



The dimensional structure of the MacNew Health Related Quality of Life questionnaire: A Mokken Scale Analysis



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ABSTRACT

Objective: The MacNew Health related Quality of Life Questionnaire is a widely used instrument for the assessment of health related quality of life in cardiac patients. The study addresses for the first time the dimensional structure of the MacNew with Mokken Scale Analysis (MSA).

Methods: Separate exploratory MSA of the MacNew was conducted in a large Spanish ($n = 1012$) and a medium sized Austrian sample ($n = 262$) of patients with Coronary Artery Disease (CAD) after Percutaneous Coronary Intervention (PCI). The results of both samples were summarized in a synthesis model. Confirmatory MSA and Confirmatory Factor Analysis (CFA) were used to evaluate the model.

Results: The synthesis model comprises 21 items forming a unidimensional sum scale of moderate strength. On the level of subdomains we define two strong unidimensional subscales (restriction: 6 items, and emotional: 10 items) and two smaller item sets (symptoms: 2 items and social: 3 items). 5 items were excluded due to low scalability in both samples.

Conclusion: Our results generally support the use of the MacNew Global score, with the limitation, that five items may be questionable with regard to scalability. On the level of unidimensional subscales MSA suggests to differentiate between a six-item restriction scale and a ten-item emotional scale. The study demonstrates that Mokken Scale Analysis complements the results of factor analysis and can contribute to a more comprehensive understanding of the dimensional structure of Health-related Quality of Life questionnaires.

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Introduction

The MacNew questionnaire is a widely used instrument for disease specific measurement of Health Related Quality of Life (HRQL) in cardiac patients. The questionnaire is originated in the Quality of Life after Myocardial Infarction (QLMI) interview, introduced by Oldridge et al. [1,2] in order to investigate the effects of cardiac rehabilitation after myocardial infarction in anxious and/or depressed patients. The QLMI instrument was generated by a clinimetric approach through interviews with physicians, nurses, health care professionals and patients with myocardial infarction leading to a set of 26 items covering five domains (symptoms, restrictions, confidence, self-esteem and emotional functioning).

Based on the QLMI Lim et al. [3] and Valenti et al. [4] developed the patient self-administered MacNew questionnaire. The MacNew contains 27 questions, 24 items of the QLMI and three newly added items,

rated by a seven point Likert scale. The MacNew measures HRQL in three domains (emotional, physical, and social). A global scale can be calculated by summing up all items [4]. The MacNew has been made available in over 80 countries and validated in over 16 languages [5] in patients with a variety of cardiac conditions ranging from myocardial infarction to angina, acute coronary syndrome, heart failure and in patients with a pacemaker and is recommended as a core heart disease quality of life instrument [6].

The three-dimensional factor structure of the MacNew, originally proposed by Valenti et al. [4] for the Australian English version on the basis of Principal Component Analysis (PCA) is characterized by some ambiguity. About half of the items (12/26 – one item was excluded from analysis) showed substantial cross-loadings and were therefore allocated to more than one subscale. The three-factor solution was generally accepted for different language versions of the MacNew even if the results of factor analysis differed sometimes partly, especially in smaller samples and in particular with regard to items of the physical and social subscales [6]. In order to analyse HRQL on the level of the subdomains a unidimensional factor structure would be highly preferable. However, given the nature of HRQL (being multidimensional and

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substantially interrelated) and the published results, the attempt to define such scales by allocating items according to item loadings in factor analysis seems problematic.

Our analysis aimed to readdress the factor structure of the German and Spanish MacNew questionnaire versions with a different approach by using Mokken Scale Analysis (MSA). MSA is based on the principles of Item Response Theory (IRT). It assumes that the probability of a given response is influenced by a latent trait (e.g. an individual's ability and item difficulty), and hence enables the evaluation of the scalability of single items with respect to this latent trait. Unlike parametric IRT techniques MSA does not require the assumption of a parametric form of item response functions [7,8]. MSA is particularly useful in order to investigate the dimensionality of scales. By employing a “bottom up” clustering search procedure using preselected cutoff points for item scalability, MSA allows, unlike other techniques, analysis of the dimensional structure of a scale on different hierarchical levels [9].

Our work comprises two parts. First, we conducted separate exploratory MSA of the MacNew in a large Spanish and a medium sized Austrian sample of patients with Coronary Artery Disease (CAD) undergoing Percutaneous Coronary Intervention (PCI). Second, we combined the results of both samples to a synthesis model, evaluated this model by confirmatory MSA and Confirmatory Factor Analysis (CFA) and compared it to existing models.

Methods

Participants

The study sample comprised 1082 Spanish and 310 Austrian patients from the PRODES Xience Stent registry treated with PCI in 40 Spanish and 7 Austrian centres. The PRODES registry was designed to investigate changes in Health related Quality of Life and Mental Distress after PCI by a prospective, multi-centre approach. Patients with acute ST-elevation myocardial infarction (STEMI) or stent deployment during the last 6 months were excluded from the registry. The data were collected between January 1st, 2008 and December 31st, 2011. All Patients answered the MacNew questionnaire during hospital stay after PCI and agreed to participate by signing an informed consent. The registry was conducted in accordance to the Helsinki Declaration and the guidelines of Good Clinical Practice after approval by the ethical committee of the City of Vienna (EK-07-202-VK). Part of the Austrian data was previously published in another context elsewhere [10].

Mokken Scale Analysis (MSA)

MSA assumes that the data fit three basic requirements constituting the Monotone Homogeneity Model (MHM): First, there are unidimensional latent traits capturing the association of item scores. Second, Item Response Curves are monotonically nondecreasing. Third, responses of one subject to the different items are stochastically independent [7]. If these assumptions are met item sum scores can be used to characterize and compare subjects with regard to a latent trait.

MSA uses the Loewinger homogeneity coefficient H_j to describe the strength of the relationship between an item and the latent trait with high values suggesting a good ability to discriminate between low and high scores of the trait. H_j values ≥ 0.3 indicate scalability of an item. The total scale coefficient H reflects the discrimination power of sets of items constituting a scale. As a rule of thumb $0.3 \leq H < 0.4$ defines a weak scale, $0.4 \leq H < 0.5$ a moderate scale and $H \geq 0.5$ a strong scale [7].

The scale search procedure in explanatory MSA follows a bottom-up approach. It starts off with the pair of items with the highest homogeneity coefficient H_j , and then stepwise adding items with maximizing the scale homogeneity coefficient H . The algorithm proceeds until no item exceeding a predefined cutoff value for H_j is left. Subsequently a new scale is formed following the same procedure. The process is finished when no items fulfilling the criterion of inclusion are left. To describe

the dimensional structure on different hierarchical levels we employed a step by step approach starting with the established cutoff value for H_j ($c = 0.3$) and subsequently increasing by steps of 0.05 up to $c = 0.6$ [8]. Confirmatory MSA was conducted by calculating homogeneity coefficients of preselected item sets.

Violations of monotonicity were assessed via CRIT statistic with values < 40 considered to be acceptable [11]. MSA was performed with R 3.0.3 and the R package Mokken [12,13].

The lower bound of scale reliability was estimated with Cronbach's α . Following recommendations with regard to Likert-type data we additionally calculated ordinal alpha, which is based on polychoric correlations instead of Pearson correlations and provides a more accurate estimate of reliability for our data [14].

Confirmatory Factor Analysis (CFA)

CFA was executed in R 3.0.3 with the R package lavaan [15] and the graphical Structural Equation Modelling software Ω nyx [16]. Model fit was estimated by Comparative Fit Index (CFI), Tucker–Lewis Index (TLI) and root mean square error of approximation (RMSEA). CFI and TLI values > 0.90 indicate good fit, RMSEA < 0.08 suggest moderate, RMSEA < 0.06 good fit [17]. Because Mardia testing indicated non-normal multivariate distribution we calculated robust indices with Satorra–Bentler correction [18]. Measurement errors of items within subscales were allowed to intercorrelate by referring to modification indices when appropriate.

Results

Study sample

The initial study samples comprised 1082 Spanish and 310 Austrian patients answering the MacNew questionnaire during hospital stay after PCI. The percentage of missing values of items 1 to 26 was between 0.9% and 2.6%. Item 27 (sexual intercourse) was skipped or answered with the “not applicable” response by 36% of participants. Because the MSA procedure requires complete datasets, we excluded all questionnaires with missing values for items 1–26. Item 27 was omitted from analysis. The final samples consisted of 1012 Spanish and 262 Austrian patients. Patient characteristics are summarized in Table 1.

Exploratory Mokken Scale Analysis

The results of the separate MSA for the Spanish and the Austrian sample are shown in Table 2. In general homogeneity coefficients were higher in the Austrian sample. With the cutoff value for H_j $c = 0.3$ in both samples a sumscale of moderate strength (Spain: $H = 0.41$, Austria: $H = 0.44$) was found. Item 3 of the Spanish sample and item 22 of the Austrian sample were unscalable ($H_j < 0.3$).

Table 1
Patient characteristics.

	Spain (n = 1012)	Austria (n = 262)
Age \pm SD	62.7 \pm 10.4	62.9 \pm 9.4
Male [%]	68.1	71.4
Smoking [%]	40.5	33.9
Hypercholesterolemia [%] ^a	71.9	87.5
Hypertonia [%] ^a	52.1	70.2
IDDM [%] ^a	9.1	7.9
Obesity (BMI \geq 30) [%]	31.6	26.7
CCS classification [%]		
CCS 0/I	20.8	15.1
CCS II	33.4	52.3
CCS III	32.2	23.4
CCS IV	13.6	9.2
Single vessel intervention [%]	84.0	81.0
AHA classification [%]		
AHA A	7.1	9.7
AHA B	70.8	62.6
AHA C	22.1	27.7

IDDM: Insulin Dependent Diabetes Mellitus; CCS: Canadian Cardiovascular Society classification of angina pectoris; AHA American Heart Association classification of cardiac stenosis.

^a Treated.

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