

Future trends in instrument development in nursing research: From traditional psychometrics to cross-cultural and digital measurement approaches

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Abstract

Measurement instruments are fundamental to nursing research, as they are a cost-effective method for nursing personnel to quickly understand various health and behaviors, such as quality of life and functional health outcomes. Although many instruments have been developed using traditional psychometric approaches, conventional measurement practices may need to be reevaluated. Specifically, emerging challenges, including cultural diversity in global research, multidimensional health constructs, and the rapid development of digital health technologies, have revealed limitations in conventional measurement practices. This editorial discusses key issues in instrument development within nursing research and highlights future directions for methodological advancement. For example, future efforts should emphasize rigorous construct validation, cross-cultural adaptation, measurement invariance testing, and the integration of digital and real-time measurement tools. Advancing these approaches will enhance the validity, applicability, and global relevance of measurement instruments, thereby strengthening the evidence base that informs nursing practice, education, and health policy.

Keywords: cross-cultural validation; digital health; instrument development; nursing research; psychometrics.

Measurement is a cornerstone of nursing research, providing the means to capture complex, multidimensional phenomena, such as symptom experiences, health-related quality of life, functional ability, psychological well-being, and patient engagement, that cannot be directly observed (Omolade et al., 2025). Symptom science research, in particular, emphasizes understanding holistic mechanisms, ensuring accurate assessment, and promoting patient-centered management, highlighting the essential role of reliable and valid measurement tools in advancing nursing knowledge. Over the past decades, nursing research has made significant strides in developing and validating instruments to assess clinical symptoms, psychosocial constructs, patient experiences, and health behaviors across diverse populations. Traditional psychometric approaches, including internal consistency, exploratory and confirmatory factor analysis, and basic construct validity testing, have contributed to methodological rigor and produced numerous widely used scales (López-Pina & Veas, 2024).

Nonetheless, the evolving landscape of nursing research presents new challenges for measurement science. Studies increasingly involve global

and cross-cultural populations, interdisciplinary collaborations, and complex theoretical models, while digital health technologies, including mobile applications, wearable sensors, and remote monitoring systems, are reshaping the ways health data are collected and analyzed. These developments underscore the need to move beyond conventional approaches and adopt more sophisticated, adaptable, and technologically informed measurement strategies. The present editorial reviews key methodological issues in current instrument development practices and proposes future directions for nursing research, with particular emphasis on three emerging areas: advanced psychometric methods, cross-cultural validation, and digital measurement approaches.

Current Issues in Instrument Development in Nursing Research

Despite substantial progress in measurement science, several challenges remain in the development and application of research instruments in nursing.

Overreliance on Classical Psychometric Indicators

Many nursing studies rely heavily on a limited set of psychometric indicators, particularly internal consistency measured by Cronbach's alpha, while other reliability indices (e.g., McDonald's omega and test-retest reliability) are rarely reported (Maric et al., 2023). Although important, reliance on alpha alone is insufficient to ensure that an instrument accurately captures the intended construct. Similarly, exploratory and confirmatory factor analyses are widely used to assess structural validity, yet they are often applied with no strong theoretical foundations, inadequate sample sizes, or improper reporting standards (Alavi et al., 2023). As a result, these instruments demonstrate acceptable statistical properties but do not have rigorous evidence to support their use because of a lack of conceptual clarity or theoretical coherence. This overemphasis on a narrow range of psychometric evidence can constrain comprehensive validation and contribute to the proliferation of instruments with overlapping constructs or unclear boundaries, reflecting broader ethical concerns in scale development, including redundancy and inefficient use of research resources (Ayala et al., 2026).

Fragmentation of Measurement Constructs

Another challenge in nursing research is the fragmentation of measurement constructs, as inherently multidimensional and dynamic phenomena (e.g., symptom clusters, self-management behaviors, and health-related quality of life), are often assessed using isolated scales that capture only limited aspects of the construct. This fragmented approach can hinder a comprehensive

understanding of complex relationships among health variables. As nursing research increasingly adopts sophisticated analytical methods, including structural equation modeling (SEM), mediation analysis, and multilevel modeling, the need for more comprehensive and theoretically grounded measurement instruments becomes evident (Henly, 2015).

Limited Cross-Cultural Validation

Nursing research is increasingly global, encompassing diverse cultural, linguistic, and healthcare contexts. However, many measurement instruments were originally developed in Western populations and may not adequately capture health experiences in cultures other than Western people. Notably, most evidence-based practice instruments have been validated in English-speaking countries, with fewer than 20% translated into other languages, limiting their global applicability and posing risks when applied to populations for which they have not been properly validated (Halm, 2024). Although translation and cultural adaptation are commonly undertaken, these efforts often emphasize linguistic conversion rather than comprehensive cross-cultural validation (Nudelman et al., 2024). Without rigorous assessment of cultural equivalence and measurement invariance, such instruments may yield biased or inaccurate results across different populations.

Emerging Trends in Instrument Development

In response to these challenges, several methodological trends are shaping the future of instrument development in nursing research.

Advanced Psychometric Approaches

Advances in psychometric theory have introduced more sophisticated methods for evaluating measurement properties, enabling a deeper and more precise understanding of instrument performance. Item response theory (IRT), for example, allows researchers to examine item-level characteristics, such as difficulty and discrimination, with parameters estimated independently of the sample, thereby enhancing generalizability (Gyamfi & Acquaye, 2023). In addition to IRT, factor analytic approaches, including exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), remain fundamental for examining the underlying structure of instruments and the relationships between latent constructs and observed variables while accounting for measurement error. More advanced extensions, such as extended SEM and bifactor CFA, further enable the evaluation of multidimensional constructs and complex mechanisms, including mediation and moderation, within theoretically driven models.

More recently, network analysis has emerged as a complementary approach to traditional latent variable models, reconceptualizing psychological and

health-related constructs as systems of interacting components rather than reflections of underlying latent factors (Cai et al., 2020). This perspective enables the examination of direct relationships among symptoms or behaviors, providing novel insights into the structure and dynamics of complex health phenomena. Another critical advancement is the assessment of measurement invariance (or differential item functioning; DIF), which determines whether an instrument measures the same construct consistently across different groups or time points (Leitgöb et al., 2023). Establishing invariance is essential for ensuring valid comparisons across populations, especially in increasingly diverse and cross-cultural research contexts. Together, these advanced psychometric approaches provide a more robust and comprehensive framework for instrument development, supporting greater precision, validity, and theoretical alignment in nursing research.

Cross-Cultural Adaptation and Global Measurement

The globalization of nursing research has intensified the need for culturally sensitive measurement instruments, as studies increasingly involve diverse populations across varying cultural and healthcare contexts. In this context, cross-cultural adaptation extends far beyond simple translation, requiring careful consideration of conceptual equivalence, semantic accuracy, and cultural relevance to ensure that instruments meaningfully capture the intended constructs across settings. Established guidelines recommend systematic and rigorous procedures for cross-cultural adaptation, including forward and back translation, expert committee review, synthesis, cognitive interviewing, and pre-testing, with the framework proposed by Beaton et al. remaining a key reference in the field (Beaton et al., 2000). In addition to these qualitative processes, statistical techniques such as multi-group confirmatory factor analysis are widely used to evaluate measurement invariance across cultural groups, ensuring that instruments function equivalently and support valid cross-cultural comparisons.

Developing culturally robust instruments not only enhances the validity and generalizability of research findings but also promotes more inclusive and equitable health research. As global collaborations continue to expand, the importance of culturally adaptable and methodologically rigorous measurement tools will become increasingly central to advancing nursing science.

Integration of Digital and Real-Time Measurement

Digital health technologies are fundamentally transforming how health-related data are collected and analyzed through the integration of information technology and healthcare systems (Pawar et al., 2024). Mobile devices, wearable sensors, and digital health platforms now enable the collection of real-time or near real-time data on individuals'

physiological signals, behaviors, and environmental contexts, offering new opportunities for more dynamic and precise measurement in nursing research. One prominent approach is ecological momentary assessment (EMA), which involves the repeated collection of real-time data on participants' experiences within their natural environments, often using smartphone-based technologies (Businelle et al., 2024). Compared with traditional retrospective self-report measures, EMA captures fluctuations in symptoms, mood, and behaviors as they occur, thereby enhancing ecological validity and reducing recall bias. This approach is particularly valuable for understanding dynamic health processes and patient experiences in everyday contexts.

Similarly, wearable devices have emerged as powerful tools for continuous health monitoring, capable of tracking physical activity, sleep patterns, heart rate, movement, and other physiological indicators in real time (Sieniawska et al., 2024). The integration of these objective data with patient-reported outcomes offers a more comprehensive and multidimensional understanding of health processes, aligning with the holistic perspective central to nursing science. Despite these advantages, the integration of digital measurement approaches presents both opportunities and challenges for nursing researchers. While digital tools can enhance data richness, temporal precision, and contextual relevance, they also require careful consideration of data privacy, technological accessibility, and measurement validity. Addressing these challenges is essential to ensure that digital innovations contribute meaningfully to rigorous and ethical nursing research.

Implications for Nursing Research

Advancing instrument development in nursing research requires a shift toward more rigorous, comprehensive, and innovative measurement practices. To support this transition, several strategic directions should be considered. First, researchers should prioritize comprehensive construct validation rather than relying primarily on internal consistency or basic factor analytic techniques. The use of advanced psychometric approaches, such as IRT, extended SEM, bifactor CFA, and network analysis, can strengthen both the theoretical grounding and statistical robustness of measurement instruments. Second, cross-cultural considerations should be integrated from the earliest stages of instrument development to ensure validity and applicability across diverse populations. Engaging in collaborative international research can provide valuable perspectives that enhance the cultural relevance and generalizability of measurement tools.

Third, nursing researchers should actively explore the integration of digital health technologies into measurement frameworks. Combining patient-reported outcomes with digital health data offers a

more comprehensive and dynamic representation of patients' experiences and health trajectories, aligning with the increasingly complex nature of healthcare. Finally, interdisciplinary collaboration with experts in psychometrics, data science, and digital health is essential for developing innovative and methodologically sound measurement strategies. Such collaboration will enable nursing research to keep pace with evolving scientific and technological advancements while ensuring the continued rigor and relevance of measurement practices.

Conclusion

Measurement instruments are fundamental to advancing nursing science, providing the foundation for understanding complex health phenomena and informing evidence-based practice. As nursing research increasingly operates within global, interdisciplinary, and technology-driven contexts, traditional approaches to instrument development must evolve to address emerging methodological and practical challenges. Future efforts should emphasize rigorous psychometric evaluation, cultural adaptability, and the integration of digital measurement technologies to enhance the validity, precision, and relevance of research instruments. Through continued innovation in measurement science, nursing researchers can more accurately capture the complexity of human health and strengthen the evidence base that supports high-quality, patient-centered care, education, and health policy.

Declaration of Interest

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Not applicable.

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