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Exhaustion, depression and hopelessness in cardiac patients: a unidimensional hierarchy of symptoms revealed by Mokken scaling

Frank Doyle, Aleksandra Kowalczyk, Hannah McGee, Ronán M Conroy

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Abstract

Objectives: Depression and vital exhaustion are associated with poor cardiovascular prognosis, but there is substantial overlap between these constructs. Factor analytic studies have been inconclusive, and may not be the optimal analytic strategy to assess dimensionality. We assessed whether exhaustion and depression formed a single, hierarchical dimension using a form of non-parametric item response theory.

Methods: Patients with acute coronary syndrome (n = 430) completed questionnaires assessing depression and vital exhaustion. Mokken scaling was used to assess dimensionality.

Results: Mokken scaling formed a strong unidimensional scale, ordered in a hierarchy reflecting prevalence: fatigue (common), depression (less common) and hopelessness (rare).

Conclusions: Depressive symptoms form a clear hierarchy in cardiac patients, from fatigue to hopelessness. Vital exhaustion may be considered a less severe form of depression. Use of hierarchical scales may allow clinicians to better determine clinical significance and target interventions.

Key words: Depression; Mokken scaling; Coronary artery disease; Item response theory; Fatigue.

Introduction

Depression is reported by approximately 20% of persons with coronary artery disease (CAD), and has also been consistently associated with a two-fold risk of recurrent cardiac events or mortality in such patients.[1,2] However, some researchers have stated that symptoms of fatigue, but not necessarily depression, may be more pertinent for poorer prognosis.[3] 'Vital exhaustion' is characterised by feelings of excess fatigue, energy loss, irritability and demoralisation, which also predict poor cardiovascular risk.[3,4] Importantly, the authors state that those exhibiting such symptoms often do not report classical depressive symptoms, such as depressed mood or negative cognitions, and argue that such symptoms should therefore be considered separately to depression.

Yet, several of the symptoms of vital exhaustion are similar to depression, reflecting poor content validity.[5] For example, although not a diagnostic criterion, hopelessness is regarded as one of the most severe symptoms of depression.[6,7] However, hopelessness is included on both vital exhaustion and depression measures.[5] Indeed, factor analytic studies which have attempted to determine the dimensionality of depression and vital exhaustion have been inconclusive, finding either one or multiple factors.[8-10] However, this may simply reflect that the scales used assessed differing symptoms,[5] or the fact that factor analysis is not appropriate for binary or highly skewed items,[11,12] and such items are typically seen in vital exhaustion and depression interviews or questionnaires.

Thus, it is time to reconsider the relationship among these symptoms in the cardiac population, using alternative latent variable analytic techniques. Item response theory states that you can order items along levels of a latent trait, and that you can predict the answers to some items from answers to other items.[11,12] For example, someone who reports feeling hopeless will also probably endorse a 'less difficult' item indicating depressed mood. We used a Mokken scaling in a sample of cardiac patients to determine the dimensionality, and hierarchy, of symptoms of depression and vital exhaustion. We expected a single dimension, with symptoms ranging from severe (ie. more difficult, eg. hopelessness) to more moderate (ie. less difficult, eg. fatigue).

Method

Participants and procedure

We used questionnaire items from a previously described study.[13] The sample consisted of 430 persons with myocardial infarction or unstable angina. Participants completed measures during hospitalisation for their acute event. Ethical approval was provided from all relevant committees.

Measures

We used the six items from the Beck Depression Inventory – Fast Screen (BDI-FS) to assess depressive symptoms.[14] The recommended threshold > 3 results in a sensitivity > .90 and specificity of > .85 for identification of major depression.[15] One item, which assessed suicidality, was omitted due to concerns over impact on response rates.[13,16] The BDI-FS items focus on cognitive symptoms of depression, and are scored on a four-point answer option.

Vital exhaustion was assessed using the 10-item version of the Maastricht Questionnaire (MQ-10).[17,18] These items are scored as binary (yes/no).

Statistics

Mokken scaling is an iterative scale-building technique, and as it is non-parametric is especially suitable for skewed and binary items.[12] It is based on Guttman scales, which are

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Table 1: Mokken scale analysis of mood items (threshold H = 0.4)

Derived scale	% endorsed item	Observed Guttman errors	Expected Guttman errors	Loevinger's H-coefficient
MQ: Do you believe that you have come to a "dead end"?	10%	201	474.6	0.58
MQ: Do you feel you want to give up trying?	11%	225	511.8	0.56
BDI-FS: Sadness	21%	461	973.1	0.53
BDI-FS: Self-dislike	22%	669	1264.3	0.47
BDI-FS: Past failure	25%	673	1272.5	0.47
MQ: Do you have the feeling these days that you just do not have what it takes anymore?	28%	493	932.0	0.47
BDI-FS: Pessimism	28%	628	1205.7	0.48
BDI-FS: Loss of pleasure	33%	674	1226.5	0.45
MQ: Do you sometimes cry or feel like crying?	38%	525	994.5	0.47
MQ: Do you feel weak all over or without energy?	41%	492	994.7	0.51
MQ: Do you feel listless?	48%	474	968.4	0.51
MQ: Do you have the feeling that you haven't been accomplishing much lately?	48%	530	966.6	0.45
MQ: Do you ever wake up with a feeling of exhaustion and fatigue?	52%	469	914.1	0.49
MQ: Do you sometimes have the feeling that your body is like a battery that is losing its power?	67%	257	696.1	0.63
MQ: Do you often feel tired?	75%	187	531.0	0.65
Overall scale		**3479**	**6962.8**	**0.50**

MQ – Maastricht Questionnaire for vital exhaustion; BDI-FS – Beck Depression Inventory Fast Screen

unidimensional, ordinal scales of binary items along a continuum. A positive answer to one item of a certain 'difficulty' indicates that all other items of lesser difficulty have also been answered positively. For example, a positive response to one particular (rare) item indicates that other (more common) items have also been endorsed. Mokken scaling can also use polytomous items, and is a probabilistic version of Guttman scaling. Loevinger's H-coefficient is used for interpretation. By convention, $0.3 \geq H < 0.4$, $0.4 \geq H < 0.5$ and $H \geq 0.5$ indicate weak, moderate and strong scales respectively. Higher H values indicate higher item discrimination power, and thus more confidence in ordering of respondents. The H-value equals [1 – (observed Guttman errors/predicted Guttman errors)]. Expected Guttman errors are the probability that the items are chosen by chance, while observed Guttman errors are the number of times items are endorsed as if not in an ordered sequence. Therefore, a coefficient of $\leq .4$ demonstrates a scale with items with a 60% rate of Guttman errors. Following a recommended procedure, which involves increasing the coefficient value until the most interpretable solution is found, items that demonstrate poor discriminability are excluded from the scale.[12] Results can be compared to factor analysis.[12] In general, factor loadings larger than .5 result in H-coefficients greater than .3. Reported scales are ordered in terms of difficulty, ie. the most infrequently endorsed items feature at the top. As BDI items were highly skewed they were treated as binary for the purposes of item ordering. Mokken scale analysis was conducted using a procedure written for Stata SE 9.2,[19] by Jean-Benoit Hardouin.[20]

Results

Sample profile

The baseline profile of the larger sample has been described in detail elsewhere.[13] The mean age was 61.3 years (SD = 10.7), with 80% (343/430) being male.

Scale consistency and correlations

Internal consistencies, indicated by Cronbach's a, of both scales was high (depression = 0.81, vital exhaustion = 0.84). The scales correlated at r = 0.42, suggesting only 18% shared variance.

Mokken scaling results

Table 1 shows the results of Mokken scaling of the depressive items at the moderate (0.4) threshold.

The overall scale H score of 0.5 indicates a 'strong' scale, showing that all items in this scale tapped a hierarchical, unidimensional variable of depressive symptoms. The scale indicates that items have a clear hierarchy: fatigue items are more common, followed by depression items, while hopelessness items are the most 'difficult' items. For example, 75% of participants endorsed the 'tired' item, but only 10% of participants stated that they had come to a 'dead end'. Those who have endorsed hopelessness, the most severe symptom, have very likely endorsed symptoms of depression and symptoms of fatigue also. However, those who have endorsed depression had also endorsed the fatigue items, but not necessarily the hopelessness items – as these were more 'difficult'.

It should be noted that one item was dropped from the analysis – a BDI-FS item assessing 'self-criticalness'. However, at a lower level of scaling (H set at 0.3), this item also scaled with the other depression scales – in the middle of the scale (data not shown), with 34% endorsing this symptom. At higher levels of scaling, the scale splits into specific symptom scales, but these also do not support the notion of two separate exhaustion and depression dimensions.[13]

Discussion

This study is the first to use Mokken scaling to investigate the link between vital exhaustion and depression in cardiac

patients. Mokken scaling has a number of advantages over the typically adopted factor analytic techniques: it is suitable for binary or highly skewed polytomous items, it can be used in relatively small samples (n = 300-400), and it systematically orders items.[12] The results clearly showed that symptoms formed a single, unidimensional scale. This is unique in that for the first time evidence has also been provided of a clear hierarchy of symptoms in cardiac patients: symptoms of fatigue were common, depressive symptoms were less so, and hopelessness was the rarest symptom assessed here.

The results question the differentiation between vital exhaustion and depression, and support results showing a one-factor solution during latent variable analysis.[9] There are several potential reasons previous work differentiated between exhaustion and depression. For example, the inappropriate use of factor analytic techniques with skewed/binary items, a misinterpretation of Cronbach's a to indicate unidimensionality, the use of simple correlations to decide whether constructs are 'moderately' related, or a choice of scales which have no overlapping symptoms.[5,10,17,21] In the present study, internal consistencies were very good for the original depression and vital exhaustion scales, which then correlated at a level which indicated only 18% shared variance. Such correlational results, however, can simply be indicative of different levels of severity of a single trait – as borne out by the subsequent Mokken results presented herein.

One of the reasons that vital exhaustion was considered different to depression was that those exhibiting such symptoms often do not report classical depressive symptoms.[3] Indeed, according to the present results it is quite possible to report fatigue but not depression. However, it is improbable that those who report depression or hopelessness would not also report fatigue. Therefore, it may be that vital exhaustion be better termed as a pre-depressive state, or a less severe form of depression. Vital exhaustion pre-hospitalisation has been shown to predict subsequent in-hospital and post-discharge depression in cardiac patients, sometimes even better than pre-hospital depression does.[9,22] According to the present results, however, it is questionable whether symptoms of hopelessness would indeed be present without depressive symptoms, but with fatigue. Importantly, previous research has suggested that symptoms of hopelessness are more important than either fatigue or depression for predicting cardiovascular prognosis.[23] If this is indeed the case, then it is possible that vital exhaustion predicted cardiovascular prognosis mainly due to the inclusion of hopelessness. Further work is needed to clarify the presence or absence of such symptoms when symptoms of fatigue are reported.

Using item response theory to form hierarchical scales has practical benefits for research into depression and cardiovascular prognosis. Utilising a hierarchical scale can help identify the 'tipping point' for when such symptoms become cardiotoxic. For example, it is possible that depressive symptoms only increase cardiovascular risk once they go beyond symptoms of fatigue to symptoms more indicative of depressed mood or anhedonia, or perhaps when moving beyond depression to hopelessness.[13,23] Such a tipping point would also give interventions to improve prognosis a definite target, rather than a reduction in an overall scale score by a set number of points. While interventions have been demonstrated to reduce symptoms of depression in cardiac patients,[21,24] it is unclear which symptoms were reduced as total scale scores of non-hierarchical scales have heretofore been adopted as outcome measures.

The present study results are limited by the use of brief questionnaires rather than interviews. Future research should concentrate on more comprehensive depression scales which better cover the symptoms of major depression, as well as diagnostic interviews. The inclusion of somatic items, for example, should be a priority, given their association with cardiovascular prognosis,[25] We also omitted an item assessing suicidality, and it is possible that such symptoms would be found at the top of the hierarchy of depressed symptoms found herein.

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