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Degree/Unit: Master of Science, School of Physical and Occupational Therapy

Thesis title: How appropriate is the patient assessment of chronic illness care (PACIC) as a measure of patient experience am

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DATE : Jan 25, 2021

SIGNATURE : Sylvie Lambert

(Dr. Sylvie Lambert)

Student's Name: Maitri Manoj MODI
Supervisor(s) Name: Ahmed Sara
Degree: Master of Science
Thesis Title: How appropriate is the patient assessment of chronic illness care (PACIC) as a measure of patient experience among individuals with chronic pain? A Rasch based analysis

Thank you for the opportunity to review this thesis. The aim is to evaluate the psychometric properties of the PACIC among individuals with chronic pain, using Rasch analysis. To my knowledge this is one of the first Rasch analyses of the PACIC, and overall represent a significant contribution to the literature. The PACIC is a well-known measure of patient-centered care. It also represents an achievement to have completed this level of psychometric analysis at the Master's level.

I have made comments directly in the PDF document sent to me and the main ones are summarized below.

The background is quite thorough and includes all the important literature on this topic, and provides a solid argument for the need to analyze this particular scale and for the methods chosen. Some typos noted in the PDF and errors in in-text formatting of references.

My main comment for the methods is to still include some of the key information about participant recruitment, even if it is described elsewhere. It makes it easier for the reader to understand the study without having to find the primary paper. Also, in my experience, some journals still ask you to include some information. Some typos in the PDF noted in this section as well.

The results were overall clear. Some typos to be reviewed. All the main Rasch analyses were clearly described. I did wonder why the subscales were not analyzed separately. More often, it is the subscale scores that are used in practice and research? This might explain why multidimensionality was found initially. Another very recent development in Rasch analysis is to use "super items" or testlets. You could try to combine subscale items into a super item and see fit of those items. Creating testlets absorbs some of the misfit and often leads to less modifications, which is important when a scale is already in use.

For the discussion, please review some comments regarding formatting references. Although some good points are raised in the discussion, some lacked proper referencing (see comments directly in the thesis).

How appropriate is the Patient Assessment of Chronic Illness Care (PACIC) as a measure of patient experience among individuals with chronic pain? A Rasch based analysis

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A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirement of the degree of **M.Sc. in Rehabilitation Science**.

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List of Abbreviations

PACIC: Patient Assessment of Chronic Illness Care

PCC: Patient Centered Care

PSI: Person Separation Index

PCA: Principal Component Analysis

DIF: Differential Item Functioning

CTT: Classical Test Theory

CCM: Chronic Care Model

IRT: Item Response Theory

RMT: Rasch Measurement Theory

LBP: Low Back Pain

CFA: Confirmatory Factor Analysis

Abstract

Background: Measuring patient-centred care is an essential element of health services performance assessment and quality improvement. The Patient Assessment of Chronic Illness Care (PACIC) questionnaire is one of the most widely used measures to evaluate patient-centred care in clinical practice and research. However, the PACIC was not validated in the chronic pain population, and there have been conflicting findings regarding its psychometric properties for other chronic conditions. We aimed to evaluate the psychometric properties of the PACIC among individuals with chronic pain. This study's objective was to assess the extent to which the PACIC items measure a single construct and fit an underlying theoretical hierarchy that forms a linear continuum with interval-like properties in patients with chronic pain.

Methods: Available cross-sectional PACIC data were used from an adult study sample with low back pain (LBP; N=270) to assess unidimensionality, local independence, item fit, person fit, item hierarchy, scale targeting and precision, person reliability.

Results: The initial analysis demonstrated the PACIC data did not fit the Rasch model. Accordingly, modifications were made, including rescoring items and removing items and persons with poor fit. The final model contained 12 items that had a satisfactory fit to the Rasch model. Support for unidimensionality was demonstrated through principal component analysis and confidence intervals.

Conclusion: The present study has shown that the 12 items PACIC version, as applied to the chronic pain population, satisfies Rasch model expectations and the unidimensionality assumptions, having accommodated local dependency issues. Further testing of these 12 items is needed to generate further evidence for the content validity of the 12 item PACIC in a LBP population.

Abrégé

Contexte: La mesure des soins centrés sur le patient dans les services de santé est un élément essentiel de l'évaluation du rendement et de l'amélioration des services lors de l'établissement de rapports sur la qualité des soins et de la définition de la politique de santé. Le questionnaire d'évaluation des soins aux patients atteints de maladies chroniques (PACIC) est l'une des meilleures mesures pour évaluer les soins axés sur le patient dans la pratique clinique et la recherche. Cependant, le PACIC n'a pas été validé dans la population de la douleur chronique, et il y a eu des résultats contradictoires concernant ses propriétés psychométriques pour d'autres conditions chroniques. Nous visions à évaluer les propriétés psychométriques de la PACIC chez les personnes souffrant de douleur chronique. L'objectif de cette étude était d'évaluer dans quelle mesure les items du PACIC mesurent un seul construit et correspondent à une hiérarchie théorique sous-jacente qui forme un continuum linéaire avec des propriétés de type intervalle chez les patients souffrant de douleur chronique.

Méthodes: Les données transversales disponibles de la PACIC ont été utilisées à partir d'échantillons d'adultes souffrant de lombalgie (N = 270) pour évaluer l'unidimensionnalité, l'indépendance locale, l'ajustement de l'item, l'ajustement de la personne, la hiérarchie des items, le ciblage et la précision de l'échelle (fiabilité et séparation des personnes).

Résultats: L'analyse initiale a démontré que les données ne correspondaient pas au modèle de Rasch. En conséquence, des modifications ont été apportées, notamment la réévaluation des éléments et le retrait des éléments et des personnes mal ajustées. Le modèle final contenait 12 éléments qui avaient un ajustement satisfaisant au modèle Rasch. La prise en charge de l'unidimensionnalité a été démontrée par l'analyse en composantes principales et les intervalles de confiance.

Conclusion: La présente étude a montré que la version PACIC à 12 items, telle qu'appliquée à la population de douleur chronique, satisfait les attentes du modèle de Rasch et les hypothèses d'unidimensionnalité, ayant pris en compte les problèmes de dépendance locale. Ces 12 éléments doivent faire l'objet d'une validation de contenu pour renforcer davantage les résultats de cette étude.

Dedication

I dedicate this thesis to my family, to whom I owe everything. To my mother, Hemali Modi, there are no words to describe your strength to let both your daughters pursue their dreams together. I know it had been very tough for you, but you put us first and let us catch our dreams. To my father, Manoj Modi, you have been our rock support in these two years, and without you and all your help (the efforts you have taken to get our loans sanctioned), we could not have possibly gone abroad for our studies. I will be eternally thankful for your unconditional love and support. To my dear sister, Yatri Modi, I do not know who is the elder one anymore because in these two years, you have been way more mature than me and always kept me grounded. You have been there for me in this entire journey, especially when my mental health got affected. I feel blessed to have this strong family by my side when I stepped out of my comfort zone. I love you all more than anything.

Acknowledgments

My MSc thesis could not have been completed without the help and support from several people. Firstly, I would like to convey my deepest gratitude to my supervisor Dr. Sara Ahmed for always believing in me. You have been very kind and understanding throughout these 2.5 years, and I never felt I was away from my home in India because of your constant guidance and support. Thank you for the financial support extended to me for tuition and conference, for allowing me to attend the Rasch course in the UK, and for letting me travel to Manipal, as well as letting me a chance to visit home in December. I would like to deeply thank you for having the confidence and trust in me when I found myself lacking it. You have been a great mentor, Sara, and I hope to work under your mentorship in the future.

I would also like to express my heartfelt gratitude to my committee members Dr. André Bussières and Dr. Kedar Mate, for committing both time and energy to proof-read my thesis. Their editorial and professional input improved the quality of my thesis. Dr. Kedar Mate's and Dr. Mike Horton's help with Rasch analysis helped me refine my analysis and obtain commendable results.

Furthermore, I would like to acknowledge my lab colleagues, Mushirah, Rehab, and Nicole for being supportive and kind throughout this journey. You guys are the best lab mates I could have ever asked for.

Thank you, Roni Molad, for your endless support, zoom study sessions, advice, and just for being there throughout these 2.5 years. I am blessed to find you as one of my best friends in Montreal. Thank you, to my dear Indian friends in Montreal, Hayati, Aayushi, Sourja, Karan, Anishi, Yashasvi, Harshita, Niketa, Anushka, Ankit, Rishi, Yash, you guys helped me survive Montreal, gave me emotional and mental support when needed and I genuinely thank you guys for all the support extended to me. All those library sessions will always be remembered and cherished.

Lastly, to my friends and cousins in India for always being a call away.

Finally, I would like to express my profound gratitude for the financial support extended to me in terms of awards, fellowships, and bursaries from the School of Physical and Occupational Therapy (SPOT).

Contribution of Authors

This thesis is presented in a manuscript format, which has been formatted for publication in a peer-reviewed journal. I, Maitri Manoj Modi, am the main contributor and lead author of all chapters and the manuscript included in this thesis with substantial guidance from my thesis supervisor and committee members. My contribution extends to the research design for the analysis, experimental setup, data analyses, statistical analyses, interpretation of findings, preparation of figures/tables, submission for publication/ conferences, and writing this thesis. The research project and manuscript presented here were developed under Dr. Sara Ahmed's supervision. The project presented in this thesis was a secondary analysis of data collected from a previous study for which Dr. Sara Ahmed was one of the principal investigators. Dr. Ahmed oriented the selection of the research design, experimental setup, data analysis, statistical analysis, interpretation of findings, and critically reviewed and provided constructive feedback on this thesis. Dr. Mate contributed to the statistical analyses, interpretation of results, and critically reviewed the entire thesis. Dr. Bussières provided constructive inputs on the background, methods, and critically reviewed this thesis.

Thesis Organization and Overview

The organization of this manuscript-based thesis adheres to the guidelines for thesis preparation published by McGill Graduate and Postdoctoral Studies.

CHAPTER 1: A general introduction to chronic pain, including the burden of chronic pain on individuals and society, evidence-based management approaches, and gaps in chronic pain health services.

CHAPTER 2: In this chapter, patient-centered care is introduced, and its importance for measuring it in chronic pain management is discussed. The relationship between the chronic care model and patient-centered care is also described. Finally, comparisons between the PACIC and other existing measures of patient-centered care were made.

CHAPTER 3: This chapter summarizes the rationale for further testing of the PACIC measure using Rasch analysis and outlines two main objectives that were tested in the manuscript.

CHAPTER 4: This chapter presents the manuscript on the psychometric properties of the PACIC in chronic low back pain. This section also presents the conclusion of the thesis, including the implications of the results and future directions for evaluating PCC for chronic conditions.

REFERENCES: list of references

APPENDICES: list of appendices

This thesis complies with McGill's policy of intellectual property and all ethical standards.

Chapter 1 Introduction

1.1 Burden of Chronic Pain

Chronic pain is recognized as a major public health problem (Dueñas, Ojeda, Salazar, Mico, & Failde, 2016) and contributes significantly to human and economic costs for families, communities, and society (Anderson et al, 2019). The International Association for the Study of Pain (IASP) has characterized chronic pain as ‘pain which has persisted beyond normal tissue healing time,’ which, ‘in the absence of other criteria, is taken to be 3 months’(Croft, Blyth, & van der Windt, 2010). Recent estimates indicate that chronic pain affects one in five Canadians (Anderson et al.). Two-thirds of Canadians living with chronic pain report their pain is moderate (52%) to severe (14%), and 50% have lived with chronic pain for over ten years (Anderson et al.). The costs for treatment and lost productivity due to chronic pain are estimated to be at least $10 billion per annum (Gogovor et al., 2017; Reitsma, Tranmer, Buchanan, & Vandenkerkhof, 2011). These costs are also extremely high in other nations, estimated at $635 billion and more than €200 billion per annum in the United States and Europe, respectively (Lalonde et al., 2015).

Chronic pain is recognized as a bio-psycho-social phenomenon in which physical, social and psychological factors contribute to the disease and dynamically interact. A 2011 publication by the Institute Of Medicine (IOM) entitled, Relieving Pain in America: A Blueprint for Transforming Prevention, Care, Education, and Research emphasized a new recognition of chronic pain as being complex and multidimensional. The implications of being multidimensional are that chronic pain should be considered from biological, psychological, and sociological perspectives that may explain (1) the wide range of individual variations in susceptibility to pain, (2) cultural and emotional interpretations of pain, and (3) responses to treatment (Worley, 2016). Chronic pain is associated with poor quality of life and impacts individuals' ability to participate in society, and contributes to high direct and indirect healthcare system costs (Weaver et al., 1997).

1.2 Current Chronic Pain Management

Current clinical practice guidelines for patients with non-specific low back pain in primary care recommend providing non-pharmacological treatment, including exercise, education, advice, and self-management support as first-line therapy (Almeida, Saragiotto, Richards, & Maher, 2018; Chou et al., 2017; Oliveira et al., 2018; Qaseem, Wilt, McLean, & Forciea, 2017). Psychological and/or pharmacological treatment as well as some forms of complementary and alternative medicine, can also be included in the treatment plan, depending on patient preferences and the nature of their symptoms. Psychological treatment includes cognitive-behavioral therapy. The World Health Organization ladder for pharmacological management includes the use of nonsteroidal anti-inflammatory agents (NSAIDs) and a limited course of opioids in selected patients'(Busse et al., 2017).

The National Pain Strategy (NPS) and the IOM reports suggest using evidence-based strategies to manage chronic pain that address the biopsychosocial nature of this problem, such as interdisciplinary pain management protocols (Skelly et al., 2018). These have been among the most successful approaches to help individuals reduce symptoms and regain functioning (Skelly et al., 2018). An interdisciplinary approach primarily emphasizes pain management (rather than cure) and improvement of function (rather than pain relief) (Debar et al., 2012). Such treatment protocols combine a variety of therapeutic modalities and rely on teams of physicians, behavioral specialists, psychologists, nurse case managers, and physical therapists to help patients develop the skills to actively self-manage their condition (Debar et al., 2012). The team gives multiple and collaborative treatments to establish and achieve a common treatment goal (Clark, 2000). Health professionals work together to comprehensively evaluate the impact of chronic pain on individuals' health and well-being, make collective therapeutic decisions, and facilitate communication between clinicians and patients (Stanos & Houle, 2006).

In addition to the interdisciplinary approach and each clinician's roles, patients have a key role to play in their own care. To effectively address the multidimensional effects of chronic pain, patients need self-management training about behaviors, strategies, and activities that may help control the negative effects of pain on their quality of life (Ogbeide & Turner, 2018). The goal of self-management training is to encourage the collaboration between patients and clinicians to ensure that patients learn the knowledge and skills required to deal with their condition (Lorig, 2002).

1.3 Gaps in chronic pain management

Several clinical practice guidelines are available to inform the management of individuals with chronic pain (Oliveira et al., 2018; Castellini et al., 2020). However, recent studies suggest that chronic pain often remains undertreated despite published guidelines, and management practices do not always conform to recommended practice guidelines (Lalonde et al., 2015). Currently, treatments for chronic pain management included in Canadian public health insurance plans are largely restricted to prescription opioid analgesics and surgical intervention (Jonesa, 2015). This response is not in line with the several practice guidelines that recommend using psychological, behavioral, or less invasive physical interventions, either on their own or in conjunction with conventional pharmacological treatment (Jonesa, 2015). Due to the combination of the physician's fear of overprescribing opioids and a lack of other publically-insured treatment options, the under-treatment of chronic pain is a consistently identified healthcare problem.

In Canada, chronic pain management services are fragmented across the private and public health systems (Lalonde et al., 2015). Many treatment approaches, which are labeled as interdisciplinary, still lead to fragmented pain care. They frequently involve patients being seen sequentially by different healthcare specialists, with variable coordination between these various treatment elements (Lalonde et al., 2015). There are limited services available across health systems at the primary care level for effective management of individuals with chronic pain, including self-management support, psychological services, and care by other allied health professionals (e.g., physiotherapy and occupational therapy). High demand for primary care interdisciplinary services exceeds available resources in many jurisdictions (Boulanger, Clark, Squire, Cui, & Horbay, 2007; santé, Dobkin, & Boothroyd, 2006).

At the provider level, primary care clinicians lack adequate education and training to appropriately diagnose, treat, and manage individuals with chronic pain to provide optimal pain care (Al-Mahrezi, 2017). Additionally, there is a lack of team-work, time, and false concerns about addiction and overdosing (Al-Mahrezi, 2017). At the patient level, beliefs and attitudes play an important role in chronic pain management. Patients' preferences to use more complementary and alternative medicine are often overlooked by health professionals (Jonesa, 2015; Lacasse, Choinière, & Connelly, 2017). Finally, patient satisfaction with care is poor because of a lack of access and coordinated referral processes to key services (Hurwitz, Morgenstern, & Yu, 2005).

In the next section, we describe how using a patient-centered approach can help address these gaps in chronic pain management (Doktorchik et al., 2018).

Chapter 2: Patient-Centered Care

2.1 Chronic Care Model from the American College of Physicians (Gee, Greenwood, & Miller, 2015)

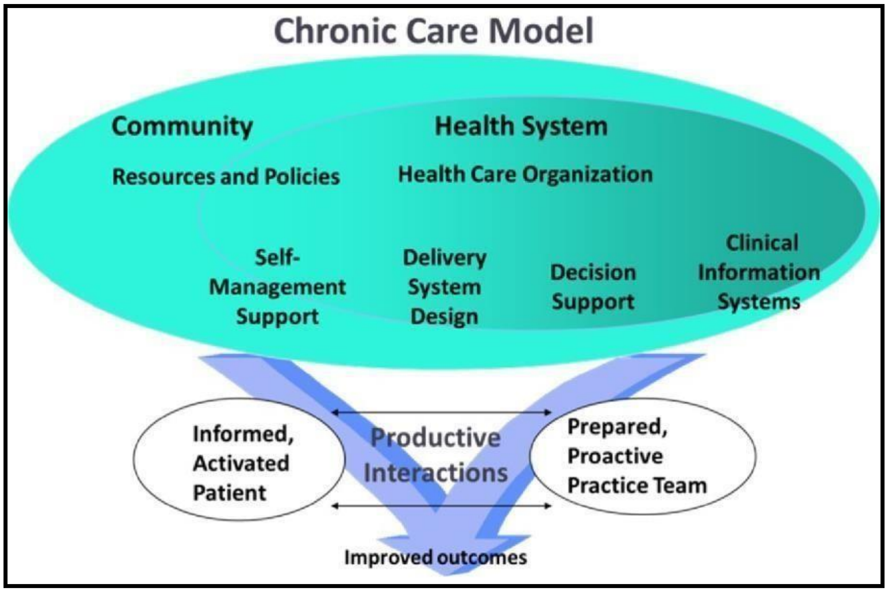

FIGURE 1: CHRONIC CARE MODEL DEVELOPED BY THE MACCOLL INSTITUTE, ©ACP-JSIM JOURNALS, AND BOOKS

The chronic care model (CCM) is an evidence-based framework for enhancing care delivery by identifying essential components of the health care system that can be modified to support high-quality, patient-centered, chronic disease management (Coleman, Austin, Brach, & Wagner, 2009). The CCM aims to transform daily care for individuals with chronic illnesses from acute and reactive to proactive, planned, and population-based (Coleman et al., 2009). It defines six domains that require attention to optimizing outcomes:

1. Delivery system design: This relates to the systems for delivery of care, such as team-based approaches to patient care and patient-centered approaches that attend to the needs of the patient both during a clinical visit and follow-up care;

2. Self-management support: It is focused on providing knowledge, effective strategies, and support for patients to successfully manage their disease;
3. Clinical information systems: These are the systems that leverage information technology to provide timely reminders to patients and providers, as well as searchable information on chronic disease populations;
4. Decision support: It is used to embed evidence-based guidelines into clinical practice and share the information with patients to encourage their participation.
5. Community: In this, patients are encouraged to participate in effective community programs, and providers partner with the community to fill care gaps.
6. Health systems: These focus on promoting effective improvement strategies, such as better reimbursement models and leadership that stresses the importance of optimal care (Stuckey, Adelman, & Gabbay, 2011).

2.2 Patient-Centered Care: An important element in chronic pain management

At the base of the CCM is patient-centered care depicted as an informed, activated, and empowered patient working with a proactive, prepared team. The gaps in chronic disease management could be addressed by modifying the community and health systems' elements leading to improved patient-centered care.

The breadth of evidence has demonstrated that improved patient-centered care results in improved patient outcomes and experiences in individuals with chronic pain (Doktorchik et al., 2018) (Gerteis, Edgman-Levitan, Daley, & Delbanco, 1997). Patient-centered care (PCC) provides a guiding framework to define the elements required to deliver effective chronic pain management. The IOM defines these elements as providing “care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions" (Gerteis et al., 1997).

It is worth noting that there are numerous proposed definitions of PCC which "encompass many of the same core principles, but no globally accepted definition" (Lusk & Fater, 2013). Based on the work of Gerteis et al. (1993), PCC was operationalized by seven dimensions: i) respect for patients' values, preferences, and expressed needs; ii) coordination and integration of care; iii) information, communication, and education; iv) physical comfort (relief of pain and suffering); v) emotional support and alleviation of fear and anxiety; vi) involvement of family and friends, and vii) transition and continuity. These dimensions were renamed the Picker Principles of PCC, with an added eighth dimension, access to care (Valderas, 2013).

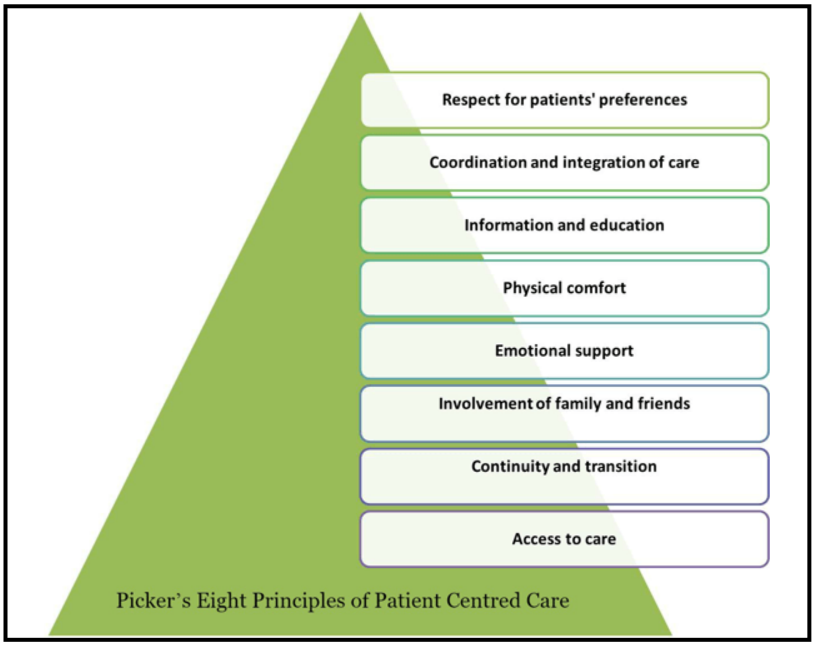

FIGURE 2: PICKER'S EIGHT PRINCIPLES OF PATIENT-CENTERED CARE FROM THE PICKER INSTITUTE AND THE COMMONWEALTH FUND.

Incorporating the eight dimensions of PCC can help address the gaps in chronic pain management. Clinicians need comprehensive education and training on clinical management guidelines, combined with elements to promote PCC. Training should target clinicians' diagnostic, communication, and self-management support skills training for patients. Consequently the risks related to opioid prescriptions (overdose or addiction) are reduced. With effective PCC, fragmented pain care would become coordinated and integrated because of better communication among clinicians. A PCC approach would also help in achieving the best results with coordinated and timely referral processes. Therefore, care must be uniquely tailored to each patient, without preconceived notions about the best approach for the patient (Melin and Arestedt, 2019). Tailored care can also help advance health services for individuals with chronic pain by identifying and addressing the gaps in and obstacles to chronic care management.

2.3 The Need to Measure Patient-Centered Care

Chronic pain is complex, costly, and worrisome for patients, families, and clinicians (Langford et al., 2018). Improvements in chronic pain management have been limited despite various management guidelines (Langford et al., 2018). This lack of progress is partly due to the multidimensionality of chronic pain, which is not routinely incorporated in the clinical evaluation and management of individuals with chronic pain (Langford et al., 2018). A patient-centered approach focuses on patient-specific goals and patient-reported outcomes, is needed to achieve the main goals of chronic pain management and includes reduction of pain impact and improvement of quality of life and function (Mills, Torrance, & Smith, 2016; Langford et al., 2018).

Involving patients as active partners in their treatment can provide clinicians with a better understanding of patients' experiences, perspectives, and motivations which are key factors in designing and implementing effective interdisciplinary management (Lalonde et al., 2015; De

Silva, 2013). To facilitate individually tailored, comprehensive chronic pain care, it is essential to use patient-reported outcome measures to assess patient-centered care. These will help inform quality improvement efforts and identify and prioritize healthcare areas where improvements are needed.

Patients are well-positioned to provide reliable and valid information about the delivery of patient-centered care. For instance, only patients can accurately determine whether care was respectful to their values, preferences, and needs. Using patient-reported outcome measures regularly to accurately assess the quality of patient-centered care could assist with promptly identifying areas of care where improvements are required and consequently may facilitate advancements in delivering patient-centered care (Tzelepis, Sanson-Fisher, Zucca, & Fradgley, 2015).

2.4 Strengths and limitations of measures of patient-centered care

The IOM has identified patient-centeredness as one of the six core domains of high-quality healthcare (Tzelepis et al., 2015). Increasing recognition of the value of PCC needs a comprehensive measure that accurately assesses, from the patient's perspective, all dimensions of PCC in chronic pain management (C. J. Gibbons et al., 2017b). Many patient-reported outcome tools are designed to assess a wide range of PCC domains, which makes choosing the most appropriate tool to assess PCC difficult. The measurement of PCC requires validated instruments that have demonstrated adequate measurement properties in populations with chronic pain. Measurement properties refer to the instrument's ability to accurately and comprehensively measure the specified construct (e.g., internal consistency, reliability, validity) (Eyles et al., 2020). However, various factors affect the choice of the most appropriate assessment tools, which should be considered: psychometric properties, whether the measure is generic or disease-specific, profile or preference based, and feasibility of administration such as the number of items in the instrument.

Several measures exist to assess PCC, such as Patient Participation in Rehabilitation Questionnaire (PPRQ), CollaboRATE, Consultation Care Measure (CCM), and Patient Perception of Patient-Centeredness (PPPC) (Hudon, Fortin, Haggerty, Lambert, & Poitras, 2011) (summarized in Appendix 2). The number of available measures makes choosing the most appropriate tool to assess PCC difficult. Most of the measures are not practical in a clinical setting because they are designed in such a way that they either assess either too many or too few PPC domains. Other limitations include lack of psychometric validation of the measure, having a complex scoring system, burdensome to administer the tool in clinical settings, and floor or ceiling effects (Lindberg, Kreuter, Person, & Taft, 2013; Vrijhoef, Berbee, Wagner, & Steuten, 2009).

One such measure is the PACIC (Patient Assessment of Chronic Illness Care)an outcome measure that was previously developed by a clinically based research team to assess PCC as guided by the principles of the Chronic Care Model (Glasgow et al., 2005). It has been used for individuals with chronic conditions including chronic pain. In a systematic review by Hubertus etal. (2009), the PACIC was identified as the most appropriate generic instrument to measure the experience and/or satisfaction of people receiving integrated chronic care (Vrijhoef et al., 2009). The review showed that the measure has relatively better psychometric properties than most otherinstruments and was one of the preferred instruments for individuals with chronic conditions

(Vrijhoef et al., 2009). The tool has been shown to have good face validity with clinical stakeholders and is sensitive to change (Noel, Jones, & Parchman, 2016). It has moderate correlations with other patient-centered care, patient activation, and primary care measures (Glasgow et al., 2005). The tool is widely used with over 80 research publications and is translated to at least 11 languages. (Glasgow et al., 2005).

The PACIC tool is based on the premise that PCC is a multidimensional concept which consists of five subscales (or dimensions): patient activation, delivery system/practice design, goal setting/tailoring, problem-solving/contextual, and follow-up/coordination (Glasgow et al., 2005). However, recent findings suggest that the scale measures a global uni-dimensional construct- patient experience (Pendrill, 2018) indicating that the five domains are part of a continuum under a broad construct of the patient experience. From a statistical point of view, the scale's structural validity demonstrated through the use of confirmatory factor analysis and exploratory factor analysis has shown conflicting results (Schwenke et al., 2019). Previous studies did not confirm the predefined five factor model of the PACIC as proposed by Glasgow et al. (Fan et al., 2014; Gugiu, Coryn, & Applegate, 2010; Taggart et al., 2011). Other studies have shown one, two, four, or five-factor structure using factor analysis (Fan et al., 2014; Gugiu et al., 2010; Hudon et al., 2011; Noel et al., 2016; Rick et al., 2012).

Other similar studies that used PACIC have suggested conceptual and interpretive cautions and limitations to its scoring methods. Although the overall summary scores appear to be useful, the subscales are often highly intercorrelated, making interpreting sub-scale scores difficult (Glasgow, Whitesides, Nelson, & King, 2005). This in turn could mean that PCC could be examined as a high-order construct.

Together, these findings warrant further testing of the measure for its psychometric properties.

Researchers have increasingly expressed the need for modern measurement approaches for scale development (Melin, Fornazar, Spångfors, & Pendrill, 2020; Vaughan, 2018; Woudstra et al., 2019). The two modern psychometric approaches are Item Response Theory (IRT) and Rasch Measurement Theory (RMT) (Melin et al., 2020). To further investigate the dimensionality and constructs of PCC measured by the PACIC, we will use the Rasch Measurement Theory (RMT). One important feature of RMT is the coupling of item attribute to person characteristic for a certain response (Pendrill, 2018). Rasch analysis is a probability modeling technique that converts ordinal scores to an interval scoring structure (Boone, 2016). With RMT, separate estimates of person and item attribute values and their scaling are allowed on the same interval scale (Melin et al., 2020). This helps with a more accurate measurement; more reliable decision making when compared to measurements based on CTT (Melin et al., 2020).

Chapter 3: Rationale and Objectives

The present study addresses the need to accurately assess PCC among individuals with chronic pain. Measuring patient PCC will inform areas to improve in order to deliver optimal care for each person with chronic pain. In turn, this will likely result in improved function and health-related quality of life outcomes. However, there is a need to further validate the use of the PACIC measure as a patient-centered tool and to explore new ways to refine the use of this measure to optimize chronic pain health services (Paul-Savoie, Bourgault, Gosselin, Potvin, & Lafrenaye, 2015; Gibbons et al., 2017a). Validation of content and item properties of the PACIC is limited (C. Gugiu et al., 2010); to date, there has been only one study that has tested the psychometric properties of the tool using Rasch analysis in people with chronic pain (Gibbons et al., 2017a; (Lambert et al., 2021)). Modern psychometric approaches represent a logical progression from Classical Test Theory because they provide an opportunity to examine the level of PCC being measured and improve the existing scales with fewer and more relevant questions (Petrillo, Cano, McLeod, & Coon, 2015; Covic, Pallant, Conaghan, & Tennant, 2007; Woudstra et al., 2019).

The primary objective of this study was to estimate the reliability of the PACIC and the extent to which each domain and all items together reflect the constructs measured within using Rasch analysis for individuals with chronic pain. A secondary objective was to examine whether individuals who have approximately the same perception of PCC level perform similarly on the individual test items across two-time points (Woudstra et al., 2019). This study will provide evidence of whether the tool fits reasonably well to the Rasch model, and which items do not reflect PCC well for individuals with chronic pain. The results will contribute to understanding if changes to the PACIC may be warranted in order to enhance its reliability and validity to provide researchers, clinicians, and healthcare system decision-makers with a tool that can be used to accurately assess PCC in individuals with chronic pain.

CHAPTER 4: Research Manuscript

Psychometric properties of the Patient Assessment of Chronic Illness Care (PACIC) Questionnaire in people with chronic low back pain: a Rasch based analysis

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Abstract

Background: Measuring patient-centered care is essential in improving the performance and quality of health services and informing health policy. The Patient Assessment of Chronic Illness Care (PACIC) questionnaire is one of the best measures to assess patient-centered care in clinical practice and research. However, the PACIC was not validated in the chronic pain population specifically, and there have been conflicting findings regarding its psychometric properties for other chronic conditions. We aimed to evaluate the psychometric properties of the PACIC among individuals with chronic pain. This study's objective was to assess the extent to which the PACIC items measure a single construct and fit an underlying theoretical hierarchy that forms a linear continuum with interval-like properties in patients with chronic pain.

Methods: Available PACIC data collected at two-time points among adults with low back pain (N=270) was used to assess unidimensionality, local independence, item fit, person fit, item hierarchy, scale targeting, and precision (person reliability and person separation).

Results: The initial analysis demonstrated the data did not fit the Rasch model. Accordingly, modifications were made, including rescoring items (n=8) and removing items (n=8) and persons (n=18) with poor fit. The final model contained 12 items that had a satisfactory fit to the Rasch model. Support for unidimensionality was demonstrated through Principal Component Analysis.

Conclusion: The study demonstrated that a 12 item PACIC version, as applied to the chronic pain population, satisfying Rasch model expectations, and the unidimensionality assumptions. Further testing of the 12 items is needed to generate evidence for the content validity of the PACIC.

Introduction

Interdisciplinary patient-centered care and patient participation are paramount for chronic pain management in modern health care (Paul-Savoie et al., 2015). Care must be tailored to each unique patient, without preconceived notions about the best approach for the patient. In practice, evaluations of patient-centered care can help health care professionals improve patient's experiences. Patient-centered care scores post-discharge can be used as quality indicators when evaluating and developing rehabilitation programs or services.

While several measures exist to assess patient-centered care, such as Patient Participation in Rehabilitation Questionnaire (PPRQ), CollaboRATE, Consultation Care Measure (CCM), and Patient Perception of Patient-Centeredness (PPPC) (Hudon et al., 2011) (summarized in Appendix 2), they have many drawbacks which limit their use in practice (Lindberg et al., 2013; Elwyn et al., 2013; Vrijhoef et al., 2009). These include lack of psychometric validation of the measure, having a complex scoring system, burdensome to administer the tool in clinical settings, and floor or ceiling effects (Lindberg et al., 2013; Vrijhoef et al., 2009).

In a systematic review by Vrijhoef J. et al. (2009), the PACIC was identified as the most appropriate generic instrument to measure the experience and/or satisfaction of people receiving integrated chronic care (Vrijhoef et al., 2009). This is because it had better psychometric properties than most instruments, making it a preferred instrument for individuals with chronic conditions (Vrijhoef et al., 2009).

The Patient Assessment of Chronic Illness Care (PACIC) survey is one of the most commonly used tools measuring patient-centered care in the scientific literature (Schmittdiel et al., 2008). It is a brief 20-item questionnaire designed to assess the extent to which care is aligned with the Chronic Care Model (Glasgow et al., 2005). The development characteristics of the scale are summarized in Table 1.

The PACIC has been validated in a variety of chronic health conditions including Type 2 diabetes, arthritis, chronic pain, pulmonary disease, and coronary artery disease (Glasgow et al., 2005; Vrijhoef et al., 2009). It has been widely used in both validation studies and as an endpoint in outcomes research (Gibbons et al., 2017a; Piette & Kerr, 2006; Reeves et al., 2014; Reid et al., 2010). However, previous research has also noted several limitations of the PACIC scale (Gibbons et al., 2017b; Gugiu, Coryn, Clark, & Kuehn, 2009). On validating the content and item properties of the PACIC, researchers found that the hypothesized five-factor structure of the PACIC was not supported using the confirmatory factor analysis (C. Gugiu et al., 2010). Studies have shown varied factor structures, including one, two, four, or five-factor structure using factor analysis (Fan et al., 2014; C. Gugiu et al., 2010; Hudon et al., 2011; Noel et al., 2016; Rick et al., 2012). Such disparities regarding the factorial structure contribute to uncertainty concerning scoring and how the scale may best be applied to measure patient experiences.

Furthermore, the procedures to validate the measure have mostly been guided by classical test theory (CTT) approaches. There have been only two studies that have used parametric and non-parametric analyses. A recent study conducted in Canada examined the dimensionality of the PACIC scale using confirmatory factor analysis(CFA) and Rasch analysis (parametric analysis) (Lambert et al., 2021). The data included a sample of 221 adults in Canada with self-identified, chronic, physical or mental diseases. When subjected to Rasch analysis, this data showed post modifications that four of the five subscales of the PACIC were psychometrically robust. Another study used the Mokken Analysis, which is analogous to non-parametric item response theory (Gibbons et al., 2017b; Gugiu et al., 2009) to validate the psychometric and scaling properties of the PACIC in the United Kingdom. The results of this analysis post some modifications to the scale showed that the 13-item PACIC fit to the non-parametric Mokken model while the 20-item PACIC represented a single underlying trait structure representing "patient assessment of chronic illness care" (Gibbons et al., 2017b; Gugiu et al., 2009).

To date, only one study has tested the validity of the PACIC using modern psychometric methods such as Rasch analysis; no study has validated the scale in patients with chronic pain (Gibbons et al., 2017a). Therefore, further validation of the PACIC measure as a patient-centered tool to explore new ways to refine the use of this measure and to optimize chronic pain interventions is needed (Paul- Savoie et al., 2015; Gibbons et al., 2017a). Rasch analysis can generate evidence about how well the items in the PACIC fit the chronic pain population and can provide information about the reliability and separation indices to indicate how well the items delineate severity levels. Therefore, the objective of this study was to evaluate the internal validity of the PACIC scale in terms of unidimensionality and the stability of responses across time (two-time points over six months).

TABLE 1. DEVELOPMENT OF PACIC

Characteristics	**Description**
Conceptual Framework	Developed to assess the quality of patient-centered care for chronic illness consistent with the CCM.
Item selection	20 items selected or modified from a larger pool of 46 items generated by a national pool of experts on chronic illness care and CCM and pilot tested with a separate, earlier sample of 130

	patients. Items retained based on those showing adequate variability, patients did not have trouble understanding, and that best represented the underlying constructs.

Scoring	Each scale is scored by a simple averaging of items completed within that scale. Overall PACIC is scored by averaging scores across all 20 items.
Administration	The written version takes 2-5 minutes to complete Phone administration takes approximately 7-8 minutes to complete Does not require any special equipment or training
Psychometric Properties	Reliability- The various scales of the PACIC, as well as the overall score, were internal consistent; test-retest reliability (over 3 months) was moderately stable. Validity- No support for content validity, to be tested in the present study; Construct validity tested (C. Gugiu et al., 2010) and the PACIC and its scales moderately correlated with patient activation and primary scale measures. Responsiveness- Not fully addressed but (Koley et al., 2015) reported responsiveness of 1.11 (large).

Methods

Study design and data collection

The study was a secondary analysis of data collected as a part of a project that aimed to evaluate the impact of a low back pain interdisciplinary care program on patient outcomes (Gogovor et al., 2019). This manuscript analyzed data from the PACIC questionnaire collected at baseline and six months after starting the program.

Study Participants

Participants were aged 18 years or older suffering from subacute (4 to 12 weeks) and chronic(>12 weeks) low back pain (LBP), referred to a primary care interdisciplinary program implemented at four Health and Social Service Centres (CSSS). Participants received an interdisciplinary evaluation at the start of the program and individualized evidence-based treatments which included pharmacological, physiotherapy and psychological therapies, and structured self-management support. Participants completed the 20-item PACIC, which measures specific actions or qualities of care experienced by patients from 1 (none of the time) to 5 (almost always) at baseline and six months. Data on baseline characteristics was also collected and has been summarized in Table 2. In total, 135 patients were recruited between December 2012 and November 2016 and completed the PACIC at baseline and six months after starting the program.

Complete responses on all 20 items were available for 84% and 78% of participants at baseline and six months, respectively (Gogovor et al., 2019).

TABLE 2: BASELINE CHARACTERISTICS OF THE STUDY POPULATION (N=135)

Variables	**N [%] or mean (SD)**
Age (range: 23-87 years)	56.7±(14.3
Sex: Women / Men	70 [53] / 62 [47]
Level of education	
College or University	79 [59.8]
Secondary School	29 [22.0]
Primary School or None	3 [2.3]
Other	7 [5.3]
Missing	14 [10.6]
Ethnicity	
Caucasian	80 [60.6]
Black	5 [3.8]
Asian	6 [4.5]
Hispanic	1 [0.8]
Other	13 [9.8]
Missing	27 [20.5]

Marital status	
Married or Common Law	78 [59.1]
Divorced or Separated	22 [16.7]
Never Married	15 [11.4]
Widowed	2 [1.5]
Other	2 [1.5]
Missing	13 [9.8]
Employment	
Full-time	49 [37.1]
Part-time	8 [6.1]
Retired	36 [27.3]
On disability	8 [6.1]
Other	19 [14.4]
Missing	12 [9.1]

Abbreviations: SD standard deviation

Measurement

The PACIC questionnaire consists of 20 items that are scored on five response categories (1 for none of the times to 5 for always) (Abdul-Razak, Ramli, Badlishah-Sham, Haniff, & Investigators, 2018). Higher scores indicate better person-centered care. These 20 items are separated into five apriori subscales based on some of the key components of the ‘activated, informed patient’ according to the CCM. The five subscales are patient activation (items 1–3), decision support (items 4–6), goal setting (items 7–11), problem-solving (items 12–15), and coordination/follow-up (items 16–20), as seen in Table 3. Each subscale score is the average of item scores, and the overall PACIC score is an average across all 20 items (Maindal, Sokolowski, et al. 2010). The items included in the original instrument were selected or modified from a larger pool of 46 items generated by a national pool of experts and pilot tested among130 individuals with chronic illness (Glasgow et al., 2005).

TABLE 3: PACIC ITEMS AND SUBSCALES

Code	Item	Subscale
ideas	Asked for my ideas when we made a treatment plan.	Patient Activation
choice	Given choices about treatment to think about	
talk	Asked to talk about any problems with my medicines or their effects	
written	Given a written list of things I should do to improve my health	Delivery system design
satis	Satisfied that my care was well organized.	
shown	Shown how what I did to take care of myself influenced my condition.	
goals	Asked to talk about my goals in caring for my condition.	Goal Setting
eat	Helped to set specific goals to improve my eating or exercise.	
copy	Given a copy of my treatment plan.	
class	Encouraged to go to a specific group or class to help me cope with my chronic condition.	
habit	Asked questions, either directly or on a survey, about my health habits.	

value	Sure that my doctor or nurse thought about my values, beliefs, and traditions when they recommended treatments to me.	Problem Solving
daily	Helped to make a treatment plan that I could carry out in my daily life.	
plan	Helped to plan so I could take care of my condition even in a hard time.	
affec	Asked how my chronic condition affects my life.	
conta	Contacted after a visit to see how things were going.	Follow up/ Coordination
atten	Encouraged to attend programs in the community that could help me.	
refer	Referred to a dietitian, health educator, or counselor.	
visit	Told how my visits with other types of doctors, like an eye doctor or other specialist, helped my treatment.	
other	Asked how my visits with other doctors were going.	

Statistical Analysis

The data were entered into the analysis in a stacked format (Las Hayas et al., 2011) to allow for comparisons of scores over time (baseline and six months) at both timelines. This approach to structuring the data permitted the testing of the dimensionality or factor structure, DIF (Differential Item Functioning) by time and measurement properties of the PACIC using psychometric analyses, such as for item and sample independent Rasch Models (Las Hayas et al., 2011).

Rasch methods were implemented using RUMM2030 software © (professional edition). Rasch analyses were conducted following the steps:

1. Targeting: Scale-to-sample targeting was evaluated by verifying a match between the range of patient-centered care measured by the PACIC items and the range of patient-centered care perceived by the sample of patients (Petrillo et al., 2015).
2. Ordering of item thresholds: Each of the items of the PACIC has multiple response categories that reflect an ordered continuum of patient-centered care (e.g. 1,2,3,4 and 5). Item fit validity analysis tests this statistically and graphically by threshold location and plots. Appropriate threshold values between adjacent pairs of response options should be ordered by magnitude (less to more). This was evaluated using graphical plots to verify that the lowest areas of probability distributions of each response category were above either adjacent category plots (Petrillo et al., 2015).
3. Item fit validity: The items of the PACIC must work together (fit) as a consistent set both clinically and statistically. Otherwise, it is inappropriate to sum item responses to reach a total score and consider the total score as a measure of patient-centered care. When items do not work together in this way (misfit), the validity of a scale is questioned. Three main indicators were

assessed to examine this: 1) fit residuals (item–person interaction) 2) chi-square values (item–trait interaction), and 3) item characteristic curves (the observed and expected scores should coincide). Fit residuals should fall between −2.5 and +2.5 with associated nonsignificant chi-square values (significance interpreted after Bonferroni adjustment). There are no absolute criteria for interpreting fit statistics. Still, it is more useful to interpret these statistics together and in the context of their clinical usefulness as an item set (Petrillo et al., 2015).

4. *Item dependency*: The response to one PACIC item should not directly influence the response to another. Item dependency determines this effect by looking at the residual correlations ($r > 0.30$ indicates potential dependency) (Petrillo et al., 2015).

5. *Reliability*: Examination of Person Separation Index (PSI) (a reliability statistic comparable to Cronbach's alpha that quantifies the error associated with the measurements of people in this sample) and the person measurements (estimates). Higher Person Separation Index values show better reliability (>0.70 indicates adequate reliability) (Petrillo et al., 2015).

6. Unidimensionality: Two item sets from a Principal Component Analysis of residuals, estimate person measures based on the two item sets, compare the two estimates on a person-by-person basis using t-tests and determine the number of cases that differ significantly at the 0.05-level; If ≥5% of tests are significant it is suggested that the scale is multidimensional (Hagell, 2014).

Results

The dataset is comprised of 270 responses across 20 items. Out of 270 participants, 135 responses were at Time 1 and 135 responses at Time 2. Forty-eight individuals had missing data for responses on items and were excluded from the analysis. The missing data were replaced using simple imputation (Fellinghauer, Prodinger, & Tennant, 2018).

Finally, 13 participants were removed as there were three invalid records (mismatch responses identified by RUMM2030 software detected between a response character and what has been specified (due to typing errors, etc.) and ten participants had extreme records (persons showing floor or ceiling effects)). After excluding invalid and extreme records, the final sample size used in the analysis was 257 participants total across both time points.

Initial Test of the Model

The partial credit model was identified as appropriate and was used for Rasch analysis. The overall model fit was poor ($\chi 2 = 328.75$ [60]; $P<0.05$) for 20 items and 257 individuals. A PSI value of 0.92 indicated that the PACIC measure had high reliability.

The 'Rasch factor' or the first component of the PCA accounted for 26.70% of the variance, suggesting multidimensionality. Local dependencies were seen amongst items by observing the residual correlations matrix (Appendix 1); however, the items did not seem to cluster around the original five subscales of the PACIC scale.

The targeting of the PACIC to the sample is shown in the person-item distribution map in Fig. 1. The distribution map indicates that the targetting was good as the dataset comprising of 257 participants were spread across the logit scale, and 20 items matched the participant distribution of abilities. The average perception of patient-centered care by participants was 0.08 (1.31) logits, in comparison with the default question difficulty average of 0 (0.36) logits.

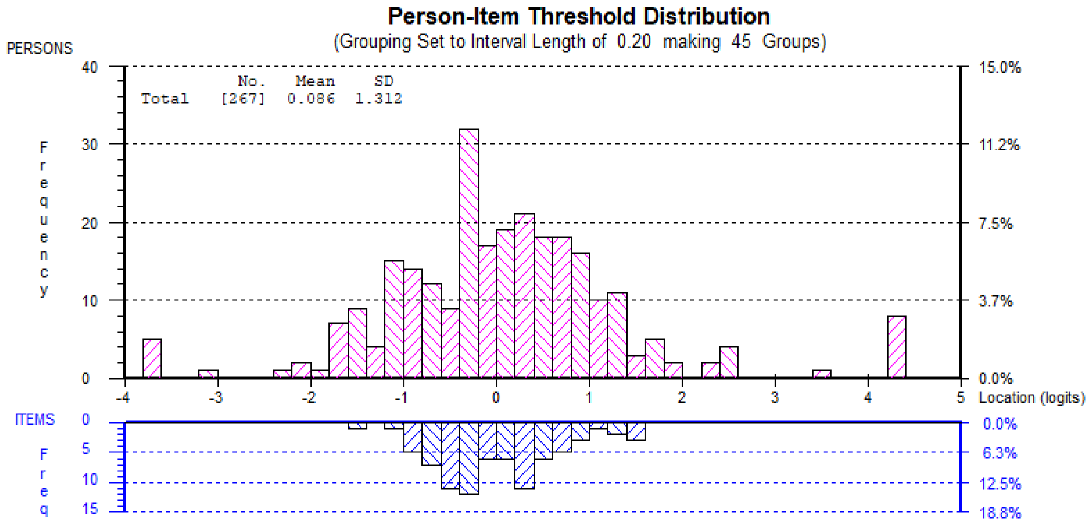


FIGURE 3. PERSON-ITEM DISTRIBUTION MAP FOR THE PATIENT ASSESSMENT OF CHRONIC ILLNESS CARE (PACIC) QUESTIONNAIRE.

Rasch analysis steps

I. Removal of misfitting items

The individual item fit was assessed. Six items showing worst fit to the model were deleted, namely: ‘Referred to a dietitian, health educator, or counselor’ (item 18), ‘Asked how my visits with other doctors were going’ (item 20),‘ Told how my visits with other types of doctors, like an eye doctor or other specialist, helped my treatment’ (item 19), ‘Encouraged to go to a specific group or class to help me cope with my chronic condition’ (item 10), ‘Encouraged to attend programs in the community that could help me’ (item 17), ‘ Contacted after a visit to see how things were going’ (item 16). The effect of the deletion of these items was evaluated, and there was a marginal improvement in the overall item fit residual to 0.35 (2.52) from 0.53 (3.03).

II. Rescoring of thresholds for 14 items

Next, the threshold map was checked for disordered thresholds. A threshold indicates the point where there is a 50/50 probability of respondents choosing between any two adjacent score categories. Seven out of the remaining 14 items showed disordered thresholds(Fig.5).

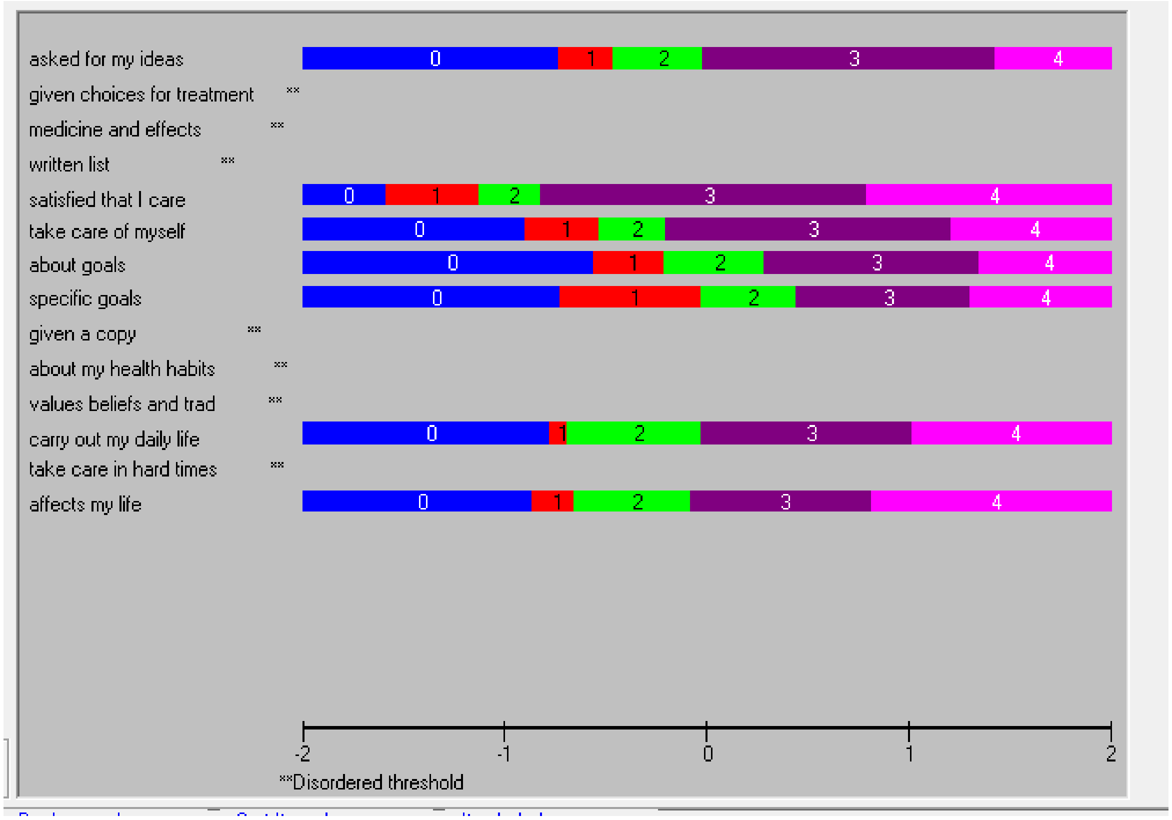


Figure 4. Threshold map for the Partial Credit model. Disordered items are those marked **.

To fix disordered thresholds, the category probability curves were assessed. For example, responses to the question of item 3 *talk* ‘Asked to talk about any problems with my medicines or their effects’ did not follow the same progression (from high to low scores) as the progression of the severity of person scoring (from low levels to high levels of person's perception of patient-centered care). Figure 6a represents the disordered threshold; the probability of scoring a 0 out of 4 on the item *talk* overlaps with the probability of scoring 1. Therefore, based on category probability curves, the item was rescored by collapsing response categories (Figure 6b). This resulted in a decrease in the number of response categories from 5 to 3. Table 4 shows how the response categories were collapsed for each disordered item. Fig. 7 presents the threshold map after re-scoring, ordered by level of difficulty.

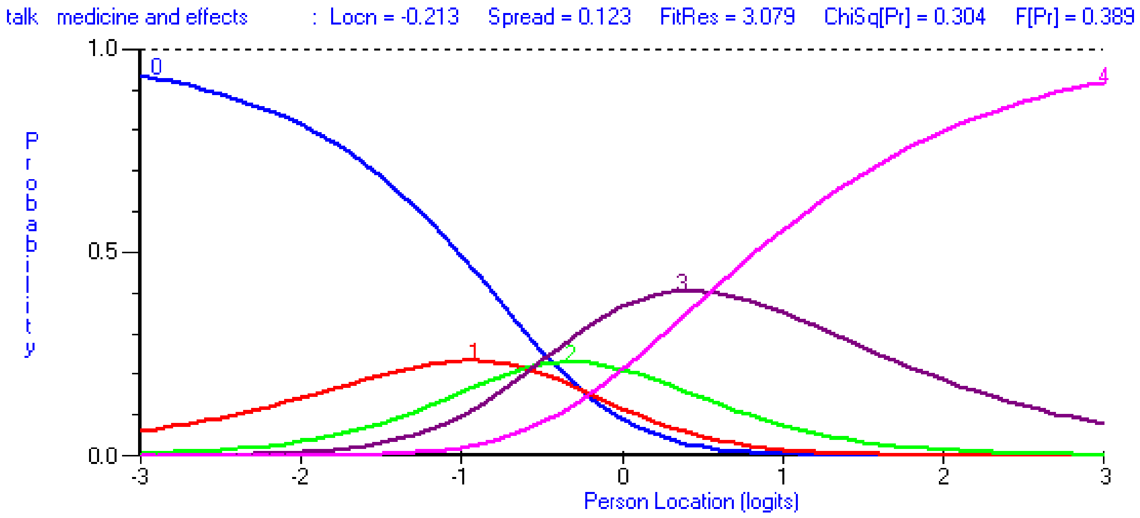


Figure 5a. Category probability curves indicating disordered thresholds for item 'Asked to talk about any problems with my medicines or their effects'

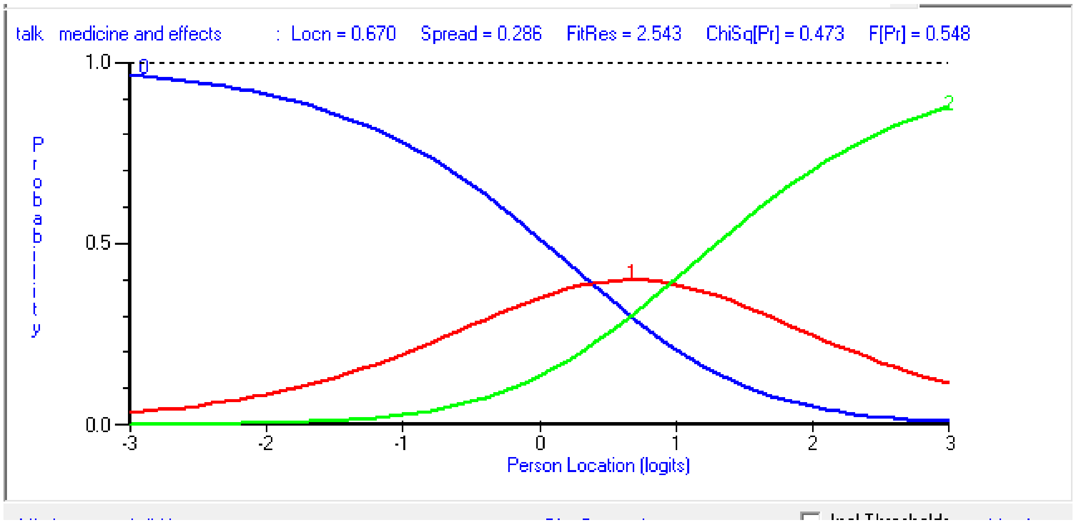


Figure 5b. Category probability curves after collapsing categories indicating ordered thresholds for item 'Asked to talk about any problems with my medicines or their effects'.

TABLE 4. RE-SCORING OF DISORDERED THRESHOLDS FOR THE 7 ITEMS

Item description	**Rescoring 5 point ordinal response categories (0-4)**
1. Given choices about treatment to think about.	Binary: 0, 1, 2 = 0; 3 and 4 = 1
2. Asked to talk about any problems with my medicines or their effects.	3 levels: 0, 1 , 2 = 0; 3=1 and 4=2
3. Given a written list of things I should do to improve my health.	3 levels: 0, 1, 2 = 0; 3=1 and 4=2
4. Given a copy of my treatment plan.	3 levels: 0 = 0; 1, 2, 3 = 1; and 4 = 2
5. Asked questions, either directly or on a survey, about my health habits.	4 levels: 0, 1= 0; 2 = 1; 3 = 2 and 4 = 3
6. Sure that my doctor or nurse thought about my values, beliefs, and traditions when they recommended treatments to me.	3 levels: 0, 1, 2 = 0; 3=1 and 4=2
7. Helped to plan so I could take care of my condition even in a hard time.	3 levels: 0, 1, 2 = 0; 3=1 and 4=2

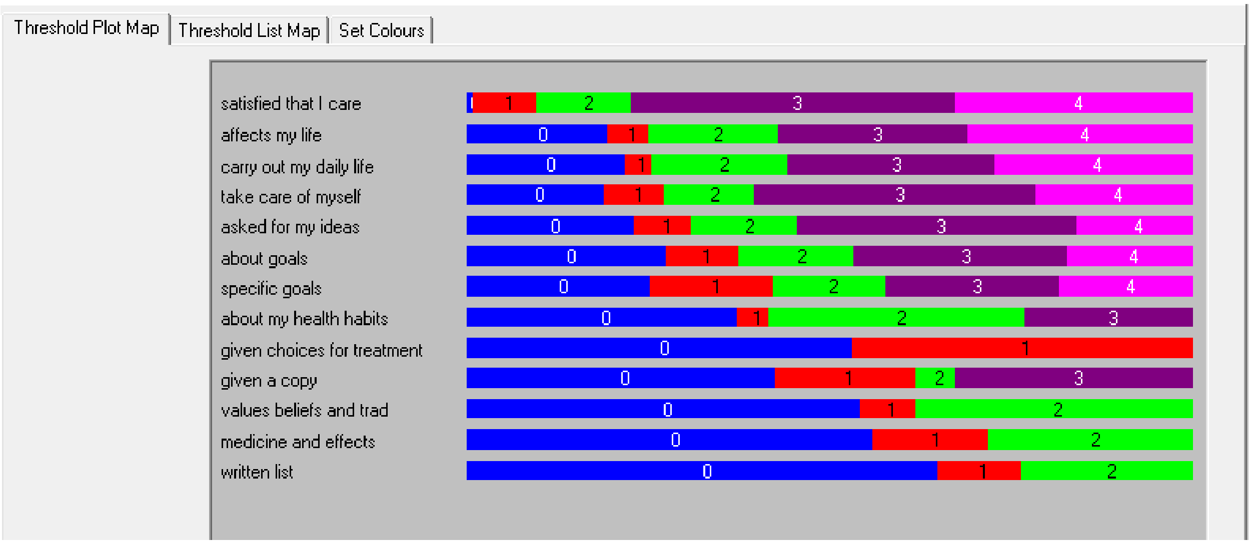


FIGURE 6. THRESHOLD MAP OF THE ITEMS PRESENTED AS LOCATION ORDER.

The next step involved checking for the individual item fit again. Two items, namely item 14 ‘given a copy of my treatment plan’ and item 7 ‘asked to talk about my goals in caring for my condition’ did not fit the model. They were deleted as there were local dependencies between the items. Despite significant overall item-trait interaction chi-square tests (p= 0.02), the cumulated item fit residuals further improved to 0.05(1.57) from 0.53(3.03).

III. Removal of misfitting persons

Person IDs 21, 63, 66, 67, 100, 128, 137, 141, 150, 151, 154, 188, 230, 244, 254, 270’, were deleted to further improve the overall model fit to p=0.09. On checking the threshold map, item ‘Given a copy of my treatment plan’ was found to have a disordered threshold. After combining response categories to order the thresholds, the chi-square fit statistic improved dramatically and was found to be non-significant (χ^2 =46.81, p=0.11) (Table 5).

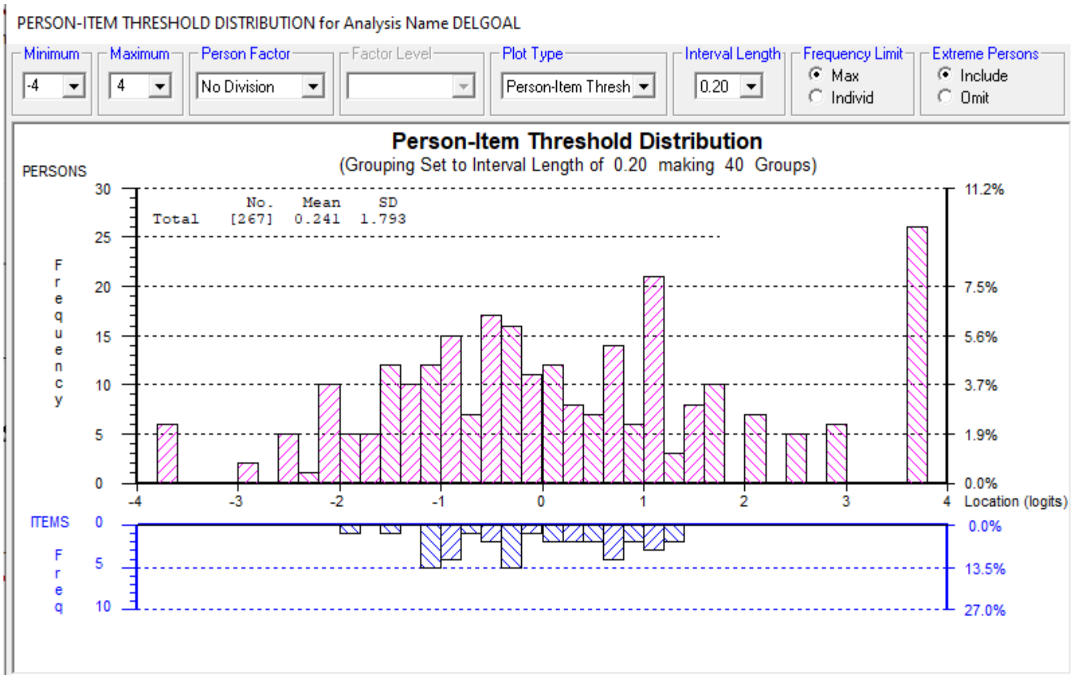
TABLE 5: OVERALL FIT STATISTICS FOR THE ORIGINAL AND FINAL MODEL

Model parameters	**Overall model fit parameters: χ^2, df, p-value**	**PSI**	**Item location**	**Item fit**	**Person location**	**Person fit**
			Mean (SD)			
All items from the original scale	328.75, 60, 0.0	0.92	0.0 (0.37)	0.53 (3.03)	0.08 (1.31)	-0.33 (2.03)
Final model	46.81, 36, 0.11	0.89	0.0 (0.50)	-0.01 (1.67)	0.23(1.85)	-0.24 (1.14)

Df: Degrees of freedom; χ^2: chi-square statistic; p: p-value, PSI: person separation index

Final model

As stated above, the overall model fit was good (p=0.11), resulting from the remaining 12 items and 216 participants. Reliability reduced to 0.89 while there was a significant improvement in dimensionality (from 25% to 7.02%). The unidimensionality was further supported by the 95% confidence interval (-0.27502, 0.28502), which included the 0.05 value. No local dependencies were found, and there was minimal change in the scale targeting between the initial and final models, as seen in Fig 5. Having reached a satisfactory fit to the Rasch model with 12 items, an assessment of DIF was conducted with both graphical and statistical procedures. Graphs were plotted to compare the item location concerning time (two-time points), age (five age groups), and gender (male/female). Significant uniform DIF over time was detected for items ‘Asked to talk about any problems with my medicines or their effects’ and ‘Given a copy of my treatment plan’ using a Bonferroni- adjusted p-value as seen in Fig 9. No DIF for gender and age was detected for any item.



PERSON-ITEM THRESHOLD DISTRIBUTION for Analysis Name DELGOAL

Minimum: -4

Maximum: 4

Person Factor: No Division

Factor Level:

Plot Type: Person-Item Thresh

Interval Length: 0.20

Frequency Limit: ● Max ○ Individ

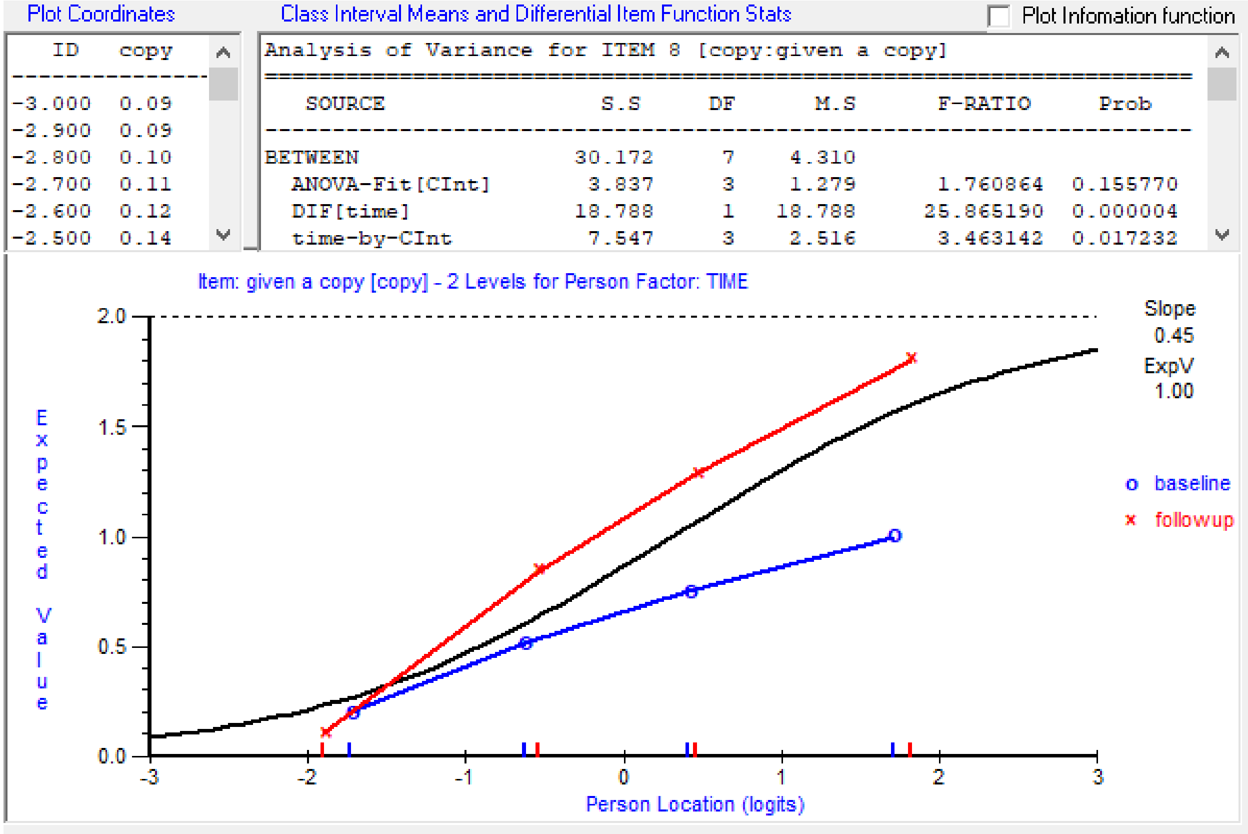
Extreme Persons: ● Include ○ Omit

Person-Item Threshold Distribution

(Grouping Set to Interval Length of 0.20 making 40 Groups)

```
          No.    Mean     SD
Total   [267]   0.241  1.793
```

FIGURE 7. PERSON- ITEM DISTRIBUTION OF THE FINAL MODEL.



```
  ID    copy
---------------
-3.000  0.09
-2.900  0.09
-2.800  0.10
-2.700  0.11
-2.600  0.12
-2.500  0.14
```

```
Analysis of Variance for ITEM 8 [copy:given a copy]
=====================================================================
   SOURCE                 S.S      DF      M.S       F-RATIO     Prob
---------------------------------------------------------------------
BETWEEN                 30.172      7    4.310
  ANOVA-Fit[CInt]        3.837      3    1.279      1.760864  0.155770
  DIF[time]             18.788      1   18.788     25.865190  0.000004
  time-by-CInt           7.547      3    2.516      3.463142  0.017232
```

FIGURE 8. ITEM CHARACTERISTIC CURVE FOR ITEM 'ASKED TO TALK ABOUT ANY PROBLEMS WITH MY MEDICINES OR THEIR EFFECTS' FOR TIME.

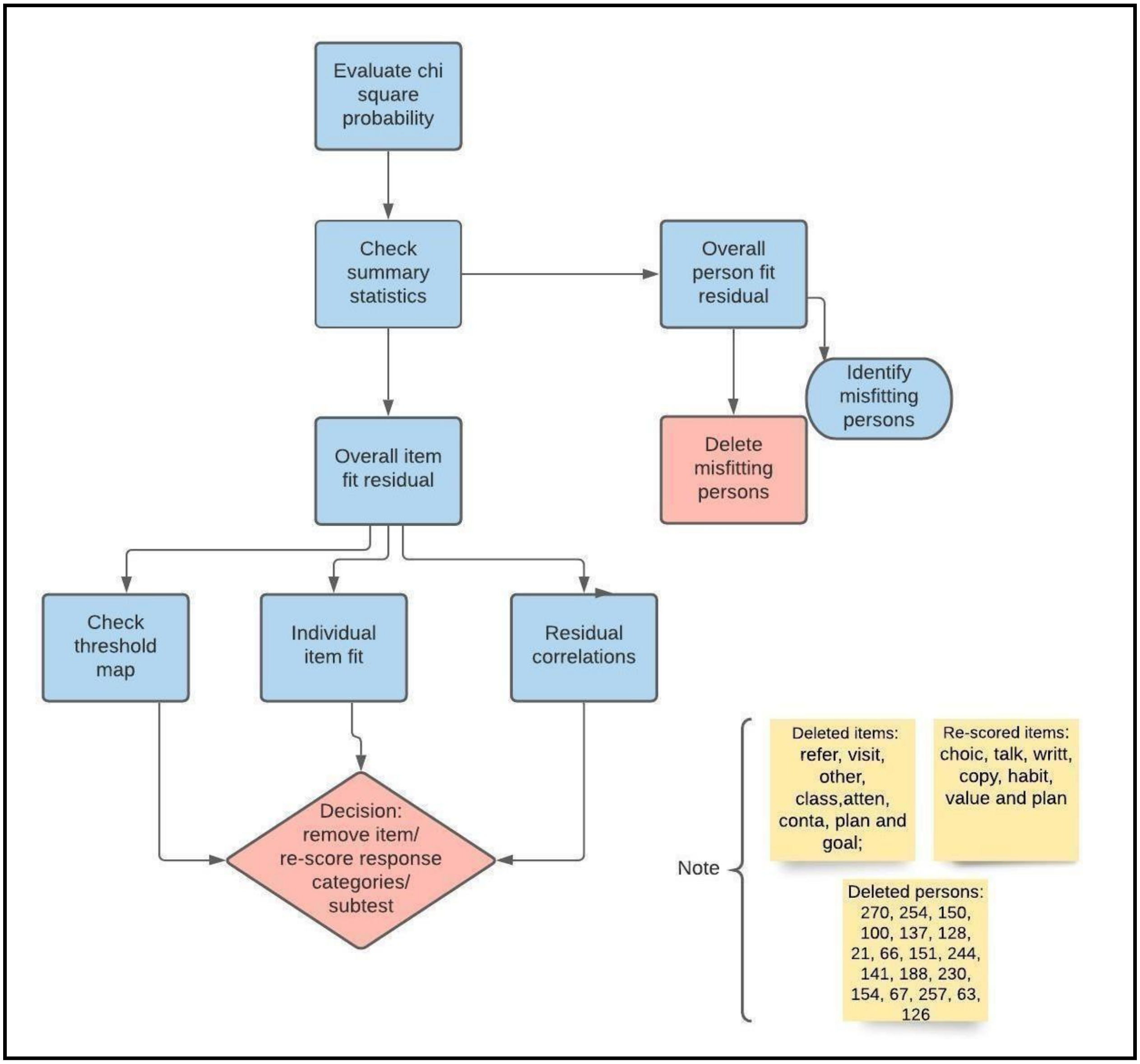


FIGURE 9. FLOW DIAGRAM OF THE PROCESS UNDERLYING RASCH ANALYSIS:

Discussion

Rasch analysis is widely used to evaluate patient-reported outcome measures (PROMs) (Aiyegbusi et al., 2017). To our knowledge, the present study was the first to use Rasch analysis to assess further the psychometric properties of the PACIC and its response stability across time, age, and gender in patients with chronic pain. The original scale had good precision and targeting, suggesting it may be a useful outcome measure to assess patient-centered care in a chronic pain population. The present study has shown that the 12 item PACIC version, as applied to the chronic pain population, satisfies Rasch model expectations and the unidimensionality assumptions, having accommodated local dependency issues. However, our results also revealed some previously unknown characteristics regarding the original 20 items of the PACIC, which would help us understand some of the limitations of the current PACIC scale as well as how to solve them.

Dimensionality

This study revealed that the items of the original PACIC scale (20 items) represented more than one dimension but did not conform to the previously hypothesized five-factor structure (C. Gugiu et al., 2010). Many studies have found similar results, but a lack of consensus remains regarding the structure of the PACIC instrument across validation studies (P. C. Gugiu et al., 2009; C. Gugiu et al., 2010; Gensichen et al., 2011; Taggart et al., 2011; Iglesias, Burnand, & Peytremann-Bridevaux, 2014). This heterogeneity of structure results could be because of statistical and methodological variations, including differences in sample sizes and timing of data collection. The different cultures, diversity of health care contexts, and types of chronic illnesses may also have contributed to variations in validation results.

Disordered Thresholds

Items showing disordered thresholds indicated that the participant responses were not able to distinguish distinct levels of perception of patient-centered care. This can lead to participants choosing response options inconsistently if they do not perceive a difference in the response options' meaning. One reason may be that the item response category may have been ambiguous or overly complicated for participants with too many response options or confusing labels (Vanhoutte et al., 2012). For example, participants did not use all response categories for the item ‘Given a written list of things I should do to improve my health’. The difference between the response options ‘little of the time’ and ‘some of the time’ was very hard to distinguish for participants. It may be that none of the response options seem relevant to them (Vanhoutte et al., 2012). For example, not all patients with chronic pain may find the item ‘Referred to a dietitian, health educator, or counselor’ relevant. This could be because not all of them may need a referral to the above-mentioned health practitioners. Further qualitative work to ask individuals with chronic pain for feedback on the clarity and relevance of those PACIC items will help confirm this hypothesis.

Item misfit

Eight items showed a misfit to the model. All the deleted items demonstrated fit issues as observed on the ICC and category probability curves, suggesting the items are measuring a construct that is inconsistent with the other PACIC items. Five of the eight items removed were originally placed in the ‘Follow up/Co-ordination’ domain (Items 16,17,18,19 and 20). The removal of these items may relate to inconsistencies in the implementation of different elements of the CCM in the chronic pain population in Canada. To date, only one study has evaluated the content validity of the PACIC scale (Vrijhoef, Berbee, Wagner, & Steuten, 2009). Therefore, qualitative interviews with clinicians and patients could help refine the scale to better understand which dimensions and items are patient-centered and are most meaningful for individuals with chronic pain. It may be that the deleted items could still be a part of the conceptual framework, however, they require different items to represent relevant areas of a given dimension (e.g., coordination of care) (Bala, Forslind, Fridlund, & Hagell, 2018;Melin et al., 2020).

Person misfit

Many of the respondents to the PACIC survey misfit (over-or under-) the Rasch model. Previous work by Curtis (Curtis, 2004) has suggested that most misfit in attitude survey occurs because of carelessness in responding which causes an "increase in the standard errors of item estimates, reduces the range of item locations on the scale and reduces the inter-threshold range within items". This is consistent with the present study in which most of the misfitting participants consistently circled 4 s (most of the time) for each item. Qualitative research is needed to reveal if this response truly reflects individuals' perceptions, or if it is a careless choice because of lack of interest or perceived benefit of responding, to explain the extreme responses.

Item modification to achieve the final model fit

One of the Rasch measurement approach's strengths is the ability to re-score/delete then re-analyze the fit of the item to the model (Lamoureux et al., 2007). This approach can ensure that the items that measure the latent construct are not removed when they can be modified to achieve model fit. Disordered thresholds contributed to a high degree of measurement ‘‘noise’’ and need to be resolved by removing the item or rescoring items (Pallant & Tennant, 2007). The removal of unnecessary items that did not contribute positively to the unidimensional measurement resulted in a 12-item PACIC measure. The final model had an acceptable fit to the Rasch model. Two items, item ‘talk’ and item ‘copy’, were found to display DIF across time, with participants, with the same level of person-centered care (i.e., same place on the logit scale) at follow-up more likely to endorse them than those at baseline. This may make the items potentially unsuitable for inclusion in core sets of scale items, but they may be clinically informative (Pickard, Dalal, & Bushnell, 2006). Further research and replication of these results would strengthen the case for retaining or excluding these items based on DIF.

Another study used Mokken analysis, a nonparametric form of Item Response Theory for assessing the psychometric properties of PACIC among individuals with long-term conditions resulting in a modified 13-item PACIC. While there is some overlap in the findings, the differences may be due to the populations and statistical methods (C. J. Gibbons et al., 2017b). Therefore, further exploration of PACIC is needed using Rasch analysis before recommending this reduced version of the scale for clinical care or research.

Strengths and Limitations

McClimans and colleagues stated that for theory-driven measurement to proceed, there should be as much attention paid to disorder as there is to order. A strength of the current study is that different methodological steps of the Rasch analysis were used to improve the model's fit (McClimans, Browne, & Cano, 2017). This implies that there is no risk of overestimation or underestimation of the remaining items. Another strength of the study was stacking the data at the two-time points, resulting in an increase in the sample size from 135 to 270. This sample size was sufficient to estimate person and item location (Linacre, 1994). Patient-centered care measures are required for quantifying improvement in chronic pain management from the patient perspective. Combining the results from this study with a qualitative evaluation of the modified PACIC scale may provide a better understanding of the gaps of chronic pain management and generate evidence for which items of person-centered care will be most relevant for chronic pain. A comprehensive measure of person-centered care, in turn, will provide healthcare professionals with a measure for accurate and reliable decision making to identify and prioritize areas of healthcare where improvements are needed.

This study also has limitations. The model was tested with a sample of low back pain participants in Canada, limiting the generalisability of our findings to this chronic pain population. Replication with more diverse samples, including other chronic conditions and other countries, could be useful. Furthermore, our findings raise doubts about the internal construct validity of the full 20-item scale for those with chronic pain, and suggest that the scale's multidimensionality may compromise the scoring.

Conclusion

The present study has shown that the 12 item PACIC version, as applied to the chronic pain population, satisfies Rasch model expectations and the unidimensionality assumptions, having accommodated local dependency issues. These 12 items must be content validated to further strengthen the results of this study. Future work is needed to review the content of the PACIC with individuals with chronic pain to understand why certain items misfit and if there are additional items needed to comprehensively evaluate patient-centered care among individuals with chronic pain. Once additional items for PCC are identified, and a larger item bank can be created, further research may be conducted on this scale to employ computer-adaptive testing, which can improve the efficiency and accuracy of assessments (Gibbons, Bower, Lovell, Valderas, & Skevington, 2016).

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APPENDICES

APPENDIX 1: Residual correlation matrix

*file attached at the end of the document

APPENDIX 2: Steps in the Rasch analysis of Patient Assessment of Chronic Illness Care

No.	Steps taken to improve model fit in a sequence	Chi-square test (χ^{2}) and p-value	PSI	Items: mean (SD)		Persons: mean (SD)		Rationale 1 (fit residuals excludes ±2.5)	Rationale 2 ((disordered thresholds)	Rationale 3 (local dependencies >0.3)
				Location	Fit Residual	Location	Fit Residual			
1	All items in the model	328.75, 0.00	0.92	0.00(0.368)	0.53(3.03)	0.08(1.31)	-0.33(2.03)	9 out of 20 items	13 out of 20 items	9 out of 20 items

2	Delete item ‘refer’	302.36, 0.00	0.92	0.00(0.36)	0.41(3.04)	0.12(1.35)	-0.34(1.98)	9 out of 19 items	12 out of 19 items	6 out of 19 items
3	Delete item ‘other’	274.14, 0.00	0.92	0.00(0.36)	0.36(3.09)	0.17(1.40)	-0.32(1.93)	9 out of 18 items	11 out of 18 items	3 out of 18 items
4	Delete item ‘visit’	205.91, p=0.00	0.92	0.00(0.34)	0.38(3.02)	0.26(1.51)	-0.35(1.92)	7 out of 17 items	10 out of 17 items	3 out of 17 items
5	Delete item ‘class’	197.54, p=0.00	0.92	0.00(0.36)	0.30(2.79)	0.29(1.58)	-0.34(1.80)	7 out of 16 items	9 out of 16 items	3 out of 16 items

6	Delete item ‘atten’	157.64, p=0.00	0.91	0.00(0.36)	0.23(2.74)	0.34(1.63)	-0.36(1.74)	6 out of 15 items	7 out of 15 items	3 out of 15 items
7	Delete item ‘conta’	126.11, p=0.00	0.91	0.00(0.26)	0.35(2.52)	0.48(1.76)	-0.44(1.90)	4 out of 14 items	7 out of 14 items	2 out of 14 items
8	Rescore item ‘choice’	128.68, p=00	0.91	0.00(0.30)	0.29(2.53)	0.45(1.77)	-0.42(1.85	4 out of 14 items	6 out of 14 items	1 out of 14 items
9	Rescore ‘talk’	131.60, p=0.00	0.91	0.00(0.35)	0.21(2.54)	0.42(1.83)	-0.34(1.69)	6 out of 14 items	5 out of 14 items	1 out of 14 items
10	Rescore ‘writt’	115.24, p=0.00	0.91	0.00(0.44)	0.15(2.42)	0.36(1.86)	-0.33(1.61)	5 out of 14 items	4 out of 14 items	0 out of 14 items

11	Rescore ‘copy’	107.92, p=0.00	0.91	0.0 (0.45)	0.13(2.37)	0.36(1.87)	-0.35(1.63)	5 out of 14 items	3 out of 14 items	0 out of 14 items
12	Rescore ‘habit’	104.1. p=0.00	0.91	0.0 (0.45)	0.11(2.37)	0.33(1.89)	-0.34(1.60)	4 out of 14 items	2 out of 14 items	0 out of 14 items
13	Rescore ‘value’	74.71, p=0.00	0.91	0. 0(0.46)	0.04(2.01)	0.27(1.92)	-0.38(1.57)	4 out of 14 items	1 out of 14 items	0 out of 14 items
14	Rescore ‘plan’	83.06, p=0.00	0.91	0.00(0.54)	0.04(1.96)	0.20(1.92)	-0.36(1.55)	4 out of 14 items	0 out of 14 items	0 out of 14 items

15.	Delete ‘plan’	71.47, p=0.00	0.91	0.00(0.47)	0.05(1.83)	0.25(1.86)	-0.37(1.51)	2 out of 13 items	0 out of 13 items	0 out of 13 items
16	Delete ‘goal’	54.70, p=0.02	0.90	0.00(0.48)	0.05(1.57)	0.24(1.80)	-0.35(1.43)	0 out of 12 items	0 out of 12 items	0 out of 12 items
17	Delete misfit persons 270, 254, 150, 100, 137, 128, 21, 66, 151, 244, 141, 188, 230,	47.95, p=0.09	0.89	0.00(0.50)	-0.02(1.66)	0.22(1.81)	-0.24(1.13)	0 out of 12 items	1 out of 12 items	0 out of 12 items

	154, 67, 257, 63, 126									
18	Rescore item ‘copy’	46.81, p=0.11	0.89	0.00(0.50)	-0.02(1.67)	0.23(1.85)	-0.24(1.14)	0 out of 12 items	0 out of 12 items	0 out of 12 items

χ^2: chi-square statistic; p: p-value, PSI: person separation index

APPENDIX 1: Residual Correlations

Item	ideas	choic	talk	writt	satis	shown	goals	eat	copy	class	habit	value	daily	plan	affec	conta	atten	refer	visit	other
ideas																				
choic	0.444																			
talk	0.256	0.36																		
writt	-0.107	-0.053	-0.113																	
satis	0.152	0.066	0.137	0.079																
shown	0.113	-0.041	-0.052	0.261	0.214															
goals	0.125	0.077	0.034	0.175	0.086	0.329														
eat	-0.153	-0.192	-0.135	0.181	0.045	0.238	0.351													
copy	-0.098	-0.062	-0.145	0.358	0.072	0.049	0.156	0.217												
class	-0.104	-0.074	-0.178	-0.1	-0.199	-0.155	-0.205	-0.081	-0.06											
habit	-0.123	-0.107	-0.069	-0.019	-0.055	0.114	0.189	0.206	0.22	0.076										
value	-0.061	-0.109	0.028	-0.229	-0.063	-0.143	-0.142	-0.102	-0.233	-0.002	0.083									
daily	-0.034	-0.058	-0.113	-0.048	0.03	0.154	0.254	0.179	0.054	-0.129	0.161	0.109								
plan	-0.043	0.02	-0.132	0.116	0.148	0.178	0.178	0.163	0.155	-0.133	0.087	0.009	0.447							
affec	0.023	-0.02	-0.111	0.052	-0.036	0.037	0.139	0.007	0.125	-0.079	-0.002	0.008	0.171	0.28						
conta	-0.158	-0.065	-0.105	-0.057	-0.028	-0.291	-0.127	-0.149	-0.042	-0.095	-0.11	0.045	-0.097	-0.047	0.033					
atten	-0.216	-0.137	-0.219	-0.166	-0.201	-0.158	-0.28	-0.238	-0.221	0.223	-0.112	0.063	-0.137	-0.138	-0.108	0.083				
refer	-0.183	-0.2	-0.123	-0.21	-0.149	-0.285	-0.402	-0.257	-0.289	0.008	-0.239	-0.055	-0.345	-0.356	-0.341	-0.052	0.157			
visit	-0.143	-0.127	-0.129	-0.326	-0.333	-0.219	-0.366	-0.264	-0.32	-0.03	-0.297	-0.104	-0.215	-0.332	-0.23	-0.034	0.144	0.535		
other	-0.148	-0.232	-0.042	-0.303	-0.185	-0.25	-0.323	-0.27	-0.346	-0.109	-0.165	0.042	-0.21	-0.335	-0.184	-0.029	0.038	0.314	0.492	