcia, A, Perez De La, CA, et al. (2010). Psychological characteristics of morbidly obese candidates for bariatric surgery. *Obesity Surgery, 20*(2), 161–167.

Antonovsky, A. (1987). *Unravelling the mystery of health*. San Francisco: Jossey-Bass.

Bergman, E, Malm, D, Karlsson, JE, & Bertero, C. (2009). Longitudinal study of patients after myocardial infarction: sense of coherence, quality of life, and symptoms. *Heart & Lung, 38*(2), 129–140.

Bond, TG, & Fox, CM. (2001). *Applying the Rasch model: Fundamental Measurement in the Human Sciences*. Mahawah, New Jersey: Lawrence Erlabum Associates.

Bond, TG, & Fox, CM. (2007). *Applying the Rasch Model: Fundamental Measurement in the Human Sciences* (2nd ed.). Mahwah, New Jersey: Lawrence Erlbaum Associates, Inc.

Dixon, JB. (2010). The effect of obesity on health outcomes. *Molecular and Cellular Endocrinology, 316*(2), 104–108.

Eriksson, M, & Lindstrom, B. (2005). Validity of Antonovsky's sense of coherence scale: a systematic review. *Journal of Epidemiology & Community Health, 59*(6), 460–466.

Eriksson, M, & Lindstrom, B. (2006). Antonovsky's sense of coherence scale and the relation with health: a systematic review. *Journal of Epidemiology & Community Health, 60*(5), 376–381.

Fisher, W. (1992). Reliability statistics. *Rasch measurement transactions, 6*(3), 238.

Forsberg, KA, Bjorkman, T, Sandman, PO, & Sandlund, M. (2010). Influence of a lifestyle intervention among persons with a psychiatric disability: a cluster randomised controlled trail on symptoms, quality of life and sense of coherence. *Journal of Clinical Nursing, 19*(11–12), 1519–1528.

Guillemin, F, Bombardier, C, & Beaton, D. (1993). Cross-cultural adaptation of health-related quality of life measures: literature review and proposed guidelines. *Journal of Clinical Epidemiology, 46*(12), 1417–1432.

Hagquist, C, & Andrich, D. (2004). Is the Sense of Coherence-instrument applicable on adolescents? A latent trait analysis using Rasch-modelling. *Personality and Individual Differences, 36*, 955–968.

Hittner, JB. (2007). Factorial invariance of the 13-item Sense of Coherence scale across gender. *Journal of Health Psychoogy, 12*(2), 273–280.

James, WP. (1998). What are the health risks? The medical consequences of obesity and its health risks. *Experimental and Clinical Endocrinology & Diabetes, 106*(Suppl 2), 1–6.

Kottorp, A, Bernspang, B, & Fisher, AG. (2003). Validity of a performance assessment of activities of daily living for people with developmental disabilities. *Journal of Intellectual Disability Research, 47*(Pt 8), 597–605.

Langeland, E, Riise, T, Hanestad, BR, Nortvedt, MW, Kristoffersen, K, & Wahl, AK. (2006). The effect of salutogenic treatment principles on coping with mental

health problems A randomised controlled trial. *Patient Education and Counseling, 62*(2), 212–219.
Lerdal, A, & Kottorp, A. (2011). Psychometric properties of the fatigue severity scale – rasch analyses of individual responses in a Norwegian stroke cohort. *International Journal of Nursing Studies, 48*(10), 1258–1265.
Lerdal, A, Johansson, S, Kottorp, A, & von Koch, L. (2010). Psychometric properties of the fatigue severity scale: rasch analyses of responses in a Norwegian and a Swedish MS cohort. *Multiple Sclerosis, 16*(6), 733–741.
Lerdal, A, Andenæs, R, Bjørnsborg, E, Bonsaksen, T, Borge, L, Christiansen, B, et al. (2011a). Personal factors associated with health-related quality of life in persons with morbid obesity on treatment waiting lists in Norway. *Quality of Life Research, 20*(8), 1187–1196.
Lerdal, A, Kottorp, A, Gay, C, Aouizerat, BE, Portillo, C, & Lee, KA. (2011b). A 7-item version of the fatigue severity scale has better psychometric properties among HIV-infected adults: An application of a Rasch model. *Quaity of Life Research, 20*(9), 1447–1456.
Linacre, JM. (2004). Optimizing rating scale category effectiveness. In EV Smith & RM Smith (Eds.), *Introduction to Rasch Measurement: Theory, Models and Applications* (pp. 258–278). Maple Grove: JAM Press Publisher.
Linacre, JM. (2009). *Winsteps Rasch measurement computer program, Version 3.69.1.16*. Chicago. http://winsteps.com. Accessed 27 Oct 2010.
Linacre, JM. (2011). *A user's guide to Winstep. Ministep rasch-model computer programs: Program Manual 3.73.0*. http://ifile.hkedcity.net/1/001/950/public/Secondary/EI0020070012/winsteps.pdf. Accessed 27 Oct 2010.
Madarasova, GA, Tavel, P, van Dijk, JP, Abel, T, & Reijneveld, SA. (2010). Factors associated with educational aspirations among adolescents: cues to counteract socioeconomic differences? *BMC Public Health, 10*, 154.
Mantel, N. (1963). Chi-square tests with one degree of freedom: Extensions of the Mantel Haenszel procedure. *Journal of American Statistics Association, 58*, 690–700.
Mantel, N, & Haenzel, W. (1959). Statistical aspects of the analysis of data from retrospective studies of disease. *Journal of National Cancer International, 22*, 719–748.
Naaldenberg, J, Tobi, H, van den Esker, F, & Vaandrager, L. (2011). Psychometric properties of the OLQ-13 scale to measure Sense of Coherence in a community-dwelling older population. *Health and Quality of Life Outcomes, 9*, 37. doi:1477-7525-9-37.
National Task Force on the Prevention and Treatment of Obesity. (2000). Overweight, obesity, and health risk. *Arch Intern Med, 160*(7), 898–904.
Nilsson, I, & Fisher, AG. (2006). Evaluating leisure activities in the oldest old. *Scandinavian Journal of Occupational Therapy, 13*(1), 31–37.
Patomella, AH, Tham, K, & Kottorp, A. (2006). P-drive: assessment of driving performance after stroke. *Journal of Rehabilitation Medicine, 38*(5), 273–279.
Smith, AB, Rush, R, Fallowfield, LJ, Velikova, G, & Sharpe, M. (2008). Rasch fit statistics and sample size considerations for polytomous data. *BMC Medical Reseach Methodology, 8*, 33. doi:1471-2288-8-33.
van Nes, SI, Vanhoutte, EK, Faber, CG, Garssen, M, van Doorn, PA, & Merkies, IS. (2009). Improving fatigue assessment in immune-mediated neuropathies: the modified Rasch-built fatigue severity scale. *Journal of the Peripheral Nervous System, 14*(4), 268–278.
Veenstra, M, Moum, T, & Roysamb, E. (2005). Relationships between health domains and sense of coherence: a two-year cross-lagged study in patients with chronic illness. *Quality of Life Research, 14*(6), 1455–1465.
World Health Organization. (2001). *International Classification of Functioning, Disability and Health (ICF)*. Geneva: World Health Organzation.
World Health Organization. (2010). *Global Database on Body Mass Index*. Geneva: World Health Organization.
Wright, BD, & Masters, GN. (1982). *Rating Scale Analysis: Rasch Measurement*. Chicago: MESA Press.
Wright, BD, & Stone, MH. (1979). *Best Test Design*. Chicago: MESA Press.

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