Development and validation of the Low Back Pain Questionnaire for Nurses (LBP-NS) in Indonesia: a structural equation modeling approach

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Abstract. Low back pain (LBP) is a prevalent global health issue, recognized as a leading cause of disability worldwide. This study aimed to address the lack of culturally and contextually relevant tools for assessing low back pain (LBP) among nurses in Indonesia, given their pivotal role in the country's healthcare system and high occupational risk of LBP. Using purposive sampling, this study included 305 nurses from 34 provinces in Indonesia to ensure diverse and representative data. A 50-item LBP-NS questionnaire was developed, encompassing Pain Intensity (PI), Walking (WK), Sitting (SI), Standing (ST), and Sleeping (SL) domains. Psychometric validation was conducted using confirmatory factor analysis (CFA) and structural equation modeling (SEM). The LBP-NS demonstrated robust psychometric properties, including good model fit (CFI = 0.929, RMSEA = 0.067) and strong reliability (Cronbach's alpha: 0.677-0.887). LBP-NS is a valid and reliable instrument for assessing low back pain risk among nurses and holds significant potential for use in clinical practice and occupational health programs to address and mitigate LBP risks.

1 Introduction

Low back pain (LBP) is a prevalent global health issue, recognized as a leading cause of disability worldwide [1][2]. With an estimated 223.5 million cases globally in 2019, LBP significantly impacts public health and occupational well-being [3]. The nursing profession, characterized by physically demanding tasks such as bending, lifting, and patient handling, is particularly vulnerable to LBP [4]. This vulnerability is especially pronounced in Indonesia, where nurses make up the largest subgroup of the country's 1.4 million healthcare workers [1][3].

Studies have demonstrated a marked increase in LBP prevalence among nurses throughout their careers, highlighting the urgent need for targeted assessment and

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intervention measures [5][6]. While the Roland-Morris Questionnaire (RMQ) and Oswestry Disability Index (ODI) are well-established tools for assessing LBP-related disability, they lack sensitivity to nursing-specific tasks and the cultural contexts of Indonesian nurses. Prolonged standing, patient lifting, and the psychosocial stresses of nursing create unique LBP risk factors that are not adequately addressed by these tools. Moreover, current assessments often fail to capture cultural nuances, such as norms surrounding patient care and workplace demands, further limiting their applicability in Indonesia [7].

This study aims to address this gap by developing and validating the Low Back Pain Questionnaire for Nurses (LBP-Ns) in Indonesia. Employing Structural Equation Modeling (SEM), this research ensures the tool's psychometric robustness, facilitates a comprehensive evaluation of the questionnaire's factor structure, validity, and reliability, and investigates the relationships between factors influencing LBP incidence among Indonesian nurses.

2 Methods

2.1 Study Design

This cross-sectional study was conducted across 34 provinces in Indonesia from August 29, 2023, to September 31, 2023. The research was divided into three key phases: the development of the Low Back Pain Risk of Nursing (LBP-NS) questionnaire, the evaluation of its validity (including face, content, convergent, and discriminant validity) and reliability, and the investigation of relationships among domains associated with the risk of low back pain in nursing.

2.2 Sampling and Participants

The study targeted nurses across Indonesia, with a population of 563,000 according to data from the Ministry of Health processed by the Central Statistics Agency (BPS). The sample size was determined using the Raosoft sample size calculator, applying a 95% confidence level and a 2% margin of error. This calculation yielded a minimum sample size of 2,391, which was increased by approximately 50% to account for the limitations of cluster sampling and to enhance the representativeness of the sample. The effect size was assessed using the r^2 metric [8].

Eligible participants included nurses working in Indonesia who could use and understand the Google Forms platform and provided informed consent to participate. Individuals unwilling to participate or who submitted incomplete questionnaire responses were excluded from the study.

2.3 Questionaire Development

The LBP-NS questionnaire was developed in four steps: (1) framework development, (2) item generation, (3) item screening (face and content validity), and (4) pilot test [9][10].

2.3.1 Framework Development

The theoretical framework was built using content analysis of the literature, and it included socio-demographics as background variables. The framework also identified four domains associated with low back pain risk in nursing: Pain Intensity (PI), Walking (WK), Sitting (SI), Standing (ST), and Sleeping (SL). These domains were selected based on a literature review of articles from international studies, including those from Norway [11], Thailand [12], Germany [13], the USA [14][15] and the Republic of Korea [16]. The domains represent

key factors influencing LBP in nurses, and their relevance to Indonesian nurses was confirmed through expert consultations.

2.3.2 Item Generation

Item generation was performed by identifying items that best fit each domain. This step involved defining the items, response options, and scoring methods [17]. The items were then drafted into a questionnaire consisting of 30 items, each rated on a 5-point Likert scale, ranging from strongly agree (5) to strongly disagree (1). The 5-point scale was chosen for its ability to capture nuanced differences in respondents' experiences while keeping the assessment process simple and user-friendly. This scale has been widely used in similar health-related surveys and offers sufficient discrimination between responses. The selected scale also aids in reducing potential response biases, as it avoids forcing respondents into extreme categories.

2.3.3 Item Screening (Face and Content Validity)

The content validity of the questionnaire was assessed by a panel of six nursing experts. The panel evaluated the relevance and clarity of each item using a 4-point Likert scale for relevance (1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, 4 = highly relevant) and clarity (1 = unclear, 2 = needing revisions, 3 = clear, 4 = very clear) [18]. Items that received relevance ratings of 3 or 4 and clarity ratings of 3 or 4 were considered acceptable. The final content validity was calculated using the Item-Level Content Validity Index (I-CVI) and Scale-Level Content Validity Index (S-CVI), with values $\geq$0.83 considered acceptable [19][20]. This process ensured that the items included in the questionnaire were both highly relevant and clear to the target population [21].

2.3.4 Pilot Test

A pilot test was conducted with 30 hospital nurses to evaluate the clarity and difficulty of the questionnaire items. This allowed for refinement of the items based on feedback from the participants [22]. The pilot test also helped identify any potential issues with the wording of items and the overall structure of the questionnaire. The feedback was used to make final adjustments before the full-scale validation [23].

2.4 Data Collection

Participants for the survey were hospital nurses who were members of the Indonesian National Nurses Association. Invitations to participate were distributed by provincial administrators via WhatsApp groups and official letters, with a link to a Google Form for online questionnaire completion. Participants were randomly invited to ensure broad representation from the 34 provinces, and the survey was open for four weeks in September 2023. No incentives were offered for participation. This recruitment method ensured a wide geographical coverage and helped minimize selection bias.

2.5 Validity and Reliability Tests

2.5.1 Convergent Validity

Confirmatory factor analysis (CFA) was employed to assess the construct validity, including both convergent and discriminant validity. Items that loaded significantly on their respective domains (loading factor > 0.5) were retained. The average variance extracted (AVE) for each factor was also examined, with values >0.5 indicating acceptable convergent validity [24][25].

2.5.2 Discriminant Validity

Discriminant validity was assessed by examining the correlation between different domains. A correlation coefficient of <0.7 between domains was considered indicative of good discriminant validity, as it suggests that the domains measure distinct constructs [26] [27].

2.5.3 Reliability

Cronbach's alpha values were used to assess the internal consistency of the questionnaire, with values >0.6 considered acceptable [28]. The composite reliability for each domain was also assessed, with values >0.6 considered satisfactory for ensuring the reliability of the scales [26].

2.6 Structural Equation Modeling

The relationships between the domains were assessed using Structural Equation Modeling (SEM). SEM was chosen for its ability to evaluate complex relationships among latent variables and to test the overall fit of the model [29]. The model fit was assessed using multiple indices, including the comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean squared residual (SRMR), all of which were within acceptable thresholds for a good fit [30][31].

3 Results and Discussion

3.1 Face and Content Validity

Thirty-five items were initially identified as eligible for inclusion in the LBP-NS questionnaire. Six experts contributed to refining the instrument, there were invited to provide feedback on the readability and comprehensibility of the LBP-NS questionnaire. Based on their feedback, all questionnaire items were deemed readable and understandable. Face and content validity are employed to verify that only relevant variables are selected and included in the draft structure of the instrument. Six experts, consisting of 6 academics, provided feedback and contributions to the instrument draft, which were incorporated into the instrument development. All 50 items obtained Content Validity Index (CVI) > 0.83 for relevance, clarity, simplicity, and completeness, as determined by the content validity approach. The Summary CVI (S-CVI) averages between the Universal Agreement (UA) approach and the Average CVI (S-CVI/Ave) were in the ranges of 1.23 and 1.54, respectively. 3.1 Face and Content Validity.

Thirty-five items were initially identified as eligible for inclusion in the LBP-NS questionnaire. Six experts (all academics) contributed to refining the instrument by evaluating its readability, comprehensibility, relevance, clarity, simplicity, and completeness. All questionnaire items were deemed readable and understandable. To ensure that only relevant variables were included, face and content validity were employed. Each item achieved a Content Validity Index (CVI) > 0.83 across all criteria, indicating excellent agreement among experts. The average Summary CVI (S-CVI) values were 1.23 and 1.54 for the Universal Agreement (UA) and Average CVI (S-CVI/Ave) approaches, respectively.

3.2 Participants Characteristics

A total of 305 nurses participated in the study, the majority of whom were male (61.3%), aged 30-39 years (41.0%), married (79.3%), held a Bachelor's degree or higher (50.2%), and

had ≥5 years of work experience (68.2%), highlighting diverse demographic characteristics that may influence low back pain risks. Table 1 presents their demographic and professional characteristics.

Table 1. Demographic and Professional Characteristics of Participants (N=305)

Characteristic	n (%)
Gender	
Male	187 (61.3%)
Female	118 (38.7%)
Age	
20-29 years	99 (32.5%)
30-39 years	125 (41.0%)
≥40 years	81 (26.6%)
Marital Status	
Married	242 (79.3%)
Not Married	59 (19.3%)
Other	4 (1.3%)
Education Level	
Diploma 3	111 (36.4%)
Diploma 4/Bachelor	41 (13.4%)
Bachelor+Ns	149 (48.9%)
Master/Specialist	4 (1.3%)
Work Experience	
<5 years	97 (31.8%)
≥5 years	208 (68.2%)
Body Mass Index	
Normal (18.5-22.9)	193 (63.3%)
Overweight/Obese (≥23)	104 (34.1%)
Underweight (<18.5)	8 (2.6%)
Exercise activity	
Regular Exercise (Yes)	79 (25.9%)
Back Ergonomic Exercises (Yes)	96 (31.5%)
Job Satisfaction (Satisfied)	270 (88.5%)

The table highlights that demographic factors such as age, work experience, and gender may influence LBP risks. For example, younger nurses and those with fewer years of experience exhibited slightly higher LBP risk scores.

3.3 Reliability and Validity

3.3.1 Internal Consistency

The internal consistency of the Low Back Pain Risk of Nursing (LBP-NS) questionnaire was evaluated using Cronbach's alpha and McDonald's omega to ensure the reliability of its subscales. The results demonstrated good to excellent reliability across all subscales, with Cronbach's alpha values ranging from 0.677 for the Pain Intensity domain (the lowest) to 0.887 for the Standing/Walking domain (the highest). Similarly, McDonald's omega values ranged from 0.724 to 0.891, confirming the robustness of the instrument. The overall

reliability of the LBP-NS questionnaire was also satisfactory, as indicated by a Cronbach's alpha of 0.821 and McDonald's omega of 0.844, supporting the internal consistency and reliability of the questionnaire for assessing low back pain risk in nursing.

3.3.2 Construct Validity and Reliability

Construct validity was assessed using Confirmatory Factor Analysis (CFA) and Composite Reliability (CR). All subscales demonstrated excellent CR (>0.9) and Average Variance Extracted (AVE >0.8). Table 2 consolidates the reliability values and model fit indices [25].

Table 2. Reliability and Validity of LBP-NS Domain

Domain	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
Pain Intensity (PI)	0.744	0.953	0.835
Walking (WK)	0.845	0.982	0.924
Sitting (SI)	0.906	0.984	0.938
Standing (ST)	0.826	0.978	0.929
Sleeping (SL)	0.882	0.987	0.937

3.3.3 Convergent and Discriminant Validity

Seven indicators (PI3, PI4, PI5, PI6, SL1, WK1, and ST1) had factor loadings <0.6, suggesting potential weaknesses in representing their latent variables. These items will be considered for revision or exclusion in future iterations to improve the questionnaire's performance.

3.4 Confirmatory Factor Analysis (CFA)

The confirmatory factor analysis (CFA) of the Low Back Pain Risk of Nursing (LBP-NS) questionnaire underwent iterative refinement to achieve an optimal model fit. The final CFA model demonstrated robust fit indices: $\chi^2 = 966.5$ ($df = 318$, $p < 0.001$), RMSEA = 0.067 (90% CI: [0.075, 0.085]), CFI = 0.929, TLI = 0.915, and SRMR = 0.049. These metrics align with established criteria for model fit, indicating the structural validity of the questionnaire. Specifically, the CFI value of 0.929 suggests that 92.9% of the variance in the observed data is accounted for by the model, meeting the thresholds commonly accepted for structural equation modeling (SEM). Collectively, these findings confirm the robustness and suitability of the instrument's structure for assessing low back pain risk in the nursing context [27][31][32].

3.5 Factor Loadings

The standardized factor loadings for items ranged from 0.192 to 3.256, with most items showing strong loadings (>0.7). Items with weaker loadings (e.g., PI5, PI6, and ST1) will be refined in future iterations. Table 3 lists the standardized factor loadings for each domain.

All factor loadings were statistically significant ($p < 0.001$), as indicated by critical ratios greater than 1.96. The majority of items showed strong factor loadings (>0.7), indicating good construct validity. However, some items (e.g., PI5, PI6, and ST1) showed lower loadings, which may warrant further investigation in future refinements of the questionnaire.

Table 3. Factor Loadings from Confirmatory Factor Analysis

Subscale	Item	Standardized Factor Loading	Standard Error	Critical Ratio
Pain Intensity (PI)	PI1	1.000	-	-
	PI2	0.994	0.055	18.000
	PI3	0.434	0.071	6.152
	PI4	0.501	0.062	8.075
	PI5	0.344	0.066	5.207
	PI6	0.269	0.066	4.094
Sleeping (SL)	SL1	1.000	-	-
	SL2	3.051	0.642	4.751
	SL3	3.108	0.651	4.772
	SL4	3.256	0.679	4.799
	SL5	3.048	0.641	4.759
	SL6	3.126	0.661	4.731
Walking (WK)	WK6	1.000	-	-
	WK5	1.147	0.067	17.209
	WK4	1.270	0.098	12.891
	WK3	1.079	0.101	10.636
	WK2	1.194	0.106	11.226
	WK1	0.340	0.092	3.691
Standing (ST)	ST6	1.000	-	-
	ST5	1.069	0.051	20.973
	ST4	1.067	0.058	18.545
	ST3	0.920	0.061	15.096
	ST1	0.192	0.072	2.669
Sitting (SI)	SI6	1.000	-	-
	SI5	1.041	0.051	20.604
	SI4	0.885	0.054	16.254
	SI3	0.849	0.058	14.546
	SI2	0.850	0.054	15.788

Note: The first item in each subscale is fixed to 1.000 for scale identification, hence no standard error or critical ratio is reported.

3.6 Structural Equation Modeling (SEM)

SEM analysis confirmed significant relationships between subdomains. Positive correlations indicated that higher perceptions of rational work practices and ergonomic awareness were associated with better postural habits and reduced LBP risks [33]. Figure 1 presents the path diagram for the SEM model (see Figure 1).

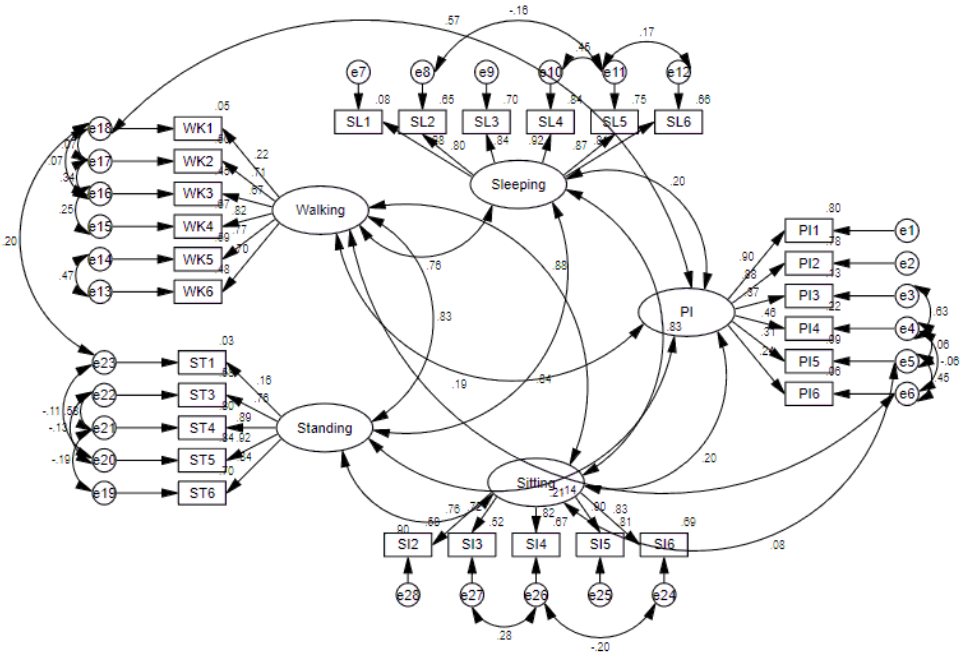

Figure. 1. Path Diagram of Structural equation modeling of LBP-Ns Questionnaire

3.7 Discussion

To the best of our knowledge, this is the first study to thoroughly validate the Low Back Pain Questionnaire for Nurses (LBP-NS) using robust psychometric methods, including Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM). Our findings provide strong evidence for the reliability and validity of the instrument, confirming its utility in both clinical and research settings. The Composite Reliability (CR) and Average Variance Extracted (AVE) values for each construct exceeded the recommended threshold of 0.6, demonstrating excellent internal consistency and construct validity. These high CR and AVE values indicate that the LBP-NS effectively measures the theoretical constructs it was designed to assess, and they are consistent with the results reported in previous studies [34]. Additionally, the strong internal correlations among indicators and substantial variance explained further support the instrument's construct validity [35].

The SEM analysis revealed that the refined LBP-NS model, with low-loading indicators removed, remains both reliable and valid. This refinement enhances the model's precision in interpreting relationships among latent variables, as reflected in the high factor loadings and robust goodness-of-fit indices [36]. The exclusion of some indicators suggests, however, that ongoing validation efforts are necessary to ensure a comprehensive representation of the constructs. Future studies should aim to validate the LBP-NS across different populations and settings to further enhance its generalizability and to help develop targeted interventions for low back pain based on these validated constructs [37].

The SEM model demonstrated significant relationships between the indicators and the latent variables, with all parameter estimates showing p-values less than 0.05, underscoring the validity of the measurement model. The model's ability to accurately represent these relationships has substantial clinical implications. By confirming these relationships, healthcare providers can assess patient outcomes with greater confidence and accuracy. This validation of the indicators allows practitioners to identify critical factors influencing patient

health, which can lead to more effective interventions and more efficient allocation of healthcare resources, ultimately improving patient care and outcomes [38].

Although the Root Mean Square Error of Approximation (RMSEA) value of 0.086 is slightly above the ideal threshold of 0.08, it remains within an acceptable range, indicating a reasonable approximation of the population data [39]. The Chi-square per Degree of Freedom (CMIN/DF) value of 3.229 suggests a good fit, as values below 5 indicate that the model does not overfit the data [40][41]. The exceptionally low Standardized Root Mean Square Residual (SRMR) value of less than 0.001 indicates minimal discrepancies between observed and estimated covariance matrices, suggesting a near-perfect model fit. These goodness-of-fit indices support the validity of the SEM model and confirm its utility in interpreting relationships among latent variables [42].

The high factor loadings (>0.6) and the CR and AVE values exceeding 0.6 provide further evidence of the robustness of the model [40][43]. These findings confirm that the LBP-NS questionnaire effectively captures the constructs of interest with strong internal consistency and construct validity, aligning with the objectives of the study.

This research also has several limitations that must be considered when interpreting the findings. First, the sample consisted solely of nurses, which may limit the generalizability of the results to other populations, particularly those in different occupational settings or cultures. While the LBP-NS tool was developed with nurses in mind, cultural and occupational factors, such as varying healthcare systems, ergonomic practices, and attitudes toward pain, could affect the applicability of the findings beyond Indonesian nurses. These differences should be considered in future studies that aim to validate the LBP-NS across diverse settings. Second, the cross-sectional design of the study prevents us from drawing causal inferences about the relationships among the variables. Third, the exclusion of low-loading indicators from the final model, while improving the model's fit, may have narrowed the scope of the constructs measured. Lastly, the use of self-reported data may introduce response bias, potentially affecting the accuracy of the results.

Future research should aim to validate the LBP-NS questionnaire across different populations and settings, including hospitals, clinics, and community health centers. Specific applications, such as routine LBP screening in hospitals, could be an important area for implementation, as it would provide healthcare providers with a reliable tool for early detection and intervention. Additionally, further validation studies should explore the inclusion of additional constructs, such as ergonomic practices and workplace-related factors, that might enhance the LBP-NS questionnaire’s comprehensiveness. For example, incorporating questions related to lifting techniques, workstation design, and shift patterns could provide a more complete understanding of the multifaceted nature of low back pain in nursing and other high-risk occupations. This would help refine the LBP-NS, making it even more relevant for targeted interventions.

4 Conclusion

This study developed and validated the LBP-NS questionnaire, a reliable and valid instrument for assessing low back pain among nurses. The questionnaire demonstrated strong psychometric properties, including high internal consistency, construct validity, and model fit, as evidenced by the SEM analysis. The findings highlight the importance of using robust measurement tools to accurately evaluate low back pain and related factors in healthcare professionals. Future research should focus on further validating the LBP-NS questionnaire in diverse populations and settings to enhance its applicability and utility in clinical practice.

Acknowledgments

This study was supported by Universitas Harapan Bangsa, Indonesia.

Ethics Statement

This review does not need any kind of ethical clearance.

Author Contributions

Conceptualization: IYK, and INW; methodology, formal analysis, software: IYK; ethics and data collection: INW, investigation: IYK, and INW; data curation and validation: IYK; writing—original draft preparation: IYK, and INW;; writing—review and editing: IYK, and INW; and funding acquisition: IYK. All authors have read and approved the final version of the manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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