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Applying MTMM validity approach to differentiate between pain and discomfort measurements in patients with advanced cancer

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ABSTRACT

The multi-trait-multi-method matrix (MTMM) is a robust method for assessing scale validity, offering a structured approach to evaluating convergent and discriminant validity by examining multiple traits measured through multiple methods. The rationale for this study stemmed from the need to distinguish between closely related constructs: pain, discomfort, and happiness in patients with advanced cancer, where accurate measurement is critical for effective symptom management. The objective was to assess the validity of these measurements using MTMM, ensuring that each construct was distinct yet reliably captured across different assessment tools. The methodology employed a cross-sectional descriptive design involving 100 patients with advanced cancer. Participants completed six questionnaires: two pain scales (numeric and non-verbal), two discomfort scales (scale and questionnaire), and two happiness measures (scale and questionnaire). The mean pain scores were 6.7 ± 2.4 (numeric scale) and 5.2 ± 2.6 (non-verbal scale), while discomfort scores were 26.6 ± 6.2 (scale) and 26.9 ± 8.0 (questionnaire). Happiness scores were 3.6 ± 1.2 (scale) and 3.2 ± 1.1 (questionnaire). Key findings revealed strong validity diagonals ($r = 0.66$ to $r = 0.89$), supporting convergent validity, while correlations between different constructs using rating scales ($r = -.29$ to $r = .77$) and hetero-trait–hetero-method coefficients ($r = -.31$ to $r = .79$) provided evidence for discriminant validity. The findings confirm MTMM as a gold-standard method in the measurement world for distinguishing between pain and discomfort in patients with advanced stages, reinforcing its utility in clinical research where precise construct differentiation is essential.

Keywords: discomfort, happiness, multi-trait multi-method, pain, validity

INTRODUCTION

The multi-trait-multi-method matrix (MTMM) is a robust and widely respected framework for evaluating construct validity, particularly convergent and discriminant validity [1]. This method requires researchers to measure a set of traits using multiple methods within a single study, making it a rigorous approach in construct validation research [2]. MTMM approach has become a cornerstone in ensuring the accuracy and reliability of research findings [2]. Its methodological rigor have led to its application across a diverse range of disciplines, including business, physical education, political science, nursing, and medicine [3]. This broad adoption underscores its significance as a gold standard in validating complex constructs and highlights its critical role in advancing research across multiple fields.

Pain is considered one of the predominant symptoms of cancer, affecting more than 53% of patients with cancer in all stages [4]. Pain is one of the most important variables that can be measured in multi-methods, especially among patients with advanced cancer caused directly by cancer often in multiple sites and different etiologies [5, 6]. Over 70% of patients with advanced cancer report having moderate to severe uncontrolled pain [4].

Despite the advancement in pain management, pain continues to be undertreated among patients with cancer and the obstacles to cancer patients' pain management are multifaceted [7]. It has a significant impact on clinical outcomes and negatively on the patient's quality of life especially; physical, psychological, and communication aspects [8].

In a recent systematic review, the prevalence of pain among patients with advanced cancer is 44.5%. The experience of pain among patients with advanced cancer is 30.6% moderate to severe pain [9]. Comprehensive assessment of pain is crucial in characterizing pain and identifying the underlying mechanisms, providing a guided decision-making process related to medical therapy [10]. In addition, the multifaceted nature of cancer pain and its wider effects on patients' health, provide a basis for cancer treatments and enhanced pain management techniques [10].

Pain characteristics including intensity, radiation, duration, qualities, provocative, and alleviating factors, are all essential for effective personalized treatment approaches [11].

Patients with advanced cancer frequently face prevalent challenges to effectively manage their pain due to inadequate pain assessment and reassessment caused by healthcare personnel's lack of experience in this area [12].

Pain can cause discomfort, but not every discomfort can be related to pain [13]. Discomfort is defined as an unpleasant state of the human body in reaction to its physical environment [14] and can include both physical and psychological states [13]. Discomfort is characterized by a lack of comfort, uneasiness, or anxiety, which can be either physical or emotional, as well as mild pain. Understanding the characteristics that define discomfort could help one realize that, while discomfort and pain are comparable, they are not the same [15].

Sometimes, patients can't distinguish between what they felt exactly which causes difficulty in the assessment and management of pain among nurses [15, 16]. It was difficult to distinguish between pain and discomfort. The following was a content analysis of the descriptions of discomfort: there was a connection between pain and discomfort; one felt discomfort because of pain, even though it wasn't pain yet [17].

Pain and discomfort differ from happiness. Patients with advanced cancer perceived happiness as a fundamental step to quality of life, helping them to deal with suffering caused by the disease, to restore the meaning of life, and to live in the best possible way [18].

Therefore, discriminating between pain and discomfort among patients with advanced cancer by using MTMM is crucial to help nurses provide effective management by appropriately evaluating pain and discomfort during the treatment process for these patients.

In Jordan, pain was the most common physical symptom reported by cancer patients (87%) [19]. There is a high level of pain among Jordanian patients who were undertreated; 82% of patients with cancer reported pain levels of at least six [20]. Up to our extensive search in literature and according to our knowledge, there were a few studies found used MTMM to discriminate between pain and discomfort among patients with advanced cancer in Jordan.

Therefore, we need to confirm that pain tools measure pain exactly among patients with advanced cancer and the discomfort tools measure the discomfort only among patients with advanced cancer. After that, we will use the happiness scale to discriminate between pain and discomfort among these patients. MTMM is the best method to achieve study purposes.

Reliable and valid tools for pain and discomfort among patients with advanced cancer can assist nurses to standardize pain and discomfort assessment and monitor them objectively. Therefore, this study aims to discriminate between pain by using three traits and two methods: two valid pain scales (verbal and non-verbal), discomfort (non-verbal and questionnaire), and happiness (scale and questionnaire) for confirmation of the discrimination among patients with advanced cancer in Jordan.

MATERIALS AND METHODS

A cross-sectional descriptive design was used in this study. The research was carried out within the oncology department of a prominent government hospital in Jordan. A non-probability convenience sampling technique was employed to collect data between January and February 2025. Inclusion criteria required participants to be patients diagnosed with stage 3 or stage 4 cancer, able to communicate verbally or in writing, and willing to participate in the study. Exclusion criteria included patients who declined to participate and those diagnosed with early-stage cancer (stage 1 or stage 2). The sample size was determined using G*Power software version 3.1 for a bivariate normal correlation model with a one-tailed test [21]. The significance level (p) was set at 0.05, and the power level was set at 0.80, with an effect size of 0.30. Based on these parameters, the calculated minimum sample size was 67 participants. However, to enhance the robustness of the study, the actual sample size recruited was 100 participants.

The researchers received approval from the scientific research ethics committee at this government hospital to collect data. Verbal and written consent forms were obtained from the patients, who met the eligibility criteria. The participants were interviewed by the researchers to fill out the questionnaires based on participants' responses including six measures at once a time in this order: pain, discomfort, and happiness.

Instruments

Numerical rating scale (NRS), patients were asked to circle the number between 0 and 10 which fits best to their pain intensity. Zero usually represents no pain at all whereas the upper limit represents the worst pain ever possible from 1-3 revealed mild pain, 4-7 revealed moderate pain, and 8-10 reflected severe pain [22]. NRSs have shown high correlations with other pain-assessment tools in several studies [22].

Adult non-verbal pain scale (NVPS) is a 10-point scale with five categories. The original categories for the NVPS included face (expression/grimacing), activity, guarding physiology I, and physiology II [23]. The lower value was 0 representing (no pain), and the highest score was 10 representing (the worst pain). The coefficient alpha for NVPS was .78 [23].

The body part discomfort scale was presented in [24]. This method was to divide the body into many parts. The subjects answered by the form of scoring to indicate which part was not comfortable, a 5-point rating scale, with 1 being 'not uncomfortable' and 5 'extremely uncomfortable'. Total body discomfort scores were obtained by summing all nine parts of the body, the highest value, the extremely uncomfortable 'was feeling [14].

Correlations for body part discomfort scale with three types of discomfort measure were done. Rated perceived effort (r = 0.875); body part discomfort frequency (r = 0.674); body part discomfort severity (r = 0.790); body part discomfort frequency severity (r = 0.838) [25, 26]. Intercorrelations for all measures, intercorrelations between novice and expert ratings exceeded 0.92, all with p 0.001 [25].

The discomfort scale provides a pain rating between 9 and 45 based on nine different parameters to determine if the patient is adequately comfortable or needs more medication due to feeling discomfort. Each parameter is rated from one to five. The total score ranges between 9 to 45, a score of 8-17 is oversedation, 17-26 generally indicates adequate sedation and pain control, and a score between 27-45 under sedated [27].

Happiness scale is a subjective assessment of whether a person is happy or unhappy. Adequate internal consistency in samples of different ages and cultures (r = .79 to r = .93), the satisfying indicators of convergent validity ranging from .52 to .72 between happiness scale and other happiness instruments [28]. Scoring is calculated by dividing the total score of questions by four. The answer ranges from 1-7, and the average score runs about 4.5-5.5.

The Oxford happiness questionnaire (OHQ) has been derived from the Oxford happiness inventory (OHI) [29]. It includes similar items to those of the OHI, each presented as a single statement that can be endorsed on a uniform six-point Likert scale [29].

Both the OHI and the OHQ demonstrated high-scale reliability with values a (167) = 0.92 and a (168) = 0.91, respectively [29].

Scoring revealed 1-2: not happy, 2-3 somewhat unhappy, 3-4 unhappy, 4-5 pretty happy, and 6: too happy [30].

RESULTS

The study included a total of 100 patients with advanced-stage cancer, with a mean age of 52 years (± 11.6). Eighty-one percent of the patients were in stage 4 of cancer, and 41% of the total sample had been diagnosed with breast cancer. Most patients (85%) undergo chemotherapy as their primary treatment. Also, 69% of the patients reported experiencing bone pain associated with chemotherapy (**Table 1**).

The mean total pain score among patients with advanced cancer, measured using the numeric pain scale, was 6.7 (± 2.4), while the NVPS yielded a mean score of 5.2 (± 2.6). Additionally, 43% of the patients reported moderate pain, 39% experienced severe pain, and 18% had mild pain.

Regarding discomfort, the mean total score based on the discomfort scale was 26.6 (± 6.2), and the discomfort questionnaire resulted in a mean score of 26.9 (± 8.0). Both tools consistently indicated that patients with advanced-stage cancer were experiencing significant discomfort, highlighting the need for interventions to address this issue.

For happiness, the mean total score measured by the happiness scale was 3.6 (± 1.2), while the OHQ yielded a mean score of 3.2 (± 1.1) (**Table 2**).

The Multi-Trait-Multi-Method Matrix Results

An MTMM correlation matrix was constructed to analyze the variables under consideration. Convergent validity coefficients, which reflect correlations between scores of the same trait measured using different methods, were examined. Discriminant validity coefficients, typically smaller than those of convergent validity, represent correlations between scores of different traits measured using the same method. The analysis proceeded in two steps.

First, the reliability diagonal was evaluated, revealing perfect correlations (r = 1) for each tool, indicating strong evidence of reliability and allowing the analysis to continue.

Table 1. Percentages of characteristics among patients with advanced-stage cancer (N = 100)

Cancer patient characteristic	Percentage (%)
Age (mean = 52 ± 11.6 years)	
Sex	
Male	46
Female	54
Marital status	
Married	47
Widowed	19
Divorced	24
Single	10
Educational level	
Primary	34
Secondary	43
Diploma	14
Bachelor's and above	9
Employment status	
Yes	32
No	68
Stages	
Stage 3	19
Stage 4	81
Cancer type	
Breast	41
Colon	20
Lung	9
Prostate	8
Testis	7
Kidney	3
Ovarian	3
Uterus	3
Brain	3
Pain location	
Bone pain	69
Others areas	31
NRS	
1-3	18
4-7	43
8-10	39

Table 2. Mean and standard deviation of the total score for each tool

Name of tool	Total scores mean (standard deviation)
NPS	6.7 (2.4)
NVPS	5.2 (2.6)
Discomfort scale	26.6 (6.2)
Discomfort questionnaire	26.9 (8.0)
Happiness scale	3.9 (1.2)
Happiness questionnaire	3.2 (1.1)

Second, the validity diagonals were assessed, showing that the relationships between measures of the same construct using different methods ranged from r = 0.66 to r = 0.89. These high correlations provide robust evidence for convergent validity (**Table 3**).

Table 3. Validity diagonal (convergent validity) in constructing a MTMM matrix

	Method one (scales)			Method two (questionnaires)		
	Pain	Discomfort	Happiness	Pain	Discomfort	Happiness
Method two (questionnaires)						
Pain	.83					
Discomfort		.66				
Happiness			.89			

Table 4. Heterotrait-monomethod and heterotrait-hertomethod (discrimination validity) in correlation in constructing a MTMM matrix

	Method one (scales)			Method two (questionnaires)		
	Pain	**Discomfort**	**Happiness**	**Pain**	**Discomfort**	**Happiness**
Method one (scales)						
Pain						
Discomfort	.77					
Happiness	-.29	-.24				
Method two (questionnaires)						
Pain		.79	-.31			
Discomfort	.63		-.26	.66		
Happiness	.29	-.28		-.28	-.26	

Table 5. An MTMM matrix employed for analysis of three constructs using two methods

	Method one (scales)			Method two (questionnaires)		
	Pain	**Discomfort**	**Happiness**	**Pain**	**Discomfort**	**Happiness**
Method one (scales)						
Pain	1					
Discomfort	.77	1				
Happiness	-.29	-.24	1			
Method two (questionnaires)						
Pain	.83	.79	-.31	1		
Discomfort	.63	.66	-.26	.66	1	
Happiness	.29	-.28	.89	-.28	-.26	1

Note. Blue diagonal: Monotriat-monomethod correlations; reliability coefficient; Brown diagonal: Monotriat-heteromethod correlations; convergent validity; Red triangles: Hetrotrait-monomethod correlations; construct validity; & Violet triangles: Hetrotrait-hetromethod correlations; discriminated validity

Third, correlations among measures of different constructs using rating scales and questionnaires were examined, with reference to the values in the diagonal validity. The heterotrait-monomethod triangle values ranged from r = -0.29 to r = 0.77, which are lower than those in the validity diagonal, providing further evidence for construct validity.

Fourth, the remaining correlations, representing measures of different constructs assessed by different methods, were entered into the lower block of the matrix. The heterotrait-heteromethod coefficients ranged from r = -0.31 to r = 0.79. These values are lower than those in the diagonal validity and the corresponding heterotrait-monomethod coefficients, offering strong evidence for discriminant validity (**Table 4**).

In summary, as shown in **Table 5**, the findings demonstrate strong evidence for reliability, convergent validity, construct validity, and discriminant validity.

DISCUSSION

This study was designed to rigorously evaluate whether the two pain measurement tools exclusively assess pain among patients with advanced cancer in Jordan, to determine whether the two discomfort measurement tools specifically capture discomfort in the same population, and to confirm the ability of the happiness scale to effectively discriminate between pain and discomfort in these patients. By addressing these objectives, the study provides critical insights into the precision and specificity of these measurement tools, contributing to a deeper understanding of how pain, discomfort, and happiness are assessed and differentiated in the context of advanced cancer care.

The numeric pain scale results indicated that 43% of patients with advanced cancer experienced moderate pain, 39% reported severe pain, and the remaining 18% had mild pain. These findings align closely with a meta-analysis conducted in [31], which found that 40% to 50% of patients with advanced cancer experienced moderate to severe pain, while 25% to 30% reported severe pain. This consistency between our results and the meta-analysis reinforces the validity of the numeric pain scale as a tool that accurately measures pain exclusively in this population.

The happiness scores indicated that patients with cancer expressed significant unhappiness, a finding consistent with the study in [32], which highlighted that patients with advanced cancer often experience feelings of hopelessness and diminishing their sense of happiness. Additionally, both discomfort measurement tools in this study consistently identified that patients with advanced cancer experienced considerable discomfort, underscoring the need for targeted interventions to alleviate it. This result aligns with the work in [33], who emphasized that discomfort is a prevalent issue among patients with advanced cancer and plays a critical role in their treatment, necessitating a focus on meeting their comfort-related needs [33].

The validity diagonals revealed strong relationships between measures of the same construct assessed using different methods, with correlations ranging from r = 0.66 to r = 0.89. These high correlations provide robust evidence for convergent validity. The strong validity of the two methods for each trait aligns with the second purpose of MTMM approach, which expects high correlations when the same trait is measured using different tools. This consistency underscores the effectiveness of MTMM framework in validating constructs through multiple measurement methods. These findings are consistent with the results of a systematic review conducted in [6], which examined pain assessment among patients with advanced cancer. The review highlighted the widespread use of multidimensional scales in numerous studies. Additionally, NRSs have demonstrated strong correlations with other pain-assessment tools across various studies, further validating their reliability and effectiveness. Notably, these scales are also practical and easy to administer [22].

The values of the heterotrait-monomethod triangle ranged from r = -0.29 to r = 0.77, which are lower than those in the validity diagonal, thereby providing evidence for construct validity. These results align with the expectations of the third step of the MTMM approach, where correlations in this step should ideally be low [34]. In this study, all traits were measured using a single method, revealing that the pain tools showed relatively high correlations with discomfort measures but very low correlations with happiness measures. This pattern further supports the discriminant validity of the constructs under investigation.

The heterotrait-heteromethod coefficients ranged from r = -0.31 to r = 0.79. These results align with the expected outcomes of the fourth step of MTMM approach, where correlation values in this step should be lower, providing evidence for discriminant validity [34]. This demonstrates that the MTMM approach effectively discriminates between the three traits: pain and discomfort show relatively high correlations with each other, while happiness exhibits low correlations with both pain and discomfort. This pattern underscores the distinctiveness of the constructs and reinforces the validity of the measurement approach.

Implication

MTMM approach stands as one of the most robust and appropriate methods for validating tools used to measure distinct traits. Discriminating between pain and discomfort among patients with advanced cancer is a critical issue in nursing practice, research, and education. It is essential to adopt a symptom-oriented approach in pain assessment, incorporating tools such as the NRP scale and NVP tool as integral components of pain assessment and management. This approach ensures the delivery of optimal interventions tailored to patients' needs. Nurses must be well-informed about these tools to select the most effective management strategies, ultimately achieving the best possible health outcomes for patients.

Hospitals should establish clear pain assessment policies for patients with advanced cancer, ensuring that validated pain measurement tools are used systematically rather than haphazardly. Nursing educators must prioritize teaching the proper use and discrimination between pain and discomfort tools, equipping nurses with the knowledge and skills necessary to provide high-quality care. Additionally, further MTMM studies should be conducted to confirm these findings and drive a transformative shift in pain assessment and management for patients with advanced cancer, fostering innovation and improving patient outcomes.

Limitations

The primary limitation of this study lies in the recruitment of the sample. Patients with advanced cancer are the most challenging populations for researchers to engage with, as they often experience severe physical, psychosocial, emotional, and spiritual distress, necessitating palliative care. Another limitation was observed in the data collection process. Administering six tools to each patient proved burdensome, as it was time-consuming, required effort, and led to patient boredom and fatigue, in some cases, an inability to complete all the tools simultaneously. These challenges highlight the need for more streamlined and patient-sensitive approaches in future research involving this vulnerable population.

CONCLUSION

MTMM approach is widely regarded as the gold standard in measurement for effectively discriminating between pain and discomfort among patients with advanced cancer. This distinction is critical for selecting appropriate assessment tools and plays a vital role in accurately evaluating pain and enhancing the prognostic precision of classification systems. By leveraging MTMM framework, nurses can make evidence-based decisions in pain management, to achieve optimal health outcomes for patients. This approach not only strengthens clinical practice but also underscores the importance of precise measurement in improving patients' quality of care.

Author contributions: SAS: design, definition of intellectual content, literature search, clinical studies, data acquisition, data analysis, statistical analysis, manuscript preparation, manuscript editing, manuscript review, and guarantor; **TRA:** design, definition of intellectual content, literature search, manuscript preparation, and guarantor; & **MA:** manuscript preparation, manuscript editing, manuscript review, and guarantor. All authors have agreed with the results and conclusions.

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Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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