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The internal consistency and construct validity of the Partners in Health scale: validation of a patient rated chronic condition self-management measure

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Topics: Construct validity, Confirmatory factor analysis and Cronbach's alpha

The psychometric properties of The Partners in Health (PIH) Scale: validation of a patient rated chronic condition self-management measure

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Abstract

Purpose

The paper describes a process for testing the construct validity and internal reliability of the Partners in Health (PIH) scale.

Design

Factor analysis and a structural equation model were used to analyze baseline self-rated scores for the Partners in Health (PIH) Scale data collected during a national chronic disease self-management demonstration programme.

Methods

Baseline PIH data were collected for 294 patients with a range of co-morbid chronic conditions including diabetes, cardiovascular disease and arthritis. Scale data were analyzed for internal consistency and construct validity using Reliability Analysis and Factor Analysis. Construct validity was established using confirmatory factor analysis and a structural equation model.

Results

Results show a Cronbach alpha value of .82 and highlight four key factors (knowledge, coping, management of condition and adherence to treatment) across the twelve domains of the scale. These four key factors were then confirmed by applying the exploratory structural equation model to a hold-back sample of 118 patients.

Conclusion

The PIH scale has been shown to exhibit construct validity and internal reliability. It therefore provides a relevant measure of health related outcomes for patients involved in chronic illness management and self-management programmes currently being implemented across Australia and around the world.

Key words: self-management, patient self report, construct validity, internal reliability

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Introduction

The Partners in Health (PIH) scale was developed in response to the finding that coordinated care for people with chronic conditions was provided by service coordinators more on the basis of whether a person was a good self-manager than on the basis of severity or complexity of their illness [1]. This led to the question of whether a person's self-management knowledge and skill could be assessed objectively so that self-management support and coordination could be targeted more appropriately to individual need. A literature review found no such existing tool or process that could be applied generically across a range of conditions by primary health care professionals with their patients. The Coordinated Care Training Unit (later the Flinders Human Behaviour and Health Research Unit) then undertook a research process including a literature review along with focus groups for patients, service coordinators and general practitioners to determine the attributes of self-management which could be assessed. This led to the adoption of the definition of self-management provided by the Centre for Health Advancement in Health [2, p1] that self-management…

> '…involves engaging in activities that protect and promote health, monitoring and managing of symptoms and signs of illness, managing the impacts of illness on functioning, emotions and interpersonal relationships and adhering to treatment regimes.'

This operational definition provided a context for the identification of 5 principles of chronic condition self-management which, if adopted by an individual with chronic conditions, could support optimal self-management. These 5 principles then formed the basis for self-rated questions within the original version of the Partners in Health scale, which consisted of 11 items for rating self-management knowledge and behaviour on a 0-8 likert scale [3]. This 11 item scale was piloted with 24 patients, 13 general practitioners and 8 service coordinators to test its acceptability and utility.

Initial evaluation showed that the scale was seen as acceptable and useful by all three groups. Psychometric analysis demonstrated high internal consistency with a Cronbach Alpha coefficient of 0.88, and high correlations between patient rated and service coordinator rated PIH scores [3].

The clinical process with patient administered PIH, clinician administered C&R and Problem and Goal assessment (a core element of the SA HealthPlus care planning process) [1, 4] underpin the patient-centred care planning process. This care plan structure combines evidence based medical services, community services and self-management education and was further developed for the national Sharing Health Care demonstration projects in Australia [5]. Subsequently, this process became known as the Flinders model of self-management support. During the development phase of the model, feedback from clinicians identified a lack of specific questions about the impact of the condition(s) on the person's physical activities, emotions and social life. Therefore, the 5 principles of chronic condition of self-management became 6.

1. improved knowledge of their condition
2. follow a structured treatment plan agreed with the health provider
3. actively share in decision making about their health care
4. monitor and manage signs and symptoms of the condition
5. manage the impact of their condition on the physical, emotional and social aspects of life
6. adopt behaviour that promotes healthy lifestyles [3]

To minimize the number of items in the scale, items 4 and 5 dealing with arranging and attending appointments were collapsed into one item; item 5. Item 10 asked about 'the effect of the health condition(s) on physical activities such as walking and household tasks' and item 11 'the effect of the health condition(s) on how patients felt and how they mixed with other people (ie emotions and social life)'. This 12 item version of the scale was then used in the Sharing Health Care demonstration projects in most Australian States and Territories [6].

Methods

The Sharing Health Care SA (SHC SA) initiative in Whyalla, Port Augusta and Port Lincoln [7] South Australia, was based on the initial work of the Eyre Peninsula coordinated care trials [4, 8-10] and a chronic illness management pilot programme conducted in rural Aboriginal communities in Port Lincoln and Ceduna [11].

This demonstration project developed self-management interventions including the use of formal care plans to structure systems of care, education programmes based on the Stanford University patient self-management approach [12] and other patient support and empowerment processes such as regular exercise, Tai Chi, and self-help groups. The Flinders care planning process [13] was used to complete 'patient-centred' care plans based on patient lifestyle goals and targets for the management of their illness.

Table 1: overview of sample demographics

Baseline data for the PIH scale were collected from a number of sites in the demonstration project. Scores for one group (n=176) of participants were used in the exploratory phase of the analysis whilst a second group (a hold-back group of n=118) were used in the confirmatory phase of the analysis.

Internal consistency

Internal consistency is measured with Cronbach's Alpha coefficient. This coefficient measures how well the set of variables measure a single uni-dimensional construct and

is therefore a measure of reliability. If the data is multi-dimensional, this coefficient will be low.

Analysis of the exploratory sample (n=176) shows the coefficient to be quite high at 0.82. The removal of item 3 increases the coefficient value slightly but this increase is negligible and the size of the coefficient is quite satisfactory for the current analysis. Norman and Streiner [14] warn that a coefficient that is too high may well be an indicator of high item redundancy and they give a general guideline that the coefficient should be more than 0.7 and not much higher than 0.9. The results indicate that the PIH scale displays satisfactory internal reliability or consistency.

Construct Validity

Item 4 is the only item in the scale that explicitly deals with decision sharing whilst Items 3 and 5 deal with following a treatment plan. Items 1 and 2 deal with knowledge but it can be argued that items 4 and 8 fall into this category as well. Certainly items 10, 11 and 12 are associated with the management of the condition with respect to physical, emotional and social aspects. Items 6, 7 and 9 measure the management of symptoms.

Exploratory Factor analysis is used to decide how many factors are necessary to explain the structure and more importantly how many factors will lead to a solution that can be interpreted readily. There are several key criteria for this process. Firstly, the number of factors is chosen so that a pre-specified amount of variance is explained. This usually results in too many factors being retained. **Table 2** shows that 10 factors would be needed to explain 95% of the variation, however, the number of factors that have eigenvalues (the amount of variance represented by the factor) greater than unity are retained. Hair [15] argues that this method, known as the Kaiser Criterion, retains

too few if there are less than 20 items and too many if there are more than 50 items in a scale. **Table 2** also shows that four factors should be retained under this criterion.

Table 2: Total Variance Explained

Cattell's Scree plot criterion [16] is a graphical method for displaying eigenvalues arranged in descending order and joined by a line. The point where the line levels off is the cut-off choice for the optimal number of eigenvalues. **Figure 1** shows that the cut-off is three factors as defined by the 'elbow'. This method has been shown to be better than the Kaiser criterion but is sometimes criticised because of its subjectivity [17]. Further, the recent availability of increased computing power has seen the emergence of more advanced analysis techniques, including Horn's Parallel Analysis [18] which has been shown to be the best technique for the optimal choice of the number of retained factors. Computationally this is a Monte-Carlo technique [19] generating random samples with the same sample size and number of items and computing "expected" eigenvalues. There is consensus in the literature that this is the optimal method for determining the number of factors to emerge within a structured questionnaire [17, 20, 21].

Figure 1 – Scree Plot

Table 3 shows that a four factor solution should be retained

The initial Factor Analysis was carried out using Principal Component extraction with Varimax rotation [15]. Varimax, results in independent and therefore uncorrelated factors being identified. This is probably a little unrealistic as the factors are likely to

be correlated in reality. However, the aim at this stage is to look for basic structure. Hair [15] gives a guideline for practical significance where absolute loadings of more than 0.5 are practically significant. For statistical significance, Norman and Streiner [14] suggest a formula for significant loadings. In this analysis, loadings of 0.41 or greater can be said to be statistically significant at the 5% level. The table below shows, for clarity, only the significant loadings.

Table 4: Rotated component solution with Varimax rotation

The Kaiser-Meyer-Olkin (KMO) measure is greater than 0.8 and indicates that 80% of the variance is likely to be explained by the factors (anything less than 0.5 is deemed to be unsatisfactory) [15]. The measure lies between 0 and 1, where a value of 1 indicates that "each variable is perfectly predicted by the other variables" [15]. The test of sphericity is a test for significant correlations amongst the variables for at least some of the variables and thus indicates that a significant latent structure is present. In this context, the term "latent" refers to sets of variables that are not directly measured but are a combination of the observed or manifest variables.

Table 5: Sphericity and Sampling Adequacy

The four factors can be interpreted in the following way…

- Factor 1 has significant loadings on items 1, 2, 4 & 8 and therefore can be interpreted as a component of **knowledge**
- Factor 2 has significant loadings on items 10, 11& 12 are interpreted as a component of **coping**
- Factor 3 has significant loadings on items 6, 7 & 9 and is a component of **recognition and management of symptoms**

- Factor 4 has significant loadings on items 3 & 5 is a component of **adherence to treatment**

These four actors are readily interpretable and follow the general principles of self-management set down by Battersby at al [1, 3, 4]. A structural equation model [15] is set up and tested for fit. In this model the latent factors are allowed to be correlated which is a more realistic approach.

Normally Maximum Likelihood would be used as the method of estimation. This is an iterative process that successively improves the parameter estimates with the purpose of minimising a specified function [15] is normally used in this analysis. However, the assumption for Maximum Likelihood is that the data is multivariate normally distributed. This is unlikely to be the case here as several indicator variables are severely skewed. As a result, Asymptotic Distribution Free (ADF) estimation is used [15].

Fig 2a: Structural Equation Model

The Chi-Square value is 61.94 with 48 degrees of freedom and a probability value of 0.085. This is not significant at the 5% level; a desirable outcome because it shows that the model is not rejected. The ratio of $\chi^2 / df = 1.29$ is very acceptable since this ratio should be less than 2 [15]. The Normed Fit Index (NFI) is 0.91 and the Confirmatory Fit Index (CFI) of 0.94. Good fit is indicated by both of these indices being greater than 0.9 [15].

The Root Mean Square Error of Approximation (RMSEA) is 0.04 (0.000 - 0.068). This is a positive outcome as the RMSEA should be less than 0.05. The significance probability score of 0.69 indicates that the hypothesis of the RMSEA of 0.05 cannot be

rejected. All parameters are very significant ($p < 0.001$) with a high correlation between the latent factors of symptom management and knowledge.

An inspection of the modification indices showed no significant cross-loading of any indicator or manifest variable other than to its own latent variable. This is a good confirmation of divergent validity and shows that the Partners in Health Questionnaire has good internal and construct reliability and that it conforms to the six principles outlined earlier. The PIH questionnaire, therefore, reliably measures aspects of patient progress within a chronic condition self-management programme.

Confirmatory Analysis

The data set of 118 separate subjects from the same chronic condition self-management demonstration programme [7] was used as the validation sample and the saved structural equation model was applied to this new data (**Fig 2b**).

The Chi-Square value is 59.90 with 48 degrees of freedom with a probability value of 0.12. This result is less significant than for the original data set and, while desirable, may be due to the smaller sample size. The ratio of $\chi^2 / df = 1.25$ (< 2) is very similar to that obtained for the exploratory phase. The Normed Fit Index (NFI) is 0.92 and the Confirmatory Fit Index (CFI) of 0.95. Good fit is again indicated by both of these indices.

The Root Mean Square Error of Approximation (RMSEA) is 0.036 (0.000-0.071). This is further confirmation of the structure fit. The significance probability score of 0.66 makes this result very acceptable. All parameters are significant ($p < 0.001$) with the highest correlation, as for the original data set, between the symptom management factor and the knowledge factor, although the magnitude of this correlation is a little

less for the confirmatory data set. The covariance between knowledge and adherence to treatment is significant only at the 5% level.

An inspection of the modification indices again showed no significant cross-loading of any indicator variable other than to its own latent variable. This is further confirmation of divergent validity and shows that the Partners in Health Questionnaire has good internal and construct reliability and that it conforms to the six chronic condition self-management principles outlined earlier. The PIH questionnaire, therefore, reliably measures aspects of patient progress within a chronic condition self-management programme.

Limitations of the Study

A post-hoc power analysis of the initial model showed the power to be 85%. This calculation uses the work of MacCallum et al [22] and is based on the effect size of the RMSEA for a close fit. Post-hoc analysis is, in many respects, unnecessary in this case since significant results have been shown to exist for this data set. However it must be acknowledged that the goal of Structural Equation Modelling is to accept the model, not to reject it. While this model may be accepted in this study, acceptance must not be due to an inadequate sample size. It is often the case that a small sample size leads to the desirable outcome of a non-significant Chi-Square statistic. A larger sample invariably leads to a significant result but a significant Chi-Square does not necessarily mean a bad fit, but rather it is often the consequence of a large sample size. In this case, the Chi-Square result bordered on significance but the other fit indices were very good.

What has been demonstrated therefore is that for this data set there is good evidence that there is a readily interpretable structure that has both statistical and practical significance for application in the monitoring of progress in chronic disease management. There is strong evidence of good dimension reduction and the four domains are readily interpretable.

Conclusion

The PIH scale with confirmed construct validity and internal reliability is a comprehensive measure of self-management of chronic conditions for patients involved in the wide range of chronic illness management and self-management programmes now being implemented across Australia. Through its application in the Sharing Health Care SA programme and subsequent analysis, the PIH Scale has been shown to produce reliable and consistent indications of patient chronic condition self-management knowledge and skill.

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Appendix 1

The PIH 12 item scale overview

- Item 1: Knowledge of illness
- Item 2: Knowledge of treatment of illness
- Item 3: Taking medication as prescribed
- Item 4: Sharing in decisions
- Item 5: Arranging and attending appointments
- Item 6: Understanding of need to check and record symptoms
- Item 7: Checking and writing down symptoms
- Item 8: Knowledge of what to do when symptoms get worse
- Item 9: Doing the right things when symptoms get worse
- Item 10: Dealing with effects of illness on physical activities
- Item 11: Dealing with effects of illness on social life
- Item 12: Progressing toward leading a healthy life

* NB the full scale is available for reviewers if required

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Appendices

Table 1

Sample demographics

n = 176 (exploratory data set)

Gender	frequency	percent	Valid percent
Male	67	38.1	38.3
Female	108	61.4	61.7
Total	**175**	**99.4**	**99.4**

n = 118 (confirmatory data set)

Gender	frequency	percent	Valid percent
Male	42	35.6	35.6
Female	76	64.4	64.4
Total	**118**	**100**	**100**

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Table 2

Total Variance Explained

	Initial Eigenvalues		
Component	**Total**	**% of Variance**	**Cumulative %**
1	4.16	34.67	34.67
2	1.48	12.36	47.03
3	1.34	11.17	58.19
4	1.03	8.60	66.79
5	.76	6.37	73.16
6	.64	5.35	78.50
7	.53	4.40	82.90
8	.60	4.24	87.14
9	.50	4.17	91.31
10	.41	3.42	94.73
11	.36	2.98	97.71
12	.28	2.30	100.00

Extraction Method: Principal Component Analysis.

Table 3

Results of Horn's Parallel Analysis for maximum likelihood factors. 1000 iterations, using the mean estimate

Component/ Factor	Adjusted Eigenvalue	Unadjusted Eigenvalue	Estimated Bias
1	1.618	2.695	1.077
2	.158	1.070	1.005
3	.519	1.544	1.025
4	.458	1.065	.607

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Table 4

Factor Analysis after Rotation (sorted by size), Rotated Component Matrix

	Component			
	1	2	3	4
Knowledge of treatment of illness	.862			
Knowledge of illness	.782			
Sharing in decision	.701			
Knowledge of what to do when symptoms get worse	.688			
Dealing with effects of illness on physical activities		.825		
Progress towards leading a healthy life		.788		
Dealing with effects of illness on social life		.652		
Check and write down symptoms			.813	
Doing the right things when symptoms get worse			.646	
Understanding of need to check and record symptoms			.601	
Taking medication as prescribed				.815
Arrange and attend appointments				.737

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

a. Rotation converged in 5 iterations

Table 5

Sampling adequacy and Sphericity: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.81
Bartlett's Test of Sphericity	Approx. Chi-Square	644.43
	df	66
	significance level	.00

Figure 1 Scree Plot

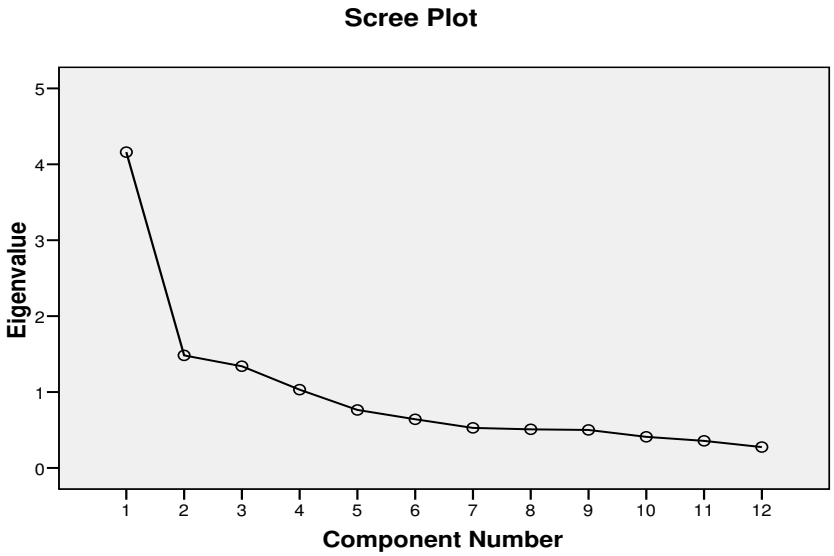

Fig 2a

Structural Equation Model (n = 176)

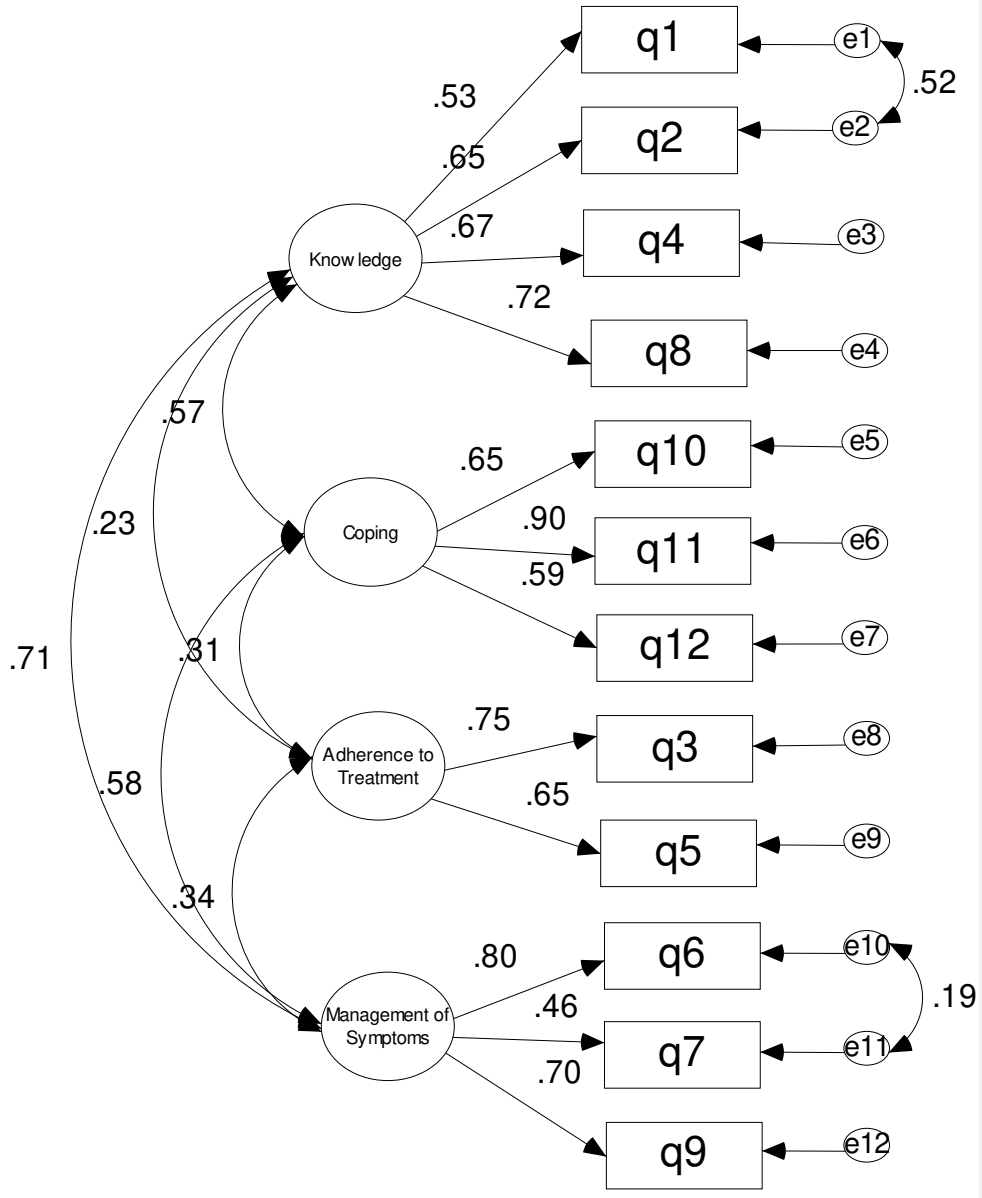

Fig 2b

Structural Equation Model (n = 118)