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Research Article

Measurement Aspects of the Mishel Uncertainty in Illness Scale (MUIS) Related to Early-Stage Osteonecrosis of the Femoral Head (ONFH)

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ABSTRACT

This study proposal aims to examine uncertainty in illness in chronic disease among individuals with early-stage osteonecrosis of the femoral head (ONFH) and its relationships with symptom severity, quality of life (QoL), and psychological adjustment (PA), as well as its predictive role in patient outcomes. Secondary aims include quantifying the level of uncertainty in illness experienced by individuals with early-stage ONFH, evaluating the associations between uncertainty in illness and symptom severity, QoL, and PA, and determining the extent to which uncertainty in illness predicts patient outcomes, including psychological distress and QoL. In addition, it seeks to explore the relative contribution of uncertainty compared to clinical and demographic variables in explaining variation in patient outcomes and examine whether uncertainty differs across subgroups (e.g., age, gender, disease characteristics) supporting future assessment of measurement invariance and tailored interventions.

KEYWORDS

Osteonecrosis of the femoral head (ONFH), Early-stage ONFH, Uncertainty in illness, Chronic disease, Symptom severity.

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Introduction

Measurement in research is the systematic assignment of numerical values to variables to represent and quantify characteristics, perceptions, or behaviors under investigation [1,2]. Within health-related research, precise measurement is essential for capturing complex and often subjective patient experiences. Constructs such as illness-related uncertainty, symptom severity, quality of life (QoL), and psychological adjustment (PA) are particularly important among individuals living with chronic disease. Uncertainty hampers the formation of a cognitive structure (or the patient's subjective evaluation of the illness or treatment), which in turn limits that person's ability to adequately appraise a situation [3]. Measuring uncertainty within these constructs provides evidence of the influence these constructs have on patient decision-making and performance based on their perception of an illness - related event.

Osteonecrosis of the femoral head (ONFH) is a progressive musculoskeletal condition associated with pain, functional impairment, and an often unpredictable clinical course. This uncertainty can significantly influence patients' cognitive and emotional responses to illness. In this study, uncertainty is conceptualized using Mishel's Uncertainty in Illness Theory (MUIT), which defines uncertainty as the inability to determine the meaning of illness-related events. The construct of uncertainty is operationalized through the four dimensions of ambiguity, complexity, inconsistency, and unpredictability [3].

To ensure accurate representation of the construct, validated quantitative instruments are required [1,2]. Guided by MUIT, the Mishel Uncertainty in Illness Scale (MUIS) provides a structured, psychometrically supported measure of uncertainty as conceptualized through the four dimensions. The use of reliable and valid measures is essential to minimize measurement error and enhance the credibility of study findings. Consistent with MUIT, precise measurement enables examination of how uncertainty influences cognitive appraisal processes and subsequent adaptation, as reflected in key health outcomes, such as symptom burden, QoL, and psychological well-being. Utilizing standardized instruments, this study aims to advance theoretical application and contribute to a better understanding of uncertainty in individuals with early stage ONFH, ultimately informing evidence-based clinical interventions that aim to support improved patient outcomes.

Population of Interest

The population of interest for this study consists of young-to-middle-aged adults diagnosed with early-stage ONFH. This population is clinically significant due to the progressive and often unpredictable nature of the condition, which can lead to chronic pain, functional limitations, and decreased QoL. Individuals with early-stage I or II ONFH [4] may face uncertainty related to progression of the disease, treatment outcomes, and prospective surgical interventions.

Inclusion criteria for this population typically includes adult individuals aged 18-65 years old with a confirmed diagnosis of early-stage ONFH. Participants at early stage ONFH may be candidates for an investigational autologous bone marrow surgical procedure that aims to preserve the integrity of the femoral head before collapse and end-stage disease. Exclusion criteria may include individuals with cognitive impairments with limited ability to provide informed responses to self-report instruments, and those with co-morbid conditions that may confound the measurement of uncertainty.

Focusing on this population allows for a targeted examination of illness-related uncertainty within a group experiencing both physical and psychological challenges associated with a chronic musculoskeletal condition.

Research Questions

1. What is the impact of illness uncertainty on symptom severity/activities of daily living (ADLs), quality of life (QoL), and psychological adjustment (PA) in patients diagnosed with early-stage ONFH?
2. To what extent does illness uncertainty (IU) predict psychological adjustment (PA) in patients with early-stage ONFH?

Construct: Illness-Related Uncertainty

Illness-related uncertainty is a multidimensional construct consisting of four dimensions that include ambiguity, complexity, inconsistency, and unpredictability [1,5]. According to MUIT, ambiguity refers to unclear or vague symptom patterns, while complexity reflects difficulty understanding treatment regimens or healthcare systems. Inconsistency involves conflicting or changing information regarding the illness, and unpredictability relates to the inability to anticipate disease progression or outcomes. The unique aspect of MUIT is its application to uncertainty as a stressor in an illness context which is particularly meaningful for nursing [6].

An operational definition provides a measurable definition of a variable. In this ONFH study, uncertainty is operationalized using the MUIS, a widely used self-report instrument designed to quantify individuals' perceptions of uncertainty. The MUIS captures the extent to which patients experience uncertainty across the four dimensions, allowing for systematic measurement of this otherwise subjective construct [2,5,7].

Understanding illness-related uncertainty is essential, as it has been linked to important outcomes such as psychological distress, coping, and QoL. The original MUIT hypothesizes that managing uncertainty is essential in adapting to illness, thereby illustrating how individuals cognitively process illness-associated events and construct meaning from them [6]. Accurately conceptualizing and measuring this construct lays the groundwork for examining its role in how patients process information and experiences and for developing interventions aimed at reducing uncertainty.

Historical Development of MUIS

The theoretical underpinning of the MUIS is the MUIT (1981; reconceptualized 1990) [2,11] conceptualized as a mid-range theory utilizing the cognitive appraisal work of several theorists and originally containing eight dimensional properties that subsequently evolved into the four primary dimensional properties of ambiguity, complexity, inconsistency, and unpredictability [3,5]. Drawn from existing information-processing models [8] and personality research [9], the main theoretical construct is that uncertainty arises when individuals encounter insufficient cues making them unable to adequately interpret illness-related stimuli and make sense of their condition [3,5,7,10].

Since its development by Mishel, the MUIS has been widely used to assess uncertainty in clinical populations and has undergone multiple adaptations (e.g., MUIS-A, MUIS-C) to enhance applicability across settings [12]. The MUIS originated in nursing research as a tool to quantify patients' perceived uncertainty associated with chronic illness. Its primary aim was to examine uncertainty as a key factor influencing patients' experience of illness, treatment, and hospitalization, and it relationship to psychological stress [3,13-15].

Based upon this conceptualization, Mishel developed a 30-item scale extracting the uncertainty in symptomatology, diagnosis, treatment, relationship with caregivers, and planning for the future. As part of her work, Mishel published the original MUIS in 1981 to operationalize her theoretical construct—that uncertainty arises

when individuals are confronted with insufficient cues leaving them unable to adequately interpret illness-related stimuli and make sense of their condition. Early validation studies supported a multidimensional conceptualization of uncertainty, including ambiguity, complexity, inconsistency, and unpredictability.

In the initial development phase of MUIS, Mishel sought to identify illness-events perceived as uncertain experienced in hospitalized patients. She developed her preliminary scale comprised of 54 items that resulted from 62 original statements derived from the interviews of forty-five hospitalized patients. The items, thought to reflect uncertainty and uncertainty-related tasks, underwent review by a panel of experts. Select items were cast into a matrix of four classes of illness events by eight dimensions of uncertainty. From the matrix, four subscales (e.g., factors) were predicted by collapsing some of the uncertainty dimensions and considering the cluster of items across dimensions and classes of events. The four predicted factors included ambiguity, lack of information, unpredictability, and lack of clarity. To evaluate and improve question clarity, the 54-item MUIS scale was constructed on a five-point Likert format which underwent review by groups of nurses, doctors, and general medical and surgical patients. Based on the findings, the scale was modified through item rewording and elimination of specific items. The modified scale was administered to 259 hospitalized patients with inclusion and exclusion criteria. The MUIS data of 250 cases underwent factor analysis using classical factor analysis and an orthogonal (Varimax®) rotation by assuming the factors are not related to each other. Varimax is a statistical technique used in factor analysis to clarify distinct dimensions, and, in this case, dimensions of uncertainty. Utilizing classical factor analysis, it was assumed that the four dimensions of uncertainty would emerge as factors that would account for the observed correlations of the data. Contrary to the hypothesized four-factor structure, however, results from the two-factor analyses did not support the emergence of four distinct factors, suggesting that the instrument did not operate as a clear four-subscale measure in this dataset. Following the initial factor analysis, a set of selected criteria applied to the items yielded a reduction in the number of scale items from 54 to 30. Subsequent psychometric evaluations consistently identified a more parsimonious two-factor structure. The MUIS demonstrated a stable two-factor solution, with ambiguity emerging as a dominant factor. Reliability estimates indicated strong internal consistency for ambiguity, whereas unpredictability showed moderate reliability, suggesting weaker coherence within this dimension.

In an independent sample, replication of the factor structure supported its stability. Construct and convergent validity were supported through expected associations with related constructs. Higher uncertainty was significantly associated with lower comprehension (r = -.56, p < .002), with a stronger relationship observed for ambiguity (r = -.63, p < .001). Unpredictability was not statistically significant, though trends were in the expected direction. Further validation demonstrated that uncertainty was positively associated with stress (r =.35, p < .001), with ambiguity accounting for 12% of the variance. Unpredictability did not contribute additional explanatory power. These findings suggested that dimensions of uncertainty did not contribute equally, with ambiguity representing the most robust component.

Overall, although the MUIS demonstrated acceptable reliability and validity supported by a two-factor structure, the emergence of a dominant general factor raised questions about whether the instrument fully captured the theoretically proposed multidimensional structure. In particular, the weaker performance of unpredictability suggested incomplete representation of the uncertainty construct. Both factors demonstrated strong reliability, and validation studies providing evidence for construct and convergent validity.

Table 1: Summary of Psychometric Evidence for the Mishel Uncertainty in Illness Scale (MUIS)

Property	Evidence	Statistics/Findings	Interpretation	Key Sources
Internal Consistency	Cronbach's alpha (total scale and subscales	Total: α = .74-.92; Subscales: α = .65-.89	Acceptable to strong internal consistency; supports structural coherence	Mishel [3], Waltz et al. [33]
Test-Retest Reliability	Stability over tie (~2-week interval and beyond)	r = .91 (original); range .74-.91; Japanese version: r = .61	Moderate to excellent temporal stability; variability across populations	Guan et al. [12]; Mishel [3]; Nogawa (2004)
Construct Validity (Convergent)	Correlations with related constructs (e.g., anxiety, distress)	Expected positive correlations observed	Supports convergent validity of uncertainty construct	Waltz et al. [33]
Factor Structure	Factor stability across populations	Some variability reported	Suggests potential construct drift or population-specific structure	Guan et al. [12]
Subscale Performance	Unpredictability subscale	Psychometrically weaker in some studies	Indicates uneven reliability across dimensions	Multiple studies
Content/Construct Coverage	Scope of uncertainty captured	Strong for ambiguity and unpredictability	May not fully capture decision-making uncertainty or healthcare system complexity	Current critique
Cross-Cultural Validity	Use across different populations	Variability in psychometric performance	Cultural/contextual adaptation may influence validity	Multiple studies
Overall Assessment	Combined reliability and validity evidence	Consistent support across studies	MUIS is a generally valid and reliable measure, though not fully comprehensive and potentially incomplete for disease specific	Guan et al. [12]; Mishel [3]

Reliability and Validity of the Contemporary MUIS

The contemporary MUIS demonstrates strong psychometric properties across diverse patient populations (Table 1). Reliability, defined as the consistency and stability of a measurement instrument, is well supported [1,2]. The MUIS exhibits high internal consistency, with Cronbach's alpha coefficients typically exceeding .80, indicating that scale consistently measures the construct of uncertainty [3,13-15].

Validity refers to the extent to which an instrument accurately measures the intended construct [1,2]. Content validity of the MUIS is grounded in Mishel's theoretical framework ensuring alignment between the construct and its operationalization. Construct validity is supported through factor analytic findings that confirm the multidimensional nature of uncertainty encompassing ambiguity, complexity, inconsistency, and unpredictability [12,13].

Convergent validity is demonstrated through significant associations with related constructs, including anxiety, depression, and coping [12,16]. Collectively, these findings indicate that the MUIS performs consistently in relation to theoretically linked variables.

Theoretical Substraction of the Mishel Uncertainty in Illness Scale (MUIS)

The MUIS operationalizes the central construct of the Uncertainty in Illness Theory (UIT) by measuring uncertainty as a cognitive state rather than an emotional response. It assesses perceived uncertainty across four domains—ambiguity, complexity, inconsistency, and unpredictability—which reflect unclear symptoms, complex healthcare systems, conflicting information, and uncertain illness trajectories [3,5]. Translated into measurable dimensions through a Likert-type scale, these domains allow for both total and subscale scores that capture how individuals interpret and respond to uncertain illness-related cues [3,5].

At the highest level, the core proposition of the theory is that illness-related uncertainty occurs when a person cannot assign meaning to illness events due insufficient cues. The core theoretical construct is the cognitive state of uncertainty. Uncertainty is defined as the inability to structure meaning, predict outcomes and/or interpret illness-related stimuli [3,13-15] Within this framework, the antecedent structure includes the stimuli frame (e.g., symptom pattern, event familiarity, event congruence) which explains why uncertainty arises and shapes how illness cues are processed. When these stimuli lack clarity, consistency or predictability, uncertainty emerges and is experienced through its defining four dimensions of ambiguity, complexity, inconsistency, and unpredictability. These dimensions (e.g., antecedents or conceptual domains) represent the structural properties of the uncertainty construct and provide the conceptual basis for operationalization. These domains directly informed item-development for the original MUIS scale which measures perceived uncertainty. The MUIS yields a total uncertainty score and, depending on the scoring approach, subscale scores. The theoretical assumptions of MUIT posit that illness events are cognitively processed; that individuals are unable to form a clear schema when stimuli are insufficient, inconsistent, or ambiguous; and that uncertainty is appraised as either a danger, resulting in distress, or an opportunity, particularly in the context of chronic illness adaptation [3,15]. (See Figure 1).

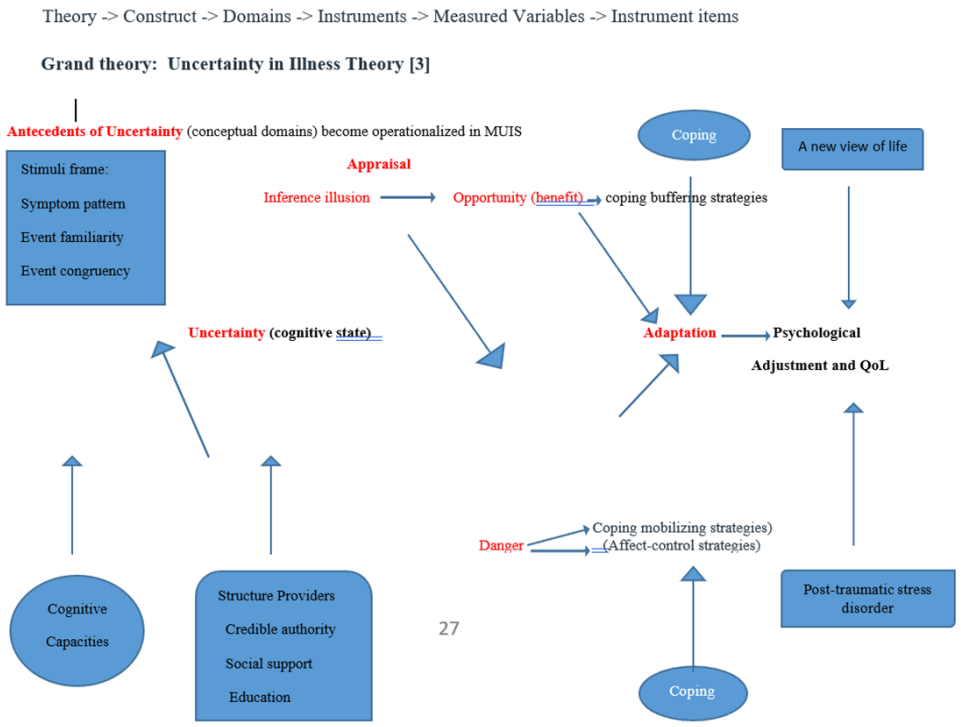

Figure 1: Concept map based on the MUIT theoretical substraction of MUIS.

The Theoretical Tree of MUIS

The theoretical tree provides a framework for guiding the development and revision of the MUIS, particularly at the construct and dimensional levels. However, this guidance is not uniformly applied across all structural components of the theory. MUIS primarily reflects the core definition of uncertainty, its dimensional properties, and the cognitive appraisal inherent in the construct. It does not directly capture key elements of a broader theoretical model, including structure providers, appraisal (e.g., danger vs. opportunity), or adaptation outcomes.

Factor analytic findings across diverse populations have demonstrated variability in the instrument's structure, indicating that empirical results have at times guided revisions more strongly than strict adherence to theoretical expectations. Consequently, MUIS revisions appear to be both theory-informed and empirically refined rather than exclusively theory-driven [16,17]. Accordingly, the MUIS can be understood as a focused operationalization of the core uncertainty construct, rather than a comprehensive measure of the full theoretical framework [3,17,18]. As such, it represents a partial mapping of the theoretical tree, with certain domains—particularly those related to appraisal and adaptation—remaining underrepresented [3,17,18].

Dimensions of Illness Uncertainty in Early-Stage ONFH

Mishel's defining concepts of uncertainty—ambiguity, complexity, inconsistency, and unpredictability—closely reflect the lived experience of individuals with early stage osteonecrosis of the femoral head (ONFH). Ambiguity refers to vague or difficult-to-interpret symptoms (e.g., deep groin pain that may mimic muscle strain). Complexity involves cognitively demanding treatment decisions, such as choosing between early hip-preserving interventions and the potential need for total hip arthroplasty (THA), often alongside multiple specialist opinions. Inconsistency arises from conflicting information provided by healthcare professionals (e.g., "You're fine for now" vs "You may eventually need a hip replacement"). Unpredictability reflects uncertainty about disease progression and future outcomes, including whether and when femoral head collapse or symptom worsening may occur. Together, these dimensions capture the multifaceted nature of uncertainty in ONFH.

Relevance of MUIS to Early-Stage ONFH

In the ONFH study, each key variable will be measured using validated quantitative instruments. Illness uncertainty (IU) will be measured using the MUIS which assesses patients' perceptions of ambiguity, complexity, inconsistency, and unpredictability related to their illness. A modified MUIS may also be utilized to assess uncertainty in illness (defined as the inability to determine the meaning of illness-related events) [3,12]. Validity and reliability of each MUIS version is established across various populations through numerous studies with most demonstrating strong internal consistency and with some nuances, construct, convergent, discriminant, and predictive validity [3,12]. To illustrate nuances, construct validity is supported but factor analysis is not always stable and with convergent validity there are overlaps with distress constructs [12].

Symptom severity will be measured using the Osteonecrosis Symptom Interference Scale (OSIS) to measure the severity and interference of ON-related symptoms specifically targeting pain, stiffness, mobility limitations and fatigue or the Numeric Pain Rating Scale (NPRS) to quantify pain intensity associated with ONFH [19]. Quality of life (QoL) will be measured using a health-related QoL instrument such as the Patient Reported Outcomes Measurement Information System (PROMIS) developed by the National Institutes of Health (NIH) aimed at measuring patient reported outcomes (PROs) across various medical conditions and used in orthopaedic studies. Psychological adjustment will be measured using the Psychological Adjustment to Illness Scale (PAIS-SR) (Self-Report Version) to measure psychological adjustment to living with early stage ONFH.

The primary variables will be measured at the interval or ratio level making parametric statistical techniques appropriate. Pearson product moment correlation coefficients will be used to examine the magnitude and direction of relationships among IU, symptom severity, QoL, and PA. Symptom severity will be treated as a continuous variable with higher scores indicating greater symptom burden. IU will be measured as a continuous psychological construct reflecting perceived ambiguity. QoL will be operationalized using a standardized scale with scores representing perceived physical and psychosocial well-being. PA will be measured as a continuous variable reflecting emotional and cognitive adaptation to illness. Multiple regression analysis will be conducted to evaluate the extent to which symptom severity and uncertainty predict QoL and PA.

Integrated Critique of the MUIS

Despite the noted strengths of the MUIS, several limitations warrant consideration. While the MUIS demonstrates conceptual relevance, it is limited by several measurement concerns that may affect validity and reliability [20]. Cognitive burden is generally manageable; however, items requiring interpretation of probabilistic outcomes or complex diagnostic information may be taxing, particularly for individuals with limited health literacy or those early in their illness trajectory, potentially reducing response accuracy [21]. Interpretation variability is a notable limitation, as item meaning may differ based on contextual factors; for example, items related to provider communication or inconsistent test results may reflect experiences unrelated to uncertainty, introducing construct-relevant variance. Ambiguity in item scope further contributes to this issue, as some items lack specificity regarding whether they refer to prognosis, symptoms, or treatment outcomes, increasing the likelihood of inconsistent interpretation. Additionally, the inclusion of reverse-worded and double-barreled items may introduce confusion and response inconsistency [22]. Collectively, these issues suggest reduced measurement precision and potential threats to construct validity. Although grounded in Mishel's theoretical framework, the MUIS represents a partial

operationalization of the construct, capturing core elements of uncertainty but not fully reflecting the breadth of the theoretical model [17].

Overall, the MUIS is psychometrically sound with strong evidence supporting its reliability and validity. MUIS demonstrates conceptual relevance for assessing uncertainty in illness; however, several measurement limitations may affect its psychometric performance, particularly in individuals with early-stage ONFH. Cognitive burden, while generally acceptable, may increase for items requiring interpretation of probabilistic outcomes or complex diagnostic information. In early-stage ONFH, where symptoms are often intermittent and diagnostic trajectories are evolving, this may reduce response accuracy and introduce random measurement error, thereby attenuating reliability. Ambiguity in item scope further limits measurement precision. Several items lack specificity regarding whether they refer to prognosis, symptoms, functional decline, or treatment outcomes. In the context of ONFH, where disease progression, pain, and functional limitations may not align temporally, this ambiguity may result in inconsistent item interpretation across respondents. Consequently, this threatens both construct validity and measurement invariance, as individuals at different disease stages may systematically interpret items differently [23,24]. Items combining multiple constructs within a single statement can produce ambiguous responses and increase measurement error [25]. These issues are particularly relevant for respondents with lower health literacy or limited illness familiarity, further compromising scale coherence.

Collectively, these limitations suggest that the MUIS may demonstrate reduced reliability, compromised construct validity, and potential violations of measurement invariance in ONFH populations. Although the instrument is grounded in MUIT [3,5,18], it represents a partial operationalization of the construct. While it captures core dimensions such as ambiguity and unpredictability, it does not fully reflect the broader theoretical framework, including evolving conceptualization such as existential uncertainty [17]. Thus, the MUIS may be best interpreted as a focused measure of uncertainty rather than a comprehensive assessment of the construct in individuals with ONFH.

Existing Instruments that Measure Uncertainty

Several validated instruments are available to measure uncertainty, however, their applicability varies depending on the clinical context. The MUIS is the most widely used and theoretically grounded measure aligning with MUIT and capturing its key four dimensions. It demonstrates strong reliability and construct validity across diverse populations, making it particularly suitable for chronic and progressive conditions such as ONFH, where patients often face unclear prognosis and variable disease trajectories. However, given the limitations of MUIS, which may affect measurement precision in early-stage ONFH where experiences of uncertainty differ in later stages, alternative measures may be considered. These include the Intolerance of Uncertainty Scale (IUS) which assesses a general dispositional tendency to respond negatively but lacks specificity to illness contexts, limiting its sensitivity to clinical phenomena [26]. The Uncertainty Response Scale (URS) expands measurement by capturing cognitive, emotional, and behavioral responses to uncertainty [27]. However, the URS shifts focus away from uncertainty as a cognitive appraisal toward coping and reaction. Other psychological measures (e.g., anxiety or distress scales) may indirectly reflect uncertainty but do not measure the construct explicitly [28].

Comparison of Other Uncertainty Scales to the MUIS

While multiple instruments exist, the MUIS provides the most conceptually and clinically relevant measure for this ONFH study. Nonetheless, its minor limitations (e.g., item ambiguity and factor variability) highlight the importance of careful interpretation, and, where appropriate, consideration of complementary measures to fully capture the multidimensional experience of uncertainty.

The IUS and the MUIS differ in both psychometric scope and conceptual focus. The IUS demonstrates strong psychometric properties, including high internal consistency (Cronbach's α often > .90, stable two-factor), selective and inhibitory anxiety, and robust convergent validity with anxiety, worry, and related constructs [26]. It also show good test-retest reliability and has been widely validated across general and clinical populations [26]. However, the IUS measures a dispositional tendency to react negatively to uncertainty rather than uncertainty with a specific illness context. In contrast, while the MUIS also demonstrates strong reliability (α~.70-.90+) and established construct, convergent, and predictive validity, it is specifically designed to assess illness-related uncertainty grounded in theory [3,14,15].

In contrast to the MUIS, the URS demonstrates acceptable reliability and construct validity, including multidimensional factor structures and criterion-related validity in predicting psychological and physiological responses [27]. However, its evidence base is less extensive, and its focus on responses to uncertainty—rather than cognitive appraisal—may limit conceptual alignment. The URS does not assess sources of uncertainty and is not illness-specific. Similarly, while the IUS shows strong psychometrics, its lack of clinical specificity limits applicability to conditions such as ONFH. Overall, the MUIS remains more appropriate for assessing illness-related uncertainty, as the URS and IUS have limited ecological validity in clinical populations.

Proposed Revised Measure of Uncertainty in Illness

A proposed revised measurement scale would be developed using a systematic, multi-phase approach grounded in theory and psychometric best practices [29]. First, item generation will be informed by MUIT, along with an integrative review of the literature, and qualitative interviews with patients experiencing chronic conditions such as ONFH. Items will be designed to reflect distinct domains of uncertainty, including cognitive appraisal, emotional responses, and behavioral responses, while avoiding double-barreled wording and ensuring clarity across varying levels of health literacy [30].

An improved measure of uncertainty in illness would build upon strengths of existing tools, such as MUIS, while addressing key limitations related to item clarity, dimensional coverage, and contextual sensitivity. The proposed instrument will be a multidimensional, patient-centered scale that captures both the cognitive appraisal of uncertainty (e.g., ambiguity, unpredictability) and the emotional and behavioral responses to uncertainty (e.g., distress, coping). Items will be written in clear, single-concept statements to avoid double-barreled wording and reduce interpretation variability. The scale will include modular subscales adaptable to disease stage (e.g., early diagnoses vs. chronic progression), thereby improving relevance for conditions such as ONFH.

Psychometrically, the instrument will be developed using modern measurement approaches, such as item response theory (IRT) and confirmatory factor analysis (CFA) to ensure strong reliability, stable factor structure, and measurement invariance across populations [31,32]. IRT is an approach to constructing cognitive and psychological measures focusing on item performance that usually serves as the basis for computerized adaptive testing (CAT) [32,33]. CFA is a statistical method that will be important to evaluate whether MUIS actually reflects the construct of uncertainty as defined by MUIT [36,37]. Reliability refers to the consistency, stability, and repeatability of a tool and is fundamental to understanding and evaluating the quality of decisions that are made by psychological measurement of the new tool [1,2]. Additional features will include short-term and CAT options to reduce respondent burden, as well as culturally-sensitive and health literacy-appropriate language. Measurement invariance is important in assessing whether the revised MUIS measures uncertainty in the same way across different groups [24]. Establishing validity is one of the most important issues in psychological measurement [1,2]. Validity is defined as the degree to which evidence and theory support the interpretations of test scores entailed by the proposed uses of a test [28,38,39]. Establishing validity of the revised MUIS scale is essential to assessing whether or not it measures what it is supposed to measure [40]. Establishing validity (e.g., content, construct, convergent, discriminant, and predictive), along with responsiveness to clinical change, would further strengthen its utility [2,41]. Overall, this improved measure will provide a more comprehensive, precise, and clinically meaningful assessment of the cognitive appraisal of uncertainty in illness. (See Figure 2).

Testing Plan for the Proposed Revised MUIS

Content validity will be established through expert panel review, including clinicians, researchers, and patient representatives, to ensure comprehensive coverage of the construct domain [2]. Content validity indexing procedures will be used to quantify item relevance [2]. Cognitive interviewing will further assess item clarity, interpretability and relevance [2,33].

Following pilot testing, construct validity will be evaluated within the framework of MUIT. Exploratory factor analysis (EFA) will be

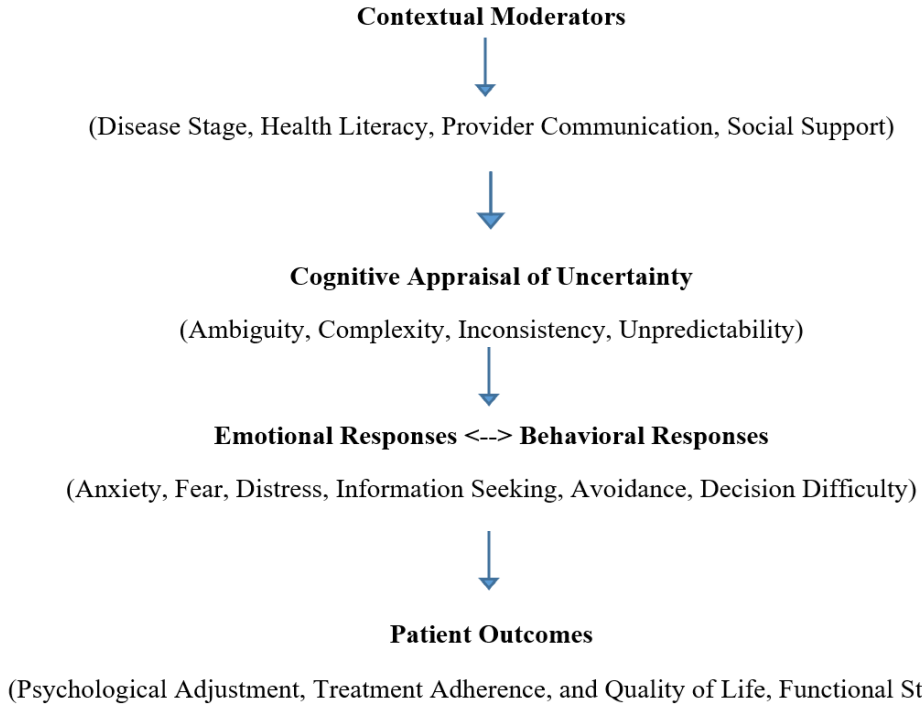

Figure 2: Conceptual Model of the Enhanced MUIS.

Note: The enhanced MUIS conceptualizes uncertainty as a multidimensional construct centered on cognitive appraisal. Contextual moderators influence both appraisal and response processes. Bidirectional arrows indicate reciprocal relationships between emotional and behavioral responses. All pathways contribute to downstream patient outcomes.

conducted to identify the underlying factor structure of uncertainty in early stage ONFH. This will be followed by confirmatory factor analysis (CFA) in an independent sample to test model fit and validate dimensional structure [33].

Psychometric evaluation will also include assessment of internal consistency reliability (Cronbach's alpha), test-retest reliability and measurement invariance across demographic and clinical subgroups [2,34]. Construct validity will be examined through convergent and discriminant validity testing with related constructs (e.g., anxiety, coping, quality of life), while predictive validity will be assessed through associations with clinical and psychosocial outcomes over time [35].

Item response theory (IRT) modeling will be used to evaluate item performance, identify poorly functioning items, and assess differential item functioning across stages [42]. These analyses will support scale refinement and the potential development of short-form and computer adaptive testing (CAT) versions to reduce respondent burden [42]. Finally, responsiveness to clinical change will be evaluated to determine the instrument's sensitivity to changes in patient status over time [50].

Anticipated Issues for the Proposed Revised MUIS

The development of a revised MUIS presents several methodological and ethical challenges. Conceptually, careful delineation of domains is required to avoid construct overlap and ensure alignment with patients' lived experiences. Psychometric challenges include establishing a stable factor structure, strong construct validity, measurement invariance across diverse populations, and adequate responsiveness to clinical change [43,50]. Failure to achieve measurement invariance may result in biased interpretations and perpetuate disparities in care [44].

Additionally, the revised instrument must demonstrate clear advantages over existing measures (e.g., MUIS, IUS, URS) to justify its development. Sampling limitations may restrict generalizability, particularly across sociocultural groups. Ethical concerns include the potential for emotional distress, risk of misinterpretation or misuse of scores in clinical contexts, and issues related to confidentiality, voluntariness, and data sensitivity control [45,51]. Ensuring clear guidance for interpretation and maintaining rigorous ethical standards are essential to support valid, equitable, and clinically meaningful use of the measure [45,46].

Alternative strategies employed if instrument performance is inadequate

If the proposed measure demonstrates inadequate psychometric performance, several alternative strategies will be employed. Item-level analyses will guide the removal or revision of poorly performing items, supplemented by cognitive interviewing and expert review to enhance clarity and content validity. Factor structure will be re-evaluated using exploratory and confirmatory factor analysis, with consideration of alternative models such as hierarchical or bifactor structures [47,48]. Reliability and validity will be strengthened through refinement of items and inclusion of theoretically relevant constructs by reducing measurement error, ensuring content accuracy, and anchoring the measurement in a robust conceptual framework [34].

Refining items—such as removing ambiguous wording and improving relevance—increases the precision of the tool (e.g., reliability) and ensures it measures the intended trait (e.g., validity), while grounding the tool in established theory ensures that crucial dimensions are not omitted [34]. Measurement invariance will be assessed with non-invariant items modified or removed as needed [49]. Responsiveness may be improved by revising item content and response scaling [50]. Additionally, sampling strategies will be expanded to enhance generalizability [50]. Advanced analytic approaches, including IRT, may be employed to improve measurement precision [42]. If necessary, established instruments, such as MUIS, IUS, or URS will be used concurrently to support validation efforts. This iterative approach ensures ongoing refinement and supports the development of a psychometrically sound and clinically meaningful instrument.

Conclusion

This review and proposed study advance understanding of uncertainty in illness among individuals with early-stage ONFH by examining its relationships with symptom severity, QoL, and PA. Uncertainty is conceptualized as a central factor influencing patient outcomes, extending Mishel's theoretical framework. Findings underscore the importance of addressing uncertainty as a modifiable psychosocial factor affecting well-being and QoL, supporting the development of targeted, theory-driven nursing interventions.

Rigorous measurement remains essential; the use of validated instruments enhances precision, interpretability, and reproducibility of findings. Robust psychometric properties enhance the credibility of study findings and strengthen the interpretation of relationships between uncertainty and health outcomes. The use of a reliable and valid instrument such as the MUIS, or an expanded version, is necessary for minimizing measurement error and ensuring that findings accurately reflect patients' experiences of uncertainty.

References

1. Alexa Colgrove Curtis, Courtney Keeler. Measurement in Nursing Research. Am J Nurs. 2021; 121: 56-61.
2. Furr M, Bacharach V. Psychometrics (2nded.). SAGE publications. 2014.
3. Mishel M. The measurement of uncertainty in illness. Nurs Res. 1981; 30: 258-63.
4. Ficat RP. Idiopathic bone marrow necrosis of the femoral head. Early diagnosis and treatment. J Bone Joint Surg Br. 1985; 67: 3-9.
5. Mishel M. Uncertainty in illness. Image J Nurs Sch. 1988; 20: 225-232.
6. Bailey D. Illness Uncertainty at 40. West J Nurs Res. 2021; 43:

507-508.

7. Julia Sabin, Elisa Salas, Jesús Martín-Martínez, Antonio Candeliere-Merlicco, Francisco Javier Barrero, et al. Assessing illness-related uncertainty in relapsing-remitting multiple sclerosis: A psychometric analysis of the Mishel Uncertainty of Illness Scale. Mult Scler J Exp Transl Clin. 2024; 10: 2052173241247680.
8. Hamilton Vernon, Warburton David M. Human stress and cognition: an information processing approach. 1979.
9. Budner S. Intolerance of ambiguity as a personality variable. J Pers. 1962; 30: 29-50.
10. https://nursekey.com/uncertainty-in-illness-theory/
11. Mishel M. Reconceptualization of the uncertainty in illness theory. Image J Nurs Sch. 1990; 22: 256-262.
12. Guan T, Zhang Y, Northouse L, Song L. Psychometric properties of the Brief Mishel Uncertainty in illness scales for patients with advanced cancer and their family caregivers. BMC Psychol. 2025; 13: 317.
13. Bailey D, Landerman L, Barroso J, Bixby P, Mishel M, et al. Uncertainty, symptoms, and quality of life in persons with chronic hepatitis C. Psychosomatics. 2009; 50: 138-146.
14. Khatun Z, Bailey D, Islam S, Hasan M. Assessment of Uncertainty in Illness and its Correlated Factors among Patients with Cancer at Tertiary Level Hospitals. Delta Med Col J. 2022; 10: 45-51.
15. https://nursing.unc.edu/news/from-the-vault-merle-mishel-transforming-research-and-patient-care
16. Sharkey C, Perez M, Bakula D, Grant D, Mullins L. Exploratory Factor Analysis of the Mishel Uncertainty in Illness Scale Among Adolescents and Young Adults with Chronic Medical Conditions. J Pediatr Health Care. 2019; 33: 186-194.
17. Eppel-Meichlinger J, Kobleder A, Mayer H. Refining Mishel's Reconceptualized Uncertainty in Illness Theory: Explaining the Development of Uncertainty in Chronic Illness. Res Theory Nurs Pract. 2024; 38: 171-192.
18. Mishel M. Reconceptualization of the uncertainty in illness theory. Image J Nurs Sch. 1990; 22: 256-262.
19. https://www.physio-pedia.com/Numeric_Pain_Rating_Scale
20. https://www.cogn-iq.org/learn/theory/scale-development/
21. Klatt E. Cognitive factors impacting patient understanding of laboratory test information. J Pathol Inform. 2023; 15: 100349.
22. Sonderen van E, Sanderman R, Coyne J. Ineffectiveness of reverse wording of questionnaire items: Let's team from cows in the rain. PLoS ONE. 2013; 8: e689767.
23. Putnick D. Bornstein M. Measurement invariance conventions and reporting. Dev Rev. 2016; 41: 71-90.
24. Vandenberg R, Lance C. A review and synthesis of the measurement invariance literature. Organizational Research Methods. 2000; 3: 4-70.
25. De Vellis R, Thorpe C. Scale development: Theory and applications (5thed.). Sage. 2021.
26. Lin Y, Mason D, Zhong S, Hirsch C, Happé, F. How is "intolerance of uncertainty" (IU) measured? A systematic review of assessment tools for IU and the psychometric properties of IU questionnaires. Clinical Psychology: Science and Practice. 2024; 31: 179-204.
27. Odintsova M, Radchikova N, Sorokova M. Uncertainty Response Scale: The Assessment Tool for Adolescent Interaction with Multidimensional Stress. DOAJ. 2024; 13: 106-128.
28. https://www.apaservices.org/practice/measurement-based-care/suggested-measures#:~:text=The%20Generalized%20Anxiety%20Disorder%20Scale,ADHD%20Hyperactive%20(subscale%20B)
29. Streiner D, Norman G, Cairney J. Health measurement scales. A practical guide to their development and use (5thed.). Oxford University Press. 2015.
30. Gupta S, Grover S, Menon V, Indu P, Vidhukumar K, et al. Item generation and establishing face and content validity of a rating scale: A primer. Indian J Psychiatry. 2025; 67: 816-822.
31. De Vellis R. Scale Development: Theory and Applications (4thed). Sage Publications. 2017.
32. Lee C, Riegel B. Psychometric Testing of the Updated Self-Care of Heart Failure Index Version 8.0. Using Item Response Theory. J Cardiovasc Nurs. 2026; 41: 87-96.
33. Waltz C, Strickland O, Lenz E. Measurement in Nursing and Health Research (5thed). Springer Publishing Co. 2017.
34. https://www.scribbr.com/methodology/construct-validity/#:~:text=Be%20clear%20on%20how%20you,variable%20bias%20or%20information%20bias.
35. https://www.simplypsychology.org/predictive-validity.html
36. Brown T. Confirmatory factor analysis for applied research (2nded). Guilford Press. 2015.
37. Kline R. Principles and practice of structural equation modeling (4thed). Guilford Press. 2016.
38. https://www.apa.org/science/programs/testing/standards
39. National Council on Measurement in Education. Educational Measurement (5thed). NCME. Oxford. 1999.
40. Steven Alfred Frost, Evan Alexandrou. Misclassification and measurement error - planning a study and interpreting results. Nurse Res. 2021; 29: 21-25.
41. https://agentsofchangeprep.com/blog/different-methods-to-assess-reliability-and- validity-in-mental-health-research/
42. Baker F, Kim S. Item Response Theory. Parameter Estimation Techniques (2nded.). CRC Press. 2004.
43. Lin Y, Mason D, Zhong S, Hirsch C, Happé, F. How is "intolerance of uncertainty" (IU) measured? A systematic review of assessment tools for IU and the psychometric properties of IU questionnaires. Clinical Psychology: Science and Practice. 2024; 31: 179-204.

44. Cross L, Choma M, Onofrey J. Bias in medical AI: Implications for clinical decision making. PLOS Digit Health. 2024; 3: e0000651.
45. Findley M, Ghosn F, Lowe S. Vulnerability in research ethics: A call for assessing vulnerability and implementing protections. PNAS. 2024; 121: e2322821121.
46. https://az.research.umich.edu/medschool/guidance/evaluating-risks-participants/
47. Markon K. Bifactor and Hierarchical Models: Specification, Inference, and Interpretation. Annu Rev Clin Psychol. 2019; 15: 51-69.
48. Polit D, Beck C. Essentials of Nursing Research: Generating and Assessing Evidence for Nursing Practice (10thed). Lippincott. 2021.
49. Protzko J. Invariance: What Does Measurement Invariance Allow Us to Claim?. Educ Psychol Meas. 2025; 85: 458-482.
50. Revicki D, Hays R, Cella D, Sloan J. Recommended methods for determining responsiveness and minimally important differences for patient-reported outcomes. J Clin Epidemiol. 2008; 61: 102-109.
51. Salifu Y. Ethical challenges in sensitive research: a reflective narrative on managing the clinician-researcher dual role. BMC Palliat Care. 2025; 24: 205.