Multidimensional structure of maternal sleep quality in the third trimester: psychometric evaluation

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Article Info	ABSTRACT

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Sleep disturbances are highly prevalent during late pregnancy and have been associated with maternal mental health vulnerability and adverse perinatal outcomes. Emerging evidence suggests that sleep quality in the third trimester is context-specific and may not represent a single, uniform construct. However, the latent structure of maternal sleep quality in late pregnancy has not been sufficiently examined using a theory-driven psychometric approach. A community-based cross-sectional study was conducted among women in the third trimester of pregnancy ($\geq$28 weeks). The Maternal Sleep Quality Index for the Third Trimester – Indonesian Version (MSQI-T3-ID), a newly developed eight-item self-report instrument, was administered. The hypothesized three-dimensional structure—Sleep Initiation and Continuity, Pregnancy-Specific Disturbance, and Daytime Impact and Fatigue—was evaluated using Confirmatory Factor Analysis within a Structural Equation Modeling framework. Confirmatory factor analysis supported a multidimensional model of maternal sleep quality in late pregnancy. The model demonstrated acceptable fit indices (CFI = 0.95; TLI = 0.93; RMSEA = 0.094; SRMR = 0.027). All items loaded significantly on their respective latent dimensions, with standardized factor loadings ranging from 0.91 to 0.99 (p < .001), indicating a coherent internal structure. The findings provide empirical support for conceptualizing sleep quality in late pregnancy as a multidimensional construct. This study provides initial structural validity evidence for a brief, trimester-specific sleep quality instrument.

Keywords : Maternal Sleep Quality; Third Trimester Pregnancy; Psychometric Validation.

1. INTRODUCTION

Sleep plays a central role in maintaining metabolic balance, cardiovascular regulation, and overall physiological function (Cappuccio et al., 2011; Weidner et al., 2010; Stenholm et al., 2011). During pregnancy, this regulatory system becomes increasingly susceptible to disruption because of cumulative hormonal shifts, anatomical adaptations, and neuroendocrine changes that intensify across gestation (Guyton & Hall, 2012). Consequently, sleep disturbances have emerged as a common and clinically relevant concern for maternal health.

A growing body of empirical research has demonstrated a progressive decline in sleep quality throughout pregnancy, with the most pronounced disturbances occurring during the third trimester. Women in late pregnancy frequently experience prolonged sleep latency, recurrent nocturnal awakening, pregnancy-related physical discomfort, and marked daytime fatigue (Christian et al., 2019; Okun & Coussons-Read, 2019; Mindell et al., 2019). Comparative investigations across gestational stages consistently indicate that sleep quality in late pregnancy is significantly poorer than that in the earlier trimesters (Effati-Daryani et al., 2021). These patterns have been observed across diverse populations, with population-based studies reporting a high prevalence of sleep problems among pregnant women in various cultural and health care contexts (Huong et al., 2019; Tamrat et al., 2021).

Importantly, sleep disturbances during pregnancy are not merely transient discomforts. Poor sleep quality has been strongly associated with heightened vulnerability to maternal mental health difficulties including increased symptoms of anxiety, stress, and depression (Ahmed et al., 2019; Gao et al., 2019; Cai et al., 2022). A comprehensive meta-analysis by Sedov et al. (2018) further confirmed that sleep problems are highly prevalent during pregnancy and are strongly associated with adverse psychological outcomes. These findings support the

conceptualization of sleep quality as a core biopsychosocial indicator of maternal well-being rather than a secondary or ancillary concern (Okun, 2020). In addition to psychological health, disrupted sleep during pregnancy has also been linked to unfavorable obstetric and perinatal outcomes such as preterm birth, hypertensive disorders of pregnancy, gestational diabetes, and adverse delivery outcomes (Chen et al., 2014; Facco et al., 2017; Umeno et al., 2020).

From a conceptual standpoint, accumulating evidence suggests that sleep quality in late pregnancy cannot be adequately understood as a single uniform construct. Instead, it appears to comprise multiple interrelated domains, including difficulties in initiating and maintaining sleep, pregnancy-specific physical and psychological disturbances, and impairments in daytime functioning (Christian et al., 2019; Okun & Coussons-Read, 2019; Sedov et al., 2018). Nevertheless, the most widely used sleep assessment instruments were originally developed for the general adult population, and may not sufficiently capture the phase-specific and context-sensitive characteristics of sleep disturbances in late pregnancy. This limitation becomes particularly salient in the third trimester, when physiological strain and psychological demands converge, potentially reshaping the latent structure of sleep quality

Despite the increasing recognition of sleep problems as a critical component of maternal health, there remains a notable gap in the availability of brief, culturally appropriate instruments specifically designed to assess the multidimensional nature of sleep quality in late pregnancy. Moreover, relatively few studies have empirically examined whether maternal sleep quality during the third trimester can be modeled as a multidimensional latent construct using a theory-driven psychometric framework.

To address this gap, the present study sought to evaluate whether sleep quality in late pregnancy constitutes a multidimensional psychological construct by examining its latent factor structure through Confirmatory Factor Analysis (CFA) within a structural equation Modeling framework. Drawing on established theoretical and empirical models of sleep during pregnancy, this study developed and psychometrically evaluated the Maternal Sleep Quality Index for the Third Trimester Indonesian version (MSQI-T3-ID). This overarching aim was to provide a concise, clinically sensitive, and phase-specific instrument that is both culturally relevant and suitable for use in antenatal care and perinatal research settings.

2. METHOD
Study Design and Setting
This study adopted a cross-sectional observational design with a psychometric framework to develop and evaluate the Maternal Sleep Quality Index for the Third Trimester Indonesian version (MSQI-T3-ID). Instrument development and validation followed established best practice recommendations for health-related measurement research (Boateng et al., 2018). The study targeted women in the third trimester of pregnancy and was conducted in March 2025 at the Semarang Regency community health centers.

Participants and Data Collection Procedures
Nineteen Puskesmas were purposively selected based on high antenatal care (ANC) attendance to ensure efficient recruitment and broad community representation. Participants were recruited using consecutive sampling, whereby all pregnant women in the third trimester (gestational age ≥28–40 weeks) who attended ANC services during the study period and met the inclusion criteria were invited to participate.

The inclusion criteria were the ability to read and understand Indonesians and the willingness to provide written informed consent. The exclusion criteria included severe obstetric complications, acute medical conditions requiring immediate clinical intervention, diagnosis of severe psychiatric disorders or ongoing intensive psychiatric treatment, and cognitive impairments that could limit independent questionnaire completion. A total of 280 participants were recruited over approximately five weeks, with an average of 8–12 respondents per health center. Data were collected using self-administered questionnaires, with assistance from trained researchers and midwives when clarification was required. All participants provided written informed consent before participation. Ethical approval was obtained from the Ministry of Health, Semarang Health Polytechnics.

Instrument Development
Phase I
The Maternal Sleep Quality Index for the Third Trimester – Indonesian Version (MSQI-T3-ID) was developed to specifically assess maternal sleep quality during the third trimester of pregnancy, a period characterized by unique physiological, psychological, and functional changes. Accumulating evidence indicates that sleep disturbances in late pregnancy are phase-specific and multidimensional, reflecting concurrent difficulties in sleep initiation and continuity, pregnancy-related physical and emotional disturbances, and impaired daytime functioning (Christian et al., 2019; Okun & Coussons-Read, 2019; Sedov et al., 2018).

Existing sleep instruments are largely designed for the general adult population and do not fully capture the contextual and gestational characteristics of the sleep problems experienced in late pregnancy. Therefore, the MSQI-T3-ID was developed as a new instrument, with item content grounded in clinical observations and empirical literature on sleep during late gestation, rather than through the adaptation or modification of existing scales.
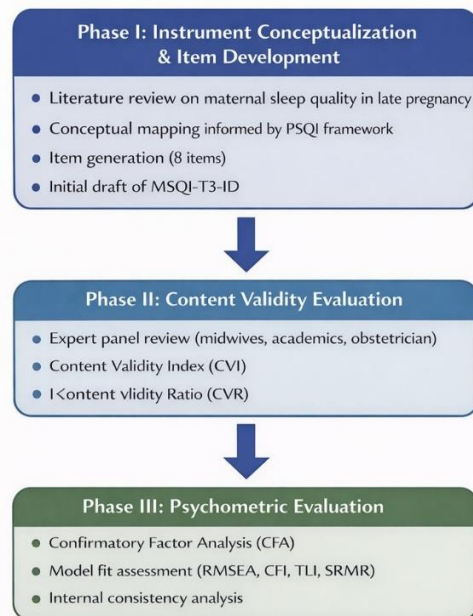
Figure 1. Instrument Development and Validation Process of the MSQI-T3-ID Existing sleep instruments are largely designed for the general adult population and do not fully capture the contextual and gestational characteristics of sleep problems experienced in late pregnancy. Therefore, the MSQI-T3-ID was developed as a new instrument, with item content grounded in clinical observations and empirical literature on sleep during late gestation, rather than through adaptation or modification of existing scales.

Eight items were generated to represent three predefined dimensions relevant to third-trimester sleep quality: Sleep Initiation and Continuity (SIC; 3 items), Pregnancy-Specific Disturbance (PSD; 3 items), and Daytime Impact and Fatigue (DIF; 2 items). Item wording was intentionally concise, culturally appropriate, and focused on experiences commonly reported by women in late pregnancy, ensuring feasibility for use in routine antenatal care and research settings.

Figure 1. Instrument Development and Validation Process of the MSQI-T3-ID

Phase II. Content Validity

Content validity was evaluated using the Content Validity Index (CVI) and Content Validity Ratio (CVR) based on assessments by a panel of seven experts, including practicing midwives, midwifery academics, and obstetrician gynecologists. Each item was rated on a four-point Likert scale for relevance and clarity. Item-level CVI values ≥0.78 and CVR values meeting Lawshe's criteria were considered acceptable. All items met the predefined content validity thresholds, with a mean scale-level CVI exceeding 0.90, indicating a strong expert agreement.

Phase III. Psychometric Analysis

The latent factor structure of MSQI-T3-ID was examined using Confirmatory Factor Analysis (CFA) within a Structural Equation Modeling (SEM) framework. Given the ordinal nature of response categories, model estimation employs the Weighted Least Squares Mean and Variance Adjusted (WLSMV) estimator, which is appropriate for categorical data (Brown, 2015; Li, 2016). Model fit was evaluated using multiple indices, including the Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker–Lewis index (TLI), and Standardized Root Mean Square Residual (SRMR), applying conventional cut-off criteria (Marsh et al., 2004). All statistical analyses were conducted using JAMOVI, with the statistical significance set at $p < 0.05$.

Data Collection Procedures

Data collection was implemented through a two-phase process designed to refine and preliminarily evaluate the Maternal Sleep Quality Index for the Third Trimester Indonesian version (MSQI-T3-ID). The initial phase involved structured consultation with an expert panel to review item relevance, linguistic clarity, and contextual suitability for pregnant women in late gestation. The feedback obtained during this phase was incorporated to optimize item formulation prior to field administration. The second phase consisted of pilot administration of the revised questionnaire among third-trimester pregnant women attending routine antenatal care services. Participants were invited to complete the MSQI-T3-ID in a self-administered format in a quiet setting at a healthcare facility. The researcher remained available to provide clarification when necessary, while minimizing intervention to preserve response authenticity.

Instrument Evaluation Strategy

Psychometric evaluation of the MSQI-T3-ID was conducted to establish foundational evidence of measurement quality appropriate for a pilot-stage instrument. Consistent with preliminary instrument development frameworks, the assessments focused on content validity and internal consistency reliability as primary indicators of measurement adequacy.

Validity Evidence

Evidence of validity was generated through expert agreement metrics and empirical item performance analysis. Content relevance was quantified using the Item Content Validity Index (I-CVI) derived from expert ratings across a four-level relevance scale. Five subject matter experts specializing in maternal health, sleep science, and behavioral

assessment independently evaluated each item. Threshold values of 0.89 or higher indicated strong content representativeness. Revisions based on expert recommendations enhanced clarity without eliminating any items. Construct alignment at the item level was examined using corrected item–total correlation coefficients derived from pilot responses obtained from 110 eligible third trimester pregnant women. Items meeting the established criterion of 0.30 or greater were considered to demonstrate satisfactory integration within the overall sleep quality construct.

Reliability Testing
Scale reliability was assessed by calculating Cronbach's alpha coefficient to evaluate internal consistency across the MSQI-T3-ID items. Values exceeding 0.78 were interpreted as reflecting acceptable reliability for early stage measurement tools. To further verify consistency, the corrected item–total correlation ranges were reviewed to confirm that each item contributed positively to the coherence of the instrument. These analyses collectively support MSQI-T3-ID as a preliminary reliable measure of maternal sleep quality during late pregnancy. Future investigations with larger sample size are required to perform dimensionality verification and broader construct validation.

Data Analysis Approach
Descriptive statistics were applied to examine response completeness, variability, and potential distributional anomalies across MSQI-T3-ID items. The internal consistency reliability was estimated using Cronbach's alpha as the primary quantitative indicator. Factor analytic techniques were not pursued because of the exploratory nature of the pilot study and the limited sample size, with the focus instead on establishing foundational psychometric performance.

Ethical Considerations
Ethical clearance was obtained from the Research Ethics Committee of the Health Polytechnic of the Ministry of Health, Semarang. Participation was voluntary, and informed consent was obtained following a detailed explanation of study aims and procedures. Participant anonymity was preserved, and all collected data were treated confidentially in accordance with ethical research standards.

3. RESULTS AND DISCUSSION
RESULTS
Participant Characteristics
The study included women in the third trimester of pregnancy (28–40 weeks), with a relatively balanced distribution across early (30.77%), mid (36.26%), and late (32.97%) gestation phases. Most participants were unemployed (62.64%) and had attained secondary (56.04%) or tertiary education (40.66%). In terms of obstetric history, over half were multiparous (53.85%), followed by primiparous women (37.36%), and a smaller proportion of grand multiparous participants (8.79%). Regarding living arrangements, 57.14% lived in nuclear family settings, whereas 42.86% lived with extended family members. Overall, the sample demonstrated sufficient demographic, obstetric, and social variability to support psychometric evaluation of maternal sleep quality in late pregnancy.

Model Fit of the Multidimensional CFA Model
Confirmatory Factor Analysis (CFA) was conducted to evaluate whether maternal sleep quality in the third trimester can be represented as a multidimensional latent construct. The chi-square test was statistically significant (χ^2 = 207.0, df = 17, p < .001), which is common in CFA models with moderate sample sizes and complex latent structures. Therefore, the model adequacy was interpreted using alternative fit indices. The Standardized Root Mean Square Residual (SRMR = 0.027) indicated very low residual discrepancies, suggesting a good absolute model fit. The Root Mean Square Error of Approximation (RMSEA = 0.094) reflects an acceptable to marginal level of approximate fit, which is still considered interpretable in psychometric model evaluation when supported by other indices. Comparative fit indices demonstrated satisfactory model performance (CFI = 0.95; TLI = 0.93), exceeding the conventional cut off criteria. Taken together, these indices indicate that the proposed three-dimensional CFA model provides an acceptable representation of the observed data.

Factor Structure and Item-Level Loadings of the MSQI-T3-ID
The standardized factor loadings for the MSQI-T3-ID are presented in **Table 1**. All eight items loaded strongly and significantly on their respective latent dimensions (p < .001), supporting the hypothesized multidimensional structure of maternal sleep quality in late pregnancy. Within the **Sleep Initiation and Continuity (SIC)** dimension, standardized loadings ranged from 0.96 to 0.99, indicating that difficulties in falling asleep, maintaining sleep, and perceived non restorative sleep were highly representative of this domain.

Table 1. Standardized Factor Loadings of the MSQI-T3-ID

Dimension	Item	Standardized Loading (β)	p-value
Sleep Initiation & Continuity (SIC)	(SIC1)	0.96	< .001
	SIC2)	0.96	< .001
	SIC3)	0.99	< .001
Pregnancy-Specific Disturbance (PSD)	PSD1)	0.98	< .001
	PSD2)	0.91	< .001
	PSD3))	0.99	< .001
Daytime Impact & Fatigue (DIF)	DIF1)	0.95	< .001
	DIF2)	0.99	< .001

For **Pregnancy-Specific Disturbance (PSD)**, loadings ranged from 0.91 to 0.99, reflecting the strong contributions of pregnancy-related physical discomfort, nocturia, and anticipatory discomfort toward childbirth. The **Daytime Impact and Fatigue (DIF)** dimension also demonstrated high loadings (0.95–0.99), indicating that daytime sleepiness and functional impairment were central manifestations of reduced sleep quality. Overall, the magnitude and consistency of the standardized loadings confirmed that each item meaningfully represented its intended latent dimension, providing empirical support for conceptualizing maternal sleep quality in the third trimester as a multidimensional construct.

The Second-Order CFA Model of the MSQI-T3-ID
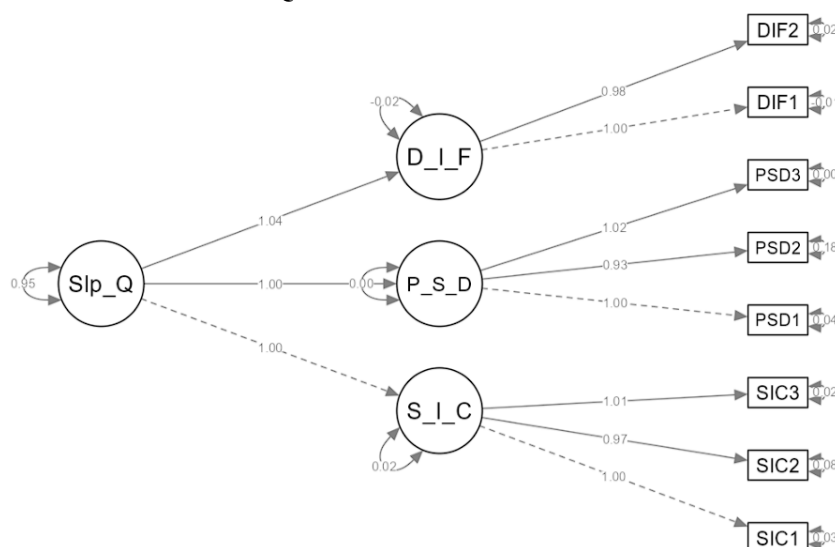
Figure 1. Second-order confirmatory factor analysis model of MSQI-T3-IDE

Figure 1 shows the standardized second-order confirmatory factor analysis (CFA) model of the Maternal Sleep Quality Index for the Third Trimester Indonesian version (MSQI-T3-ID). In this model, maternal sleep quality is specified as a higher-order latent construct that is reflected by three first-order dimensions: Sleep Initiation and Continuity (SIC), Pregnancy-Specific Disturbance (PSD), and Daytime Impact and Fatigue (DIF). Rectangles represent observed items, while circles represent latent variables. The single-headed arrows indicate factor loadings and the values shown along the arrows represent standardized estimates. The solid arrows indicate freely estimated parameters, whereas the dashed arrows indicate fixed parameters for model identification. Curved arrows represent error. All items showed strong loadings on their respective dimensions, indicating that each item adequately measured its intended aspect of sleep quality. In addition, all three first-order dimensions loaded substantially on the higher-order sleep quality construct. This finding supports the conceptualization of sleep quality in the third trimester as a multidimensional construct that includes nocturnal sleep difficulties, pregnancy-specific sleep disturbances, and daytime functional impact. The reported results adequately and directly addressed all the stated research objectives. The CFA findings provide coherent empirical support for the conceptualization of thirdtrimester maternal sleep quality as a multidimensional latent construct, consistent with the study aims and methodological design.

4. DISCUSSION

This study sought to examine whether sleep quality in late pregnancy could be conceptualized as a multidimensional construct by evaluating its latent factor structure using a theory-driven psychometric approach. In line with the study objectives, the findings provide empirical support for a multidimensional representation of maternal sleep quality during the third trimester, as operationalized by the MSQI-T3-ID. The confirmatory factor analysis results indicated that sleep quality in late pregnancy is not optimally represented as a single, undifferentiated construct. Instead, the data support a three-dimensional structure comprising sleep initiation and continuity, pregnancy-specific disturbances, and daytime impact and fatigue. This structure is consistent with theoretical perspectives that conceptualize sleep as a complex process involving nocturnal regulation and daytime functioning, rather than a unitary outcome (Guyton & Hall, 2012; Cappuccio et al., 2011; Stenholm et al., 2011). Importantly, the present findings suggest that these components can be empirically distinguished within a late pregnancy context.

The identification of a pregnancy-specific disturbance dimension highlights the relevance of physical and psychological factors unique to late gestation, such as bodily discomfort, nocturia, and anxiety related to impending childbirth. Previous studies have consistently reported that these factors are prominent contributors to sleep disruption during the third trimester (Christian et al., 2019; Mindell et al., 2019; Effati-Daryani et al., 2021). The current findings extend this literature by providing psychometric evidence that pregnancy-related disturbances form a coherent latent domain within an integrated sleep quality framework. The emergence of Daytime Impact and Fatigue as distinct dimensions underscores the functional correlates of disrupted sleep during late pregnancy. Prior research has shown that sleep fragmentation and insufficient sleep are associated with daytime sleepiness, reduced alertness, and impaired functioning (Weidner et al., 2010; Hirshkowitz et al., 2015). In pregnant populations, such daytime effects have been linked to increased psychological vulnerability, including higher levels of anxiety and depressive symptoms (Ahmed et al., 2019; Gao et al., 2019; Cai et al., 2022). The present findings support the inclusion of daytime functioning as an integral component of maternal sleep quality assessments.

From a psychometric perspective, the use of confirmatory factor analysis within a structural equation Modeling framework aligns with contemporary recommendations for theory-driven scale development and construct validation (Boateng et al., 2018; Brown, 2015). The observed model fit indices and consistently high standardized factor loadings provide initial evidence supporting the internal structure of MSQI-T3-ID. However, these findings should be interpreted as preliminary and specific to the study context. The MSQI-T3-ID were developed as a phase-specific instrument intended to reflect the contextual characteristics of sleep during the third trimester, rather than as a replacement for existing general sleep measures. Previous reviews have noted that widely used sleep instruments may not fully capture pregnancy-related sleep experiences (Sedov et al., 2018; Okun, 2020). Within this scope, the present study proposes and empirically examines a concise trimester-specific measurement framework. Consistent with psychometric recommendations, the model fit was interpreted based on multiple indices rather than reliance on a single criterion (Marsh et al., 2004).

This study has several limitations The cross-sectional design limits conclusions regarding the temporal stability or causal relationships between sleep quality and maternal outcomes. In addition, the findings are based on a community-based sample within a specific regional context, which may limit their broader generalizability. Future research employing longitudinal designs, additional sources of validity evidence, and replication in diverse populations is warranted to further evaluate the measurement properties and applicability of the MSQI-T3-ID.

5. CONCLUSIONS

This study provides empirical support for conceptualizing sleep quality in late pregnancy as a multidimensional construct comprising sleep initiation and continuity, pregnancy-specific disturbances, and daytime impact and fatigue. Using a theory-driven confirmatory factor analytic approach, the findings demonstrate that these dimensions can be meaningfully distinguished within a third-trimester context. The MSQI-T3-ID offers initial psychometric evidence as a brief, culturally relevant, and phase-specific instrument to assess maternal sleep quality during late pregnancy. Although further validation is required, particularly across time and diverse populations, the present findings contribute to a more nuanced understanding of sleep quality in late pregnancy, and support the use of multidimensional assessment frameworks in antenatal and perinatal research.

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