Korean Journal of Health Promotion
KJHP

https://e-kjhp.org

pISSN 2234-2141
eISSN 2093-5676

Korean Journal of Health Promotion

KJHP

VOL. 26 / NO. 2 / June 2026

Korean Society for Health Promotion and Disease Prevention

Korean Journal of Health Promotion
VOL. 26 / NO. 2 / June 2026

pages 45-81

Korean Society for Health Promotion and Disease Prevention

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pISSN: 2234-2141 · eISSN: 2093-5676
https://e-kjhp.org

VOL. 26 / NO. 2 / June 2026

Aims and Scope

The *Korean Journal of Health Promotion (KJHP)* is an open access, multidisciplinary journal dedicated to publishing high-quality research in various areas of the medical, nursing, nutritional, physical educational, epidemiological, and public health sciences associated with health promotion and disease prevention. *KJHP*, which has been published continuously since 2001, is an official journal of the Korean Society for Health Promotion and Disease Prevention.

The aim of the *KJHP* is to advance and disseminate new knowledge and scientific information in all the areas associated with health promotion and disease prevention. KJHP publishes original articles, narrative reviews, systematic reviews and meta-analyses, letters to the editor, and perspectives in English.

Abbreviation
The correct abbreviation for abstracting and indexing purposes is *Korean J Health Promot*.

This journal is financially supported by the Korean Federation of Science and Technology Societies (KOFST) Grant funded by the Korean Government.

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Publisher: President, Sung SUNWOO, MD, MPH, PhD
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Korean Society for Health Promotion and Disease Prevention

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https://doi.org/10.15384/kjhp.2026.00255

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Questioning Personalised Health: Limitations of Interpreting Wearable Data at the Individual Level

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ABSTRACT

Wearable technologies are increasingly used to support personalised health management and promote health-related behaviours. These devices generate continuous, real-time data that are often interpreted as individualised health information. However, the key issue is not only data accuracy, but whether wearable-derived metrics are valid at the individual level or truly reflect personalisation. While wearable data may appear precise, their interpretation is limited by measurement variability, lack of contextualisation, and reliance on population-based models. This paper introduces the concept of the illusion of personalisation to describe the discrepancy between the apparent specificity of wearable-derived data and their limited individual-level interpretability. Data alone do not create meaning, and additional data do not necessarily improve clarity. In health promotion and preventive medicine, uncritical interpretation of wearable data may overestimate their clinical relevance. A cautious approach is therefore warranted, recognising wearable data as indicators of general trends rather than definitive representations of individual health.

Keywords: Wearable devices, Digital biomarkers, Illusion of personalisation, Health promotion, Personalised health

The rapid adoption of wearable technologies has transformed how individuals engage with their health. Devices that continuously monitor heart rate, physical activity, sleep, and other physiological parameters are now widely promoted as tools for personalised health management. This shift aligns with broader trends in digital medicine, where data-driven approaches promise to tailor interventions to individual needs. This broader shift reflects the ongoing transformation of healthcare through digital medicine, characterised by increasing reliance on data-intensive approaches and continuous monitoring outside traditional clinical settings [1]. However, the increasing reliance on wearable-derived metrics raises an important question: do these data truly represent individualised health information, or do they merely create the appearance of personalisation? This issue is particularly relevant in the context of health promotion, where wearable-derived data are increasingly used to guide individual behaviours and decisions. While such data may enhance awareness and support engagement with health-related activities, their interpretation is not always straightforward. Variability in measurement, differences in usage contexts, and reliance on population-based algorithms may limit the extent to which these data reflect individual health states. As a result, the apparent precision of wearable outputs may not necessarily correspond to meaningful or actionable insights.

Wearable devices are often presented as empowering tools that enable individuals to take control of their health. Their

Received: March 29, 2026; **Revised:** April 20, 2026; **Accepted:** April 23, 2026
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appeal lies in the ability to generate continuous, real-time data outside traditional clinical settings [2]. This accessibility has positioned wearables as key instruments in health promotion, particularly in encouraging physical activity, improving sleep habits, and facilitating self-monitoring. Recent developments have further expanded their role, with wearable sensors increasingly integrated into predictive models and digital health ecosystems [3,4]. These advances may suggest a future in which health decisions are informed by highly granular, individual-level data, but more data does not necessarily mean better insight.

Despite this promise, the validity of wearable-derived data remains a fundamental concern. Numerous studies have demonstrated variability in the accuracy of commonly measured parameters such as heart rate and energy expenditure, particularly across different populations and activity contexts [5]. Systematic reviews have also highlighted inconsistencies in the reliability and validity of commercially available devices, suggesting that measurement error is not negligible [6]. While such limitations may be acceptable for general tracking purposes, their implications become more significant when these data are interpreted as clinically meaningful indicators of individual health.

Beyond measurement accuracy, a more critical issue may lie in how these data are interpreted. Wearable technologies now generate large volumes of personal health data. However, translating these data into clinically meaningful or actionable insights remains uncertain, particularly given ongoing challenges in the definition and validation of digital biomarkers [7,8]. Unlike conventional physiological or biochemical biomarkers, which are typically measured under controlled conditions and supported by established validation frameworks, digital biomarkers derived from wearable devices often rely on heterogeneous data sources and less established validation approaches [7]. As a result, their interpretation at the individual level may be inherently constrained. Without appropriate contextualisation, such data may be misinterpreted. For example, heart rate or sleep-related metrics obtained from wearable devices may vary depending on activity type, measurement conditions, or device characteristics, reflecting known variability in wearable-derived measurements [5,6]. Such fluctuations may be influenced by transient physiological or environmental factors rather than meaningful changes in underlying health status. In this sense, the assumption that more data necessarily leads to better insight may be overly simplistic.

This challenge becomes more apparent in real-world settings. Continuous monitoring can certainly increase data availability, but it does not automatically improve interpretability. In practice, the clinical use of these data is still limited by the lack of standardised validation approaches and the absence of universally accepted gold standards for many digital biomarkers [8]. In addition, linking digital signals to clinically meaningful outcomes in complex, real-world environments remains a recognised challenge [8]. As a result, numerical outputs generated by wearable devices—such as composite indices or summary scores—may convey a sense of precision that is not fully supported by their methodological foundations. Caution may therefore be warranted when interpreting such metrics as definitive indicators of individual health status.

Building on these considerations, the concept of the illusion of personalisation is proposed. This concept describes the gap between the apparent individual specificity of wearable-derived data and their limited interpretability at the individual level. The illusion may arise from several factors. Continuous data streams, numerical outputs, and algorithmically derived summaries can create a strong impression of precision. At the same time, these data are shaped by measurement variability, contextual influences, and population-based modelling. Together, these factors may constrain their validity when applied to individuals. As a result, wearable-derived metrics can appear highly personalised, while in practice they may reflect broader patterns rather than precise individual states. This distinction between perceived and actual personalisation is particularly relevant in health promotion and preventive care, where such data are increasingly used to guide individual decision-making. In practice, wearable-derived data may be most appropriately used to monitor general trends or support behaviour change rather than to inform precise individual-level decisions. For example, gradual changes in activity patterns or sleep duration may provide useful signals for health promotion. However, interpreting short-term fluctuations or relying on single measurements as indicators of individual health status may be more problematic. In such cases, these data may require cautious interpretation, particularly when used outside validated clinical contexts. Recognising this distinction may help ensure that wearable technologies are used in ways that are both meaningful and appropriate for individual health management.

A central issue underpinning these concerns is the difficulty of translating population-level data into individual-level conclusions. Much of the evidence supporting wearable-derived metrics is based on aggregated data, which may not generalise reliably to individual users. In clinical research, it is well rec-

https://doi.org/10.15384/kjhp.2026.00255

ognised that treatment effects and risk predictions derived from populations do not necessarily apply uniformly to individuals [9]. This limitation extends to wearable technologies, where algorithms trained on population data are often used to generate personalised outputs. The apparent individualisation of these outputs may therefore mask substantial uncertainty. Population-level evidence does not guarantee individual-level validity. What works on average does not always work for the individual.

Recent advances in precision medicine and digital health have sought to address this challenge by incorporating more sophisticated modelling techniques. Approaches such as dynamic predictive modelling and digital twins aim to capture individual variability more accurately [4,10]. However, these approaches also highlight the complexity of achieving true personalisation in practice. Developing reliable individual-level models requires rigorous validation. It also demands careful consideration of uncertainty, both of which remain ongoing challenges in the field [10]. In this context, the expectation that wearable-derived data alone can provide precise, individualised health insights may be premature.

Importantly, the issue is not that wearable technologies lack value. On the contrary, they offer significant opportunities for enhancing health awareness, supporting behaviour change, and facilitating large-scale data collection. Their utility in health promotion is well established, particularly in encouraging physical activity and monitoring general health trends [2,3]. However, the growing perception of wearables as tools for precise, individualised health assessment warrants careful scrutiny.

In the context of health promotion and preventive medicine, this distinction is particularly relevant. The use of wearable data to guide individual health decisions—such as adjusting exercise intensity, modifying sleep habits, or interpreting physiological fluctuations—requires a clear understanding of the limitations of these data. Without such understanding, there is a risk that individuals may attribute undue significance to metrics that are inherently uncertain or context-dependent.

A more cautious approach to interpreting wearable-derived data is needed. Rather than assuming that continuous monitoring equates to personalised insight, it may be more appropriate to view these data as indicative of general trends rather than precise individual states. Emphasising the limitations of wearable metrics does not diminish their value; instead, it promotes a more realistic understanding of their role in health management.

Ultimately, the promise of personalised health through wearable technologies must be balanced against the realities of data accuracy, interpretation, and individual variability. Personalised does not always mean precise. While wearables have the potential to contribute meaningfully to health promotion, their outputs should not be uncritically regarded as definitive representations of individual health.

In conclusion, wearable health data may appear to offer personalised insights, but their interpretation at the individual level remains uncertain. As the use of these technologies continues to expand, it is important to critically evaluate the assumptions underlying their application. In this regard, wearable-derived data may be most appropriately used to support general health awareness and behavioural guidance rather than as standalone indicators of individual health status. Integrating these data with clinical context and professional judgement may be important for their appropriate use in practice. In practical terms, this may involve considering wearable-derived data alongside clinical assessment, patient-reported symptoms, and contextual factors rather than interpreting these metrics in isolation. Such an approach may help reduce the risk of overinterpretation while preserving the potential value of wearable technologies in supporting health-related decision-making. A more nuanced understanding of wearable data—one that acknowledges both their potential and their limitations—will be essential for advancing their role in health promotion and preventive care.

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AUTHOR CONTRIBUTIONS

Jun Woo KWON takes responsibility for the content of the manuscript. The author reviewed and approved the final manuscript.

Conceptualization: JWK. Writing–original draft: JWK. Writing–review & editing: JWK.

CONFLICTS OF INTEREST

No existing or potential conflict of interest relevant to this article was reported.

FUNDING

None.

DATA AVAILABILITY

Not applicable. This article is a viewpoint and does not contain original research data.

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 https://doi.org/10.15384/kjhp.2026.00255

Original Article

Korean J Health Promot 2026;26(2):49-55
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2026.00206

Korean Journal of Health Promotion
KJHP

Age-Specific Differences in Factors Associated with Obstructive Sleep Apnea among Middle-Aged Men: Analysis of the Korea National Health and Nutrition Examination Survey (2021–2023)

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ABSTRACT

Background: Obstructive sleep apnea (OSA) is a prevalent sleep disorder in middle-aged men, yet age-specific risk factors within this population remain unclear. This study compared the prevalence and associated factors of high-risk OSA between men aged <50 years and ≥50 years using national survey data.

Methods: This cross-sectional study analyzed 11,761 middle-aged men (aged≥40 years) from the Korea National Health and Nutrition Examination Survey (2021–2023). Weighted multivariable logistic regression was performed to identify associated factors in each age group, adjusting for sociodemographic, health-related, and lifestyle variables.

Results: High-risk OSA prevalence was 37.2% in men <50 years and 43.6% in men ≥50 years (P<0.001). In men aged <50 years, abdominal obesity showed the strongest association with high-risk OSA (odds ratio [OR]=6.03, 95% confidence interval [CI]=4.75–7.65), followed by current smoking (OR=5.07, 95% CI=3.79–6.79), past smoking (OR=3.21, 95% CI=2.44–4.22), high-risk drinking (OR=2.04, 95% CI=1.51–2.76), high stress level (OR=1.89, 95% CI=1.02–3.48), moderate stress level (OR=1.55, 95% CI=1.02–2.34), and poor subjective health (OR=1.50, 95% CI=1.07–2.09). In men aged ≥50 years, past smoking was the strongest factor (OR=5.69, 95% CI=4.98–6.49), followed by current smoking (OR=3.88, 95% CI=3.28–4.59), abdominal obesity (OR=2.94, 95% CI=2.61–3.31), poor subjective health (OR=2.09, 95% CI=1.77–2.46), high stress level (OR=1.85, 95% CI=1.30–2.63), high-risk drinking (OR=1.63, 95% CI=1.32–2.00), and married status (OR=1.30, 95% CI=1.14–1.48).

Conclusions: Risk factors for high-risk OSA differed between younger and older middle-aged men. Younger men require interventions focused on abdominal obesity management, smoking cessation, and alcohol reduction, while older men need comprehensive approaches addressing smoking, metabolic health, and social support. Age-specific screening and prevention strategies are warranted to reduce the burden of OSA in middle-aged men populations.

Keywords: Obstructive sleep apnea, Middle aged, Risk factors, Health surveys

Received: February 9, 2026; **Revised:** March 27, 2026; **Accepted:** March 27, 2026

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INTRODUCTION

Obstructive sleep apnea (OSA) is a common sleep disorder characterized by recurrent upper airway obstruction during sleep, leading to intermittent cessation of breathing [1]. OSA affects approximately 9%–38% of adults worldwide, with particularly high prevalence among middle-aged men [2,3]. Beyond being a simple sleep disturbance, OSA is associated with various adverse health outcomes, including hypertension, cardiovascular disease, and cognitive impairment [4,5].

Age is one of the most well-established risk factors for OSA, and numerous studies have reported an increased prevalence with advancing age [6,7]. However, most previous research has compared younger adults with older adults, and few studies have examined age-specific differences within the middle-aged population itself [8].

Understanding the specific risk factors for OSA among men in their 40s is particularly important for several reasons. First, this age group experiences rapid changes in metabolic and cardiovascular health [9]. Second, early detection and intervention during middle age may prevent the progression of OSA-related complications [10]. Third, middle-aged men often have competing health priorities and may not recognize OSA symptoms [11].

Emerging evidence suggests that OSA risk factors may vary depending on age, sex, and ethnicity [12,13]. However, research specifically examining how risk factors differ between younger and older middle-aged men remains limited [14].

In Korea, several epidemiological studies have examined OSA, but most have focused either on the general adult population or elderly individuals [15-17]. To our knowledge, no study has systematically compared OSA prevalence and risk factors between middle-aged men in their 40s versus those in their 50s and older using nationally representative data.

Therefore, this study aimed to (1) compare the prevalence of high-risk OSA between middle-aged men <50 years and those ≥50 years, and (2) identify age-specific risk factors associated with OSA in each age group using data from the Korea National Health and Nutrition Examination Survey (KNHANES).

METHODS

This cross-sectional study analyzed data from the KNHANES, conducted from 2021 to 2023. KNHANES is a nationally representative survey that employs a complex, multistage, probability sampling design.

The study population comprised middle-aged men aged ≥40 years who completed the STOP-BANG questionnaire. After excluding participants with missing data on key variables, the final analytical sample consisted of 11,761 men.

The STOP-BANG questionnaire is a validated screening tool for OSA consisting of eight yes/no questions: Snoring, Tiredness, Observed apnea, high blood Pressure, Body mass index (BMI) >35 kg/m^2, Age >50 years, Neck circumference >40 cm, and male Gender [16]. Total STOP-BANG scores range from 0 to 8. While the original scoring system categorizes risk into low (0–2), intermediate (3–4), and high (5–8) [16], we dichotomized the scores into low risk (0–2) and high risk (3–8) for the purpose of this study. Furthermore, since the 'Age' item (≥50 years) is a constituent component of the score, we conducted a sensitivity analysis by excluding the age criteria to address potential endogeneity issues when comparing OSA risk across different age groups.

Participants were categorized into two age groups: <50 years and ≥50 years. Independent variables included demographic characteristics (education, marital status), health behaviors (smoking, high-risk drinking, aerobic physical activity), anthropometric measurements (waist circumference), and psychosocial factors (self-rated health, perceived stress).

Categorical variables were presented as weighted frequencies and Rao-Scott chi-square tests compared categorical variables between age groups. Under the complex sample design, multiple logistic regression analysis identified factors associated with high-risk OSA in each age group, adjusting for potential confounders. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. All analyses accounted for the complex survey design using sampling weights. Statistical significance was set at $P<0.05$. Analyses were performed using IBM SPSS Statistics version 31 (IBM Corp.). This study used publicly available secondary data. The KNHANES data were obtained from the Korea Disease Control and Prevention Agency, and all personal identifying information had been fully anonymized. The study was conducted with approval from the Institutional Review Board of Gachon University (approval number: 1044396-202512-HR-287-01).

RESULTS

Prevalence of high-risk obstructive sleep apnea

Among the total study population, 41.8% of individuals had

https://doi.org/10.15384/kjhp.2026.00206

high-risk OSA. By age group, 37.2% of participants in the <50 years group and 43.6% of participants in the ≥50 years group were classified as high risk, showing a statistically significant difference (Rao-Scott χ^2=36.698, *P*<0.001) (Table 1).

Comparison of sociodemographic characteristics and health behaviors by age group

Significant differences were observed across all variables between age groups (*P*<0.05). This study comparing health behaviors between age groups (<50 years vs. ≥50 years) among Korean men aged ≥40 years (n=11,761) revealed that the ≥50 years group had significantly higher prevalence of abdominal obesity (29.0% vs. 31.8%), current smoking (22.0% vs. 14.9%), and high-risk drinking (16.1% vs. 10.1%).

Educational disparities were notable, with the ≥50 years group showing higher proportions of lower education levels (23.4% elementary or less vs. 0.8%). Higher smoking and drinking rates in older adults indicate prolonged exposure to health risk factors. Aerobic physical activity and stress levels also differ by age (Table 2).

Factors associated with high-risk obstructive sleep apnea by age group

Weighted multivariable logistic regression analyses revealed that factors associated with high-risk OSA differed by age group (Table 3). In the <50 years group, the strongest risk factor was waist circumference ≥90 cm (OR=6.03, 95% CI=4.75–7.65), indicating that abdominal obesity had a substantial impact on OSA risk in younger middle-aged men. Smoking was also a significant risk factor: current smokers had a 5.07-fold higher risk (95% CI=3.79–6.79), and former smokers had a 3.21-fold higher risk (95% CI=2.44–4.22) compared with never smokers. Participants with poor self-rated health had a 1.50-fold higher risk (95% CI=1.07–2.09) than those reporting good health. High-risk drinking was associated with a 2.04-fold increased risk (95% CI=1.51–2.76) compared with non–high-risk drinking. Participants with high stress level had a 1.89-fold higher risk (95% CI=1.02–3.48) than those reporting no stress. Moderate stress level was associated with a 1.55-fold increased risk (95% CI=1.02–2.34) compared with no stress. In contrast, educational attainment, marital status, and physical activity were not statistically significant in this age group.

In the ≥50 years group, former smoking emerged as the strongest risk factor, with a 5.69-fold higher risk (95% CI=4.98–6.49) compared with never smokers; current smokers also showed a 3.88-fold higher risk (95% CI=3.28–4.59). Waist circumference ≥90 cm was associated with a 2.94-fold higher risk (95% CI=2.61–3.31) compared with <90 cm, although the magnitude of the effect was smaller than that observed in the <50 years group. Poor self-rated health was associated with a 2.09-fold higher risk (95% CI=1.77–2.46), and fair self-rated health with a 1.17-fold higher risk (95% CI=1.02–1.35), compared with good health. Psychosocial factors showed significant associations in the ≥50 years group. Being married was associated with a 1.30-fold higher risk (95% CI=1.14–1.48) compared without being married. With no perceived stress as the reference category, those reporting high stress had a high risk (OR=1.85, 95% CI=1.30–2.63).

Regarding educational attainment, having a high school education was associated with a lower risk of high-risk OSA (OR=0.78, 95% CI=0.68–0.89) compared with elementary school education or less. High-risk drinking was associated with a 1.63-fold higher risk (95% CI=1.32–2.00) compared with non–high-risk drinking.

DISCUSSION

This nationwide study demonstrates age-specific differences in OSA prevalence and risk factors among middle-aged Korean men. High-risk OSA was more prevalent in men ≥50 years (43.6%) compared to those <50 years (37.2%), demonstrating an age gradient within the middle-aged population itself. The observed age-related increase aligns with previous reports [6-8] and may be related to pathophysiological changes including up-

Table 1. Prevalence of high-risk OSA by age group

OSA risk category	Total[a]	Age, <50 yr[b]	Age, ≥50 yr[b]	Rao-Scott χ^2	*P*-value
Low-risk	58.2	62.8	56.4	36.698	<0.001
High-risk	41.8	37.2	43.6		

Values are presented as weighted %.
OSA, obstructive sleep apnea.
[a]According to the original STOP-BANG score, 0–2 indicates low risk and 3–8 indicates high risk; [b]According to the modified STOP-BANG score (excluding the age ≥50 yr item), 0–1 indicates low risk and 2–7 indicates high risk.

Table 2. Comparison of sociodemographic characteristics and health behaviors by age group (n=11,761)

Variable	Age, <50 yr	Age, ≥50 yr	Rao-Scott χ^2	*P*-value
Education level			1,890.392	<0.001
Elementary or less	0.8	23.4		
Middle school	2.2	13.5		
High school	31.8	35.7		
≥College	65.2	27.4		
Marital status			18.339	0.002
Without spouse	19.8	23.5		
With spouse	80.2	76.5		
Smoking status			89.404	<0.001
Non-smoker	54.1	57.0		
Past smoker	23.9	28.1		
Current smoker	22.0	14.9		
High-risk drinking			81.052	<0.001
No	83.9	89.9		
Yes	16.1	10.1		
Aerobic physical activity			83.930	<0.001
Not practicing	51.4	60.7		
Practicing	48.6	39.3		
Self-rated health			83.761	<0.001
Good	34.0	30.2		
Fair	51.3	47.5		
Poor	14.7	22.2		
Abdominal obesity (WC≥90 cm)			8.524	0.025
No	71.0	68.2		
Yes	29.0	31.8		
Stress level			227.932	<0.001
None	10.4	21.1		
Low	59.3	59.7		
Moderate	25.4	16.0		
High	4.9	3.2		

Values are presented as weighted %.
WC, waist circumference.

per body fat redistribution, reduced upper airway muscle tone, and hormonal alterations [9,10].

Our analysis revealed distinct risk factor profiles between age groups. In younger middle-aged men, abdominal obesity emerged as the predominant risk factor, suggesting a potential role of central adiposity in OSA pathogenesis [18,19]. The strong association may reflect metabolic consequences of central fat accumulation, including increased neck circumference and pharyngeal fat deposition [20-25].

Smoking showed significant associations in both groups but with different patterns. Among younger men, current smoking (OR=5.07) showed a stronger association with OSA than past smoking (OR=3.21). In contrast, among older men, past smoking was the most significant risk factor (OR=5.69), outweighing the effect of current smoking (OR=3.88). While smoking intensity was not quantified in this study, the robust association between past smoking and OSA in older men suggests a possible lasting influence of smoking history. This observation may point toward a potential link between long-term smoking and age-related increases in airway collapsibility [26,27].

Interestingly, marital status was associated with an increased OSA risk specifically in older men. While the exact mechanism remains unclear, this association may be attributed to spousal observation and reporting of symptoms rather than a true increase in disease prevalence. Since the STOP-BANG score includes subjective items such as witnessed apnea and loud snor-

https://doi.org/10.15384/kjhp.2026.00206

Table 3. Factors associated with high-risk OSA by age group: multivariable logistic regression

Variable	Age, <50 yr	Age, ≥50 yr
Education level (Ref. elementary or less)		
Middle school	1.13 (0.28–4.66)	0.91 (0.78–1.08)
High school	0.56 (0.16–2.00)	0.78 (0.68–0.89)
≥College	0.93 (0.26–3.27)	0.88 (0.76–1.04)
Marital status (Ref. without spouse)	1.04 (0.78–1.38)	1.30 (1.14–1.48)
Smoking status (Ref. non-smoker)		
Past smoker	3.21 (2.44–4.22)	5.69 (4.98–6.49)
Current smoker	5.07 (3.79–6.79)	3.88 (3.28–4.59)
High-risk drinking (Ref. no)	2.04 (1.51–2.76)	1.63 (1.32–2.00)
Aerobic physical activity (Ref. not practicing)	1.22 (0.97–1.54)	1.03 (0.92–1.16)
Self-rated health (Ref. good)		
Fair	0.99 (0.77–1.28)	1.17 (1.02–1.35)
Poor	1.50 (1.07–2.09)	2.09 (1.77–2.46)
Abdominal obesity (WC≥90 cm) (Ref. <90 cm)	6.03 (4.75–7.65)	2.94 (2.61–3.31)
Stress level (Ref. none)		
Low	1.11 (0.75–1.65)	0.96 (0.83–1.10)
Moderate	1.55 (1.02–2.34)	1.14 (0.95–1.36)
High	1.89 (1.02–3.48)	1.85 (1.30–2.63)

Values are presented as odds ratio (95% confidence interval). High-risk OSA was defined based on the modified STOP-BANG score (excluding the age ≥50 yr item), with scores of 0–1 indicating low risk and 2–7 indicating high risk.
OSA, obstructive sleep apnea; Ref., reference category; WC, waist circumference.

ing, participants with spouses are more likely to be informed of these nocturnal symptoms, potentially leading to higher scores. This suggests that the presence of a bed partner may play a critical role in the clinical screening of OSA in older populations.

Regarding psychological factors, perceived stress showed a significant association with OSA risk in both age groups, but the patterns of sensitivity differed. In men aged <50 years, even moderate stress levels were associated with significantly higher odds of OSA risk, whereas in the older group, this association was more pronounced at higher stress levels. These results may indicate that younger individuals are more responsive to stress, or that stress-related physiological changes, such as increased sympathetic activity, could contribute more noticeably to OSA risk in this group.

The findings have important clinical implications. For younger middle-aged men, interventions may benefit from prioritizing aggressive abdominal obesity management alongside smoking cessation. Although abdominal obesity was a significant risk factor in both age groups [14], its stronger association in younger middle-aged men may reflect earlier pathophysiological vulnerability before age-related structural changes become predominant. The finding that past smoking history—rather than current smoking—emerged as the most potent risk factor among older men may indicate a possible long-term influence of smoking on airway physiology [20]. This pattern suggests that smoking-related respiratory effects could persist or become more apparent with age, even after cessation. Therefore, our results highlight the potential importance of early smoking cessation; quitting at a younger age may help reduce the cumulative physiological burden on the upper airway and may be associated with a lower risk of developing OSA later in life.

Study strengths include large nationally representative data, validated screening tool, and age-stratified analysis within middle-aged men. Age-specific approaches to screening and intervention may enhance OSA detection and management effectiveness in middle-aged men. Limitations include cross-sectional design precluding causal inference, self-reported data potentially introducing bias, and lack of polysomnography confirmation. Future longitudinal studies with objective OSA measures are needed.

This study identified age-specific differences in factors associated with high-risk OSA among middle-aged men. Study findings suggest that age-tailored public health strategies may be beneficial. Further longitudinal studies using objective diagnostic measures are needed to clarify causal relationships and to inform more effective intervention strategies [28].

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AUTHOR CONTRIBUTIONS

Dr. Jiyun KIM had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: HJS and JK. Data curation: HJS and JK. Formal analysis: JK. Investigation: HJS and JK. Methodology: HJS and JK. Resources: JK. Software: HJS and JK. Supervision: JK. Validation: JK. Visualization: HJS. Writing–review & editing: HJS and JK.

CONFLICTS OF INTEREST

No existing or potential conflict of interest relevant to this article was reported.

FUNDING

None.

DATA AVAILABILITY

The data presented in this study are available upon reasonable request from the corresponding author.

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Original Article

Korean J Health Promot 2026;26(2):56-62
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2026.00248

Korean Journal of Health Promotion
KJHP

Analysis of the Association between Health Literacy and Health Behaviors in Korean Adults

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ABSTRACT

Background: Health literacy is increasingly recognized as a key determinant of health behavior and preventive practice. This study aimed to evaluate the association between health literacy and major health behaviors in Korean adults using nationally representative data.

Methods: We conducted a cross-sectional analysis using the 2023–2024 Korea National Health and Nutrition Examination Survey. A total of 11,555 adults with complete health literacy responses were included. Health literacy was assessed using a 10-item questionnaire and categorized into quartiles (Q1: lowest; Q4: highest). Current smoking, high-risk drinking, insufficient physical activity, and non-participation in health screening were evaluated. Multivariable complex-sample logistic regression analyses were performed after adjusting for demographic and clinical covariates.

Results: Lower health literacy was associated with higher prevalence of current smoking, insufficient physical activity, and non-participation in health screening. In the fully adjusted model, participants in the lowest literacy group had significantly higher odds of current smoking (odds ratio [OR], 1.83; 95% confidence interval [CI], 1.44–2.32), insufficient physical activity (OR, 1.48; 95% CI, 1.26–1.74), and not receiving health screening (OR, 1.38; 95% CI, 1.16–1.65) compared with the highest group. High-risk drinking was not independently associated with health literacy.

Conclusions: Health literacy was independently associated with key health behaviors and preventive practice in Korean adults. Strategies to improve population health should consider not only access to information but also individuals' capacity to understand and use health information.

Keywords: Health literacy, Smoking, Exercise, Mass screening, Health behavior

INTRODUCTION

As the modern healthcare environment shifts toward patient-centered care, health literacy (HL), which refers to the capacity of individuals to obtain, process, and understand basic health information and services needed to make appropriate health decisions, has become more critical than ever [1,2]. HL transcends mere individual cognitive ability and is gaining attention as a core social determinant of health that influences health equity and the success of disease prevention [3,4]. Evidence consistently indicates that groups with low HL experience a higher prevalence of chronic diseases and inefficient use of healthcare services, which ultimately leads to poor health outcomes and increased healthcare expenditures [2,5].

Received: March 20, 2026; **Revised:** April 12, 2026; **Accepted:** April 13, 2026
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Health behaviors such as smoking, alcohol consumption, physical activity, and regular participation in health screenings are direct factors determining an individual's risk of disease and mortality [6,7]. These behaviors are closely linked to the ability to evaluate healthcare information and translate it into actual practice rather than being simple matters of personal choice [6,8]. In the current infodemic environment, which is characterized by an aging population, a surge in chronic diseases, and a vast influx of health information, the ability to select accurate information and apply it to self-care is essential [9,10]. Individuals with low HL encounter barriers in interpreting and utilizing complex health information, and this can lead to a decline in preventive health actions and a lack of self-care capacity [11,12].

While several studies have reported associations between HL and health behaviors, most have been limited to specific age groups or restricted samples [8,13]. In particular, systematic analyses evaluating various preventive health practices simultaneously using nationally representative data for Korean adults remain relatively scarce [14,15]. Reflecting the importance of these indicators, the Korea Disease Control and Prevention Agency newly introduced a multidimensional 10-item measurement tool in the 2023 Korea National Health and Nutrition Examination Survey (KNHANES) that covers the searching, understanding, evaluating, and utilizing of health information [16,17]. This provides a vital foundation for precisely measuring the HL of Koreans and elucidating its role as a determinant of health behavior [18].

Accordingly, this study aims to assess the level of HL among Korean adults using the 2023–2024 KNHANES data and evaluate its independent impact on major health behaviors, including smoking, high-risk drinking, and insufficient physical activity, as well as the utilization of preventive health services such as health screening [14,15]. The findings will confirm the independent value of HL beyond socioeconomic variables and educational attainment, providing practical evidence for establishing future public health strategies and patient-centered information delivery systems in clinical settings [19,20].

METHODS

Study population

This study was a cross-sectional analysis using data from the 2023–2024 KNHANES. KNHANES is a nationally representative survey conducted by the Korea Disease Control and Prevention Agency using a stratified, multistage probability sampling design to represent the Korean population [14].

Among 20,191 participants, individuals who had missing, inapplicable, or non-response answers to all 10 HL items were excluded. A total of 11,555 adults were included in the final analysis.

This study was conducted according to the guidelines for the use of KNHANES data. The 9th KNHANES (2023–2024) was approved by the Institutional Review Board of the Korea Disease Control and Prevention Agency (approval no. 2022-11-16-R-A, 2022-11-16-R-03) [16], and all participants provided written informed consent.

Measurement

Health survey and examination

The health interview and examination components of KNHANES were conducted by trained personnel following standardized procedures. Demographic characteristics including education level, household income, and marital status, as well as health behaviors such as smoking, alcohol consumption, and physical activity, were collected through face-to-face interviews and self-administered questionnaires. Beginning in 2023, some self-administered surveys were conducted online.

Height and weight were measured using standardized equipment, and body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared.

Health literacy

HL was assessed using a 10-item questionnaire included in the KNHANES [17]. The items are designed to measure individuals' self-reported ability to understand and use health information in daily life [18]. Specifically, the questionnaire includes the following domains:

1. Ability to judge necessary vaccinations.
2. Ability to understand the risks of mental health problems such as stress and depressive symptoms.
3. Ability to recognize health warning signs related to smoking, drinking, and lack of physical activity.
4. Ability to evaluate the impact of daily behaviors on health.
5. Ability to understand doctors' explanations and instructions during medical visits.
6. Ability to determine appropriate actions in emergency situations.
7. Ability to understand healthcare professionals' instructions regarding medication use.
8. Ability to understand patient education materials provided

by hospitals.
9. Ability to evaluate the reliability of health information obtained from the internet and media.
10. Ability to use health information obtained from the internet and media for health-related decision-making.

Each item was rated on a 4-point Likert scale ("strongly disagree"=1, "disagree"=2, "agree"=3, "strongly agree"=4). The total score was calculated by summing the scores of the 10 items, with higher scores indicating higher HL. The internal consistency of the 10-item HL scale in this study population was high, with a Cronbach's alpha of 0.912. In this study, participants were categorized into quartiles based on the total score distribution: Q1 (≤26), Q2 (27–29), Q3 (30–32), and Q4 (≥33).

Health behaviors and preventive practice

Current smoking was defined as daily or occasional smoking at the time of the survey.

High-risk drinking was defined as consuming alcohol at least twice per week and drinking seven or more drinks per occasion for men, or five or more drinks per occasion for females.

Insufficient physical activity was defined as not meeting the recommended level of at least 150 minutes of moderate-intensity physical activity per week, 75 minutes of vigorous-intensity activity per week, or an equivalent combination of moderate and vigorous activity [7,21].

Participation in preventive health screening was assessed based on whether participants had undergone health screening within the past 2 years. Individuals who had not received screening were classified as non-participants.

Covariates

Demographic covariates included age, sex, household income (quartiles), education level (elementary school or less, middle school, high school, college or higher), and marital status (currently living with a spouse). Health-related covariates included BMI and physician-diagnosed chronic diseases, including hypertension, dyslipidemia, and diabetes.

Statistical analysis

All analyses accounted for the complex sampling design of KNHANES by applying sampling weights. When combining the 2023 and 2024 datasets, survey weights were adjusted accordingly.

General characteristics were compared according to HL quartiles. Continuous variables were presented as mean±standard error using complex sample general linear models, and categorical variables were presented as weighted percentages using complex sample cross-tabulation analyses.

To evaluate the independent association between HL and each health behavior, complex sample logistic regression analyses were performed. Three models were constructed. Model 1 was unadjusted. Model 2 was adjusted for age and sex. Model 3 was fully adjusted for age, sex, BMI, household income, education level, marital status, hypertension, dyslipidemia, and diabetes. Additionally, to account for the potential confounding effect of psychological status, a sensitivity analysis (Model 4) was conducted by further adjusting for perceived stress level on top of the variables in Model 3; the detailed results of this analysis are provided in Supplementary Table 1. Results were presented as odds ratios (ORs) with 95% confidence intervals (CIs). A *P*-value less than 0.05 was considered statistically significant.

All statistical analyses were conducted using SPSS version 21.0 (SPSS Inc.).

RESULTS

From the 2023–2024 KNHANES, a total of 20,191 participants were identified. Among them, individuals who had missing, inapplicable, or non-response answers to all 10 HL items were excluded, and 11,555 participants were finally included in the analysis.

Participants were classified into four groups according to HL level (Q1–Q4), and their baseline characteristics are presented in Table 1 and Supplementary Fig. 1. The group with the highest HL level (Q4) was significantly younger than the group with the lowest HL level (Q1) (43.27±0.35 years vs. 57.08±0.61 years, $P<0.001$). In addition, higher HL level was clearly associated with higher household income (high income: Q4 39.9% vs. Q1 21.8%) and higher education level (college or higher: Q4 61.8% vs. Q1 23.4%) ($P<0.001$).

In the distribution analysis of health behaviors (Supplementary Fig. 1), lower HL level showed a stepwise increase in the prevalence of current smoking, insufficient physical activity, and non-participation in health screening.

Among health behaviors and preventive practices, statistically significant differences between HL groups were observed in all variables except high-risk drinking. The prevalence of current smoking (Q1 21.1% vs. Q4 13.4%, $P<0.001$), insufficient physical activity (Q1 62.1% vs. Q4 42.8%, $P<0.001$), and non-participation in health screening within the past 2 years (Q1 32.8% vs. Q4 25.7%, $P<0.001$) were all higher in groups with lower HL level. In contrast, high-risk drinking did not show a statistically significant

https://doi.org/10.15384/kjhp.2026.00248

Table 1. Baseline characteristics of the study population according to health literacy quartiles (Q1–Q4)

Characteristic	Q1 (n=1,945)	Q2 (n=2,526)	Q3 (n=4,260)	Q4 (n=2,824)	*P*-value[a]
Health literacy quartiles	22.56±0.131	28.17±0.017	30.36±0.012	36.69±0.057	
Sociodemographic characteristics					
Age (yr)	57.08±0.61	51.24±0.51	49.63±0.34	43.27±0.35	<0.001
Sex					<0.001
Male	842 (50.9)	1,157 (52.7)	1,926 (51.1)	1,080 (45.6)	
Female	1,103 (49.1)	1,369 (47.3)	2,334 (48.9)	1,744 (54.4)	
Body mass index (kg/m^2)	24.60±0.11	24.33±0.10	24.09±0.07	24.16±0.09	0.002
Household income					<0.001
Low	690 (28.5)	550 (17.1)	601 (11.3)	286 (8.5)	
Low-mid	478 (24.3)	649 (24.0)	1,038 (23.0)	586 (20.2)	
High-mid	420 (25.4)	668 (29.1)	1,244 (31.3)	859 (31.4)	
High	350 (21.8)	656 (29.8)	1,362 (34.4)	1,085 (39.9)	
Education level					<0.001
Elementary or less	794 (31.5)	504 (14.7)	448 (7.6)	147 (3.1)	
Middle	298 (13.5)	340 (10.3)	426 (7.7)	115 (3.1)	
High	512 (31.7)	857 (36.1)	1,556 (36.6)	895 (32.1)	
College or higher	335 (23.4)	824 (38.8)	1,827 (48.1)	1,666 (61.8)	
Marital status					<0.001
Married/living together	1,143 (56.0)	1,669 (63.3)	2,969 (66.1)	1,865 (61.3)	
Other	802 (44.0)	857 (36.7)	1,291 (33.9)	959 (38.7)	
Health behaviors & preventive practices					
Current smoking					<0.001
Non-smoker	1,616 (78.9)	2,101 (79.8)	3,625 (82.9)	2,503 (86.6)	
Current smoker	329 (21.1)	425 (20.2)	635 (17.1)	321 (13.4)	
High-risk drinking					0.452
Normal	1,334 (85.1)	1,984 (86.1)	3,368 (85.6)	2,312 (86.9)	
High-risk	204 (14.9)	270 (13.9)	495 (14.4)	312 (13.1)	
Insufficient physical activity					<0.001
Normal (meets guideline)	594 (37.9)	966 (44.6)	1,818 (48.2)	1,461 (57.2)	
Abnormal (does not meet guideline)	1,149 (62.1)	1,400 (55.4)	2,164 (51.8)	1,213 (42.8)	
No health screening in past 2 years					<0.001
Normal (screened)	1,221 (67.2)	1,757 (72.2)	3,006 (74.5)	2,043 (74.3)	
Abnormal (not screened)	527 (32.8)	613 (27.8)	977 (25.5)	632 (25.7)	
Comorbidities					
Hypertension					<0.001
Yes	801 (35.0)	797 (25.5)	1,095 (21.6)	458 (13.7)	
No	1,144 (65.0)	1,729 (74.5)	3,165 (78.4)	2,366 (86.3)	
Hyperlipidemia					<0.001
Yes	609 (27.6)	731 (23.5)	1,059 (21.2)	502 (14.4)	
No	1,336 (72.4)	1,795 (76.5)	3,201 (78.8)	2,322 (85.6)	
Diabetes					<0.001
Yes	359 (16.3)	367 (11.6)	517 (10.4)	209 (6.3)	
No	1,586 (83.7)	2,159 (88.4)	3,743 (89.6)	2,615 (93.7)	

Values are presented as mean±standard error or unweighted number (weighted column %). Health literacy was categorized into quartiles (Q1: inadequate, Q2: marginal, Q3: sufficient, and Q4: excellent).
[a]*P*-values were obtained using design-based F tests for continuous variables and Rao–Scott adjusted chi-square tests for categorical variables.

difference between groups (Q1 14.9% vs. Q4 13.1%, *P*=0.452).

The results of complex sample logistic regression analyses according to HL level are presented in Table 2 and Supplementary Fig. 2. In the fully adjusted model (Model 3), compared with the highest HL group (Q4), the lowest HL group (Q1) had a significantly higher risk of current smoking (OR, 1.83 [95% CI, 1.44–2.32]; *P*<0.001).

Insufficient physical activity also showed increased risk as HL level decreased (Q1 vs. Q4: OR, 1.48 [95% CI, 1.26–1.74]; Q2 vs. Q4: OR, 1.34 [95% CI, 1.19–1.52]; Q3 vs. Q4: OR, 1.23 [95% CI, 1.11–1.37]; all *P*<0.001), and a linear trend was observed.

The association with non-participation in health screening within the past 2 years was also maintained (Q1 vs. Q4: OR, 1.38 [95% CI, 1.16–1.65]; *P*=0.005), indicating that lower HL level was associated with lower screening participation.

However, high-risk drinking did not show a statistically significant association after adjustment (Q1 vs. Q4: OR, 1.19 [95% CI, 0.92–1.53]; *P*=0.485). Furthermore, in the sensitivity analysis (Model 4) that additionally adjusted for perceived stress level, the significant independent associations between lower HL and current smoking, insufficient physical activity, and non-participation in health screening remained robust, while high-risk drinking remained insignificant (Supplementary Table 1).

DISCUSSION

This study evaluated the association between the level of HL and major health behaviors as well as preventive health practices in Korean adults using the 2023–2024 KNHANES data. As a result of the study, lower HL was associated with higher rates of current smoking, insufficient physical activity, and non-participation in health screening; these associations were maintained even after adjusting for socioeconomic factors and chronic diseases. On the other hand, high-risk drinking did not show a statistically significant association after adjustment. This study suggests that HL is an important factor independently associated with actual health behaviors, beyond being a mere indicator of education level [15,20].

The association between HL and health behaviors has been repeatedly reported in existing studies [7,8]. Individuals with low HL are highly likely to experience difficulties in understanding and evaluating health information and translating it into action [14]. This can directly affect self-care behaviors such as smoking cessation, maintaining physical activity, and participating in preventive screenings. In particular, the linear trend observed in this study shows that HL is a continuous capacity rather than a discrete category, and health behaviors can vary stepwise accord-

Table 2. Adjusted associations between health literacy (HL) level and health risk behaviors

Characteristic	HL Q1 vs. Q4	HL Q2 vs. Q4	HL Q3 vs. Q4	*P* for trend[a]
Current smoking				
Model 1	1.73 (1.41–2.12)	1.64 (1.38–1.94)	1.33 (1.13–1.57)	<0.001
Model 2	1.97 (1.56–2.47)	1.67 (1.38–2.02)	1.36 (1.13–1.63)	<0.001
Model 3	1.83 (1.44–2.32)	1.59 (1.31–1.92)	1.30 (1.07–1.57)	<0.001
High-risk drinking				
Model 1	1.16 (0.93–1.45)	1.07 (0.89–1.28)	1.12 (0.95–1.31)	0.495
Model 2	1.16 (0.91–1.48)	1.03 (0.85–1.25)	1.11 (0.94–1.32)	0.531
Model 3	1.19 (0.92–1.53)	1.01 (0.83–1.23)	1.09 (0.92–1.30)	0.485
Insufficient physical activity				
Model 1	2.19 (1.88–2.55)	1.66 (1.47–1.87)	1.44 (1.30–1.59)	<0.001
Model 2	1.60 (1.36–1.87)	1.39 (1.23–1.57)	1.24 (1.12–1.37)	<0.001
Model 3	1.48 (1.26–1.74)	1.34 (1.19–1.52)	1.23 (1.11–1.37)	<0.001
No health screening				
Model 1	1.41 (1.21–1.65)	1.12 (0.97–1.29)	0.99 (0.88–1.13)	<0.001
Model 2	1.86 (1.58–2.19)	1.30 (1.13–1.51)	1.13 (0.99–1.28)	<0.001
Model 3	1.38 (1.16–1.65)	1.13 (0.97–1.32)	1.07 (0.94–1.22)	0.005

Values are presented as odds ratio (95% confidence interval). HL was categorized into quartiles (Q1: inadequate, Q2: marginal, Q3: sufficient, and Q4: excellent). Model 1: Unadjusted; Model 2: Adjusted for age and sex; Model 3: Adjusted for age, sex, body mass index, household income, education level, marital status, hypertension, dyslipidemia, and diabetes mellitus. Odds ratios and 95% confidence intervals were estimated using complex-sample logistic regression.

[a]The highest HL group (Q4) was used as the reference. *P* for trend was calculated across ordered HL categories.

https://doi.org/10.15384/kjhp.2026.00248

ing to that level [6].

The association with participation in preventive health screenings carries important meaning from a public health perspective. Health screening plays a key role in the early detection and management of diseases, but participation in screenings depends heavily on an individual's information literacy and health decision-making ability [22,23]. The result showing lower screening participation rates in groups with low HL suggests that health inequalities may originate from differences in information accessibility and comprehension capacity [3].

In contrast, high-risk drinking, unlike other health behaviors, did not show an independent association with HL. This suggests that drinking habits are influenced more by social and cultural environments than by a person's ability to understand health information. In South Korea, social drinking is very common, and people often drink to meet social expectations rather than by personal choice [24]. Also, previous studies show that a culture that easily accepts drinking often leads to alcohol problems among Korean adults [25]. In this kind of environment, social pressure can be stronger than personal health knowledge. This explains why HL did not strongly affect high-risk drinking in our study. Therefore, not all health behaviors work the same way, and public health strategies need to be customized for each specific behavior [26,27].

This study has strengths in that it performed an analysis considering the complex sample design using nationally representative data. Furthermore, it provides practical public health implications in that it evaluated HL through multidimensional items and analyzed its connection with various health behaviors.

However, several limitations exist. First, as it is a cross-sectional study design, causality cannot be established. While it is possible that HL affects health behaviors, the possibility that health behaviors affect information seeking and comprehension ability cannot be excluded. Therefore, future longitudinal studies utilizing cohort data, such as the National Health Insurance Service database, are essential to establish clear causality. Second, health behaviors were collected through a self-reporting method, so there is a possibility of reporting bias, including recall bias and social desirability bias. To ensure objectivity, future studies should validate these findings using objective measures, such as claims data for actual health screening records or wearable device data for physical activity. Third, the measurement of HL is based on self-evaluation, which may not fully reflect actual performance ability.

Nevertheless, the results of this study show the possibility that HL acts as an independent determinant in health behaviors and preventive practices. In future health promotion policies and intervention strategies, not only the quantity of information provision but also the understandability, accessibility, and personalized delivery methods of information need to be importantly considered [19]. Particularly, in order for healthcare professionals in clinical settings to identify patients' HL levels in advance and provide tailored information, practical efforts such as strengthening customized communication skills training in the medical school curriculum and clinical training stages should be paralleled [20].

SUPPLEMENTARY MATERIAL

Supplementary Table 1. Adjusted associations between health literacy (HL) level and health risk behaviors
Supplementary Fig. 1. Prevalence of health risk behaviors and preventive practices according to health literacy level.
Supplementary Fig. 2. Multivariable-adjusted odds ratios (ORs) for health risk behaviors according to health literacy quartiles (Model 3).

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AUTHOR CONTRIBUTIONS

Dr. Gee Youn SONG had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization, Data curation, Formal analysis, Methodology, Investigation, Writing–original draft, Writing–review & editing: all authors.

CONFLICTS OF INTEREST

No existing or potential conflict of interest relevant to this article was reported.

FUNDING

None.

DATA AVAILABILITY

The data used in this study are publicly available from the Korea National Health and Nutrition Examination Survey (KNHANES).

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Original Article

Korean J Health Promot 2026;26(2):63-71
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2026.00241

Korean Journal of Health Promotion
KJHP

Associations of Life-Sustaining Treatment-Related Knowledge, Role Perception, and Nursing Stress with End-of-Life Nursing Care Performance among Intensive Care Unit Nurses

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ABSTRACT

Background: This study examined the associations of intensive care unit (ICU) nurses' knowledge of life-sustaining treatment (LST), role perception regarding LST, and nursing stress related to LST with their performance of end-of-life nursing care.

Methods: A total of 179 ICU nurses from tertiary general hospitals participated in this descriptive correlational study. Data were collected using structured self-administered questionnaires. The data were analyzed using the independent t-test, one-way ANOVA, Mann–Whitney U-test, Kruskal–Wallis test, Pearson's correlation coefficient, and multiple regression analysis, employing IBM SPSS version 28.0.

Results: The performance of end-of-life nursing care was significantly higher among nurses with 5 to <7 years (β=0.17, *P*=0.032) and ≥7 years (β=0.20, *P*=0.011) of total clinical experience, as well as those who had performed end-of-life nursing care 20 times or more (β=0.17, *P*=0.014). Higher role perception regarding LST (β=0.27, *P*<0.001) and lower nursing stress related to LST (β=−0.41, *P*<0.001) were also associated with better performance. These variables explained 31.3% of the variance in end-of-life nursing care performance.

Conclusions: These findings suggest that tailored educational and support programs based on clinical experience and care exposure may be helpful for supporting end-of-life nursing care performance among ICU nurses. In particular, role perception regarding LST and nursing stress related to LST may be important considerations when designing strategies to support the quality of end-of-life nursing care. Such strategies may also contribute to patient dignity and family-centered supportive care in ICU end-of-life situations.

Keywords: Terminal care, Intensive care units, Nurses, Professional role, Psychological stress

Received: March 5, 2026; **Revised:** April 29, 2026; **Accepted:** May 2, 2026

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INTRODUCTION

Advances in medical technology have increased medically futile life-sustaining treatment (LST), intensifying debate on death with dignity [1]. LST includes interventions such as cardiopulmonary resuscitation, dialysis, chemotherapy, and mechanical ventilation that may prolong the dying process without reasonable expectation of therapeutic benefit at the end of life [2]. In South Korea, the Act on Hospice and Palliative Care and Decisions on LST for Patients at the End of Life was enacted in 2016 and implemented in 2018 to protect human dignity, promote patients' best interests, and respect self-determination [2].

Patients admitted to the intensive care unit (ICU) often face decisions regarding the withdrawal or withholding of LST [3]. The ICU is a specialized unit providing intensive monitoring, treatment, and nursing care for critically ill patients [4]. Because mortality is higher in this setting, end-of-life situations occur more frequently than in other departments, and ICU nurses frequently perform end-of-life nursing care [5]. Nursing care related to LST refers to the care provided to patients who are receiving such treatment, and it is conceptually distinct from end-of-life nursing care or hospice care [3]. Limited LST education in nursing curricula and clinical practice has led to insufficient LST knowledge; consequently, ICU nurses often experience difficulty providing appropriate LST-related care [6]. Nurses who care for patients at the end of life must possess sufficient knowledge about LST decisions, to provide accurate information and deliver appropriate end-of-life nursing care [6]. Thus, assessing ICU nurses' level of LST knowledge and its association with end-of-life nursing care performance for patients receiving such treatment is necessary.

Nurses should not view LST withdrawal as merely the cessation of medical interventions but should integrate the LST decision-making process with end-of-life nursing care to ensure a death with dignity [7] and play a supportive role during the terminal stage after LST decisions [5]. According to previous research [5], a clearer role perception regarding LST is associated with a higher level of performance in end-of-life nursing care. Therefore, it is necessary to investigate ICU nurses' role perception regarding LST and its association with the performance of end-of-life nursing care.

ICU nurses care for both general patients and those receiving LST without differentiating between them, often experiencing ethical dilemmas during LST continuation or withdrawal and psychological burdens from heavy workloads and advanced facilities and equipment [3]. Nursing stress related to LST may be associated with ICU nurses' performance of end-of-life nursing care [8]. However, studies report inconsistent associations between LST-related nursing stress and end-of-life nursing care performance [7,9]: general-hospital studies reported a significant negative correlation [7], whereas ICU-nurse research found no significant correlation [9]. Replication studies are needed to clarify this relationship.

Although previous studies have explored LST-related or end-of-life care issues among nurses, many have focused primarily on general hospital nurses [7] or examined selected factors related to end-of-life care performance among ICU nurses [3,8,9]. Furthermore, findings regarding the association between LST-related nursing stress and end-of-life care performance have remained inconsistent [7,9]. This study is distinctive in that by simultaneously investigating these modifiable factors within the ICU, emphasizing the potential role of psychological variables alongside clinical knowledge. In the ICU, appropriate end-of-life nursing care supports patient dignity and family-centered care [2,4], and may contribute to a more health-promoting care environment. By identifying specific modifiable nursing-related factors associated with care performance, this study provides practical evidence for developing targeted support strategies.

Therefore, this study aimed to investigate whether ICU nurses' LST-related knowledge, role perception, and nursing stress were associated with their performance of end-of-life nursing care, and to provide foundational data to inform the development of tailored end-of-life nursing care programs.

METHODS

Study design

This study employed a descriptive correlational design to identify factors associated with the performance of end-of-life nursing care among ICU nurses.

Participants

The participants of this study were nurses working in ICUs of tertiary general hospitals.

The inclusion criteria were as follows:

(1) nurses currently working in the ICUs of tertiary general hospitals; (2) nurses who have experience providing end-of-life nursing care for patients receiving or withdrawing LST; and (3) nurses who understood the purpose of the study and voluntari-

https://doi.org/10.15384/kjhp.2026.00241

ly agreed to participate.

The exclusion criteria were as follows:

(1) nurses with less than 1 year of ICU work experience, and (2) nurse managers who do not directly provide end-of-life nursing care.

Nurses with less than 1 year of ICU experience were excluded because they generally have a lower understanding of the meaning of death and higher death anxiety, resulting in an underdeveloped perception of death [5]. Nurse managers were also excluded because they are not directly involved in providing end-of-life nursing care.

Using G*Power version 3.1.9.2, the required sample size for multiple regression analysis was calculated with a significance level (α) of 0.05, a power (1–β) of 0.95, an effect size of 0.15, and 16 predictor variables. The minimum required sample size was 143 participants. Considering a potential dropout rate of 20%, data were collected from a total of 179 ICU nurses, and all 179 completed questionnaires were included in the final analysis.

Measures

General characteristics

General characteristics included age, sex, marital status, religion, highest education level, total work experience, ICU work experience, working department, participation in LST education, participation in end-of-life nursing education, and the number of end-of-life nursing care experiences within the past year. Based on a clinical ladder framework for nurses in tertiary hospitals, total work experience and ICU work experience were categorized into 1–<3, 3–<5, 5–<7, and ≥7 years [10]. Because nurses with less than 1 year of ICU experience were excluded from this study, the <1 year category in the original framework was not applied. The number of end-of-life nursing care experiences within the past year was categorized into <10, 10–<20, and ≥20 times based on a previous nursing study [11].

Knowledge of life-sustaining treatment

Knowledge of LST was measured using the instrument developed by Kim [12]. The tool consists of 16 items answered with "yes," "no," or "don't know." Correct answers were scored as 1 point, and incorrect or "don't know" responses were scored as 0. Total scores range from 0 to 16, with higher scores indicating greater knowledge of LST. Reliability was Kuder–Richardson 20 (KR-20)=0.63 in Kim's study [12] and KR-20=0.72 in this study.

Role perception regarding life-sustaining treatment

Role perception regarding LST was assessed using the scale developed by Byun et al. [13]. The instrument comprises 13 items rated on a 5-point Likert scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Twelve items are positively worded and one item is negatively worded. Higher scores represent a higher level of role perception regarding LST. Reliability was Cronbach's α=0.88 in Byun et al.'s study [13] and Cronbach's α=0.82 in this study.

Nursing stress related to life-sustaining treatment

Nursing stress related to LST was measured using the tool developed by Lee and Kim [3]. This instrument consists of 28 items rated on a 5-point Likert scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Higher scores indicate greater nursing stress related to LST. Reliability was Cronbach's α=0.93 in Lee and Kim's study [3] and Cronbach's α=0.90 in this study.

Performance of end-of-life nursing care

Performance of end-of-life nursing care was measured using the instrument developed by Park and Choi [14] and revised by Choi [15]. The tool includes 18 items rated on a 4-point Likert scale, ranging from 1 ("never") to 4 ("always"). It consists of three subdomains: physical (7 items), psychological (8 items), and spiritual (3 items). Higher scores indicate greater performance of end-of-life nursing care. Reliability was Cronbach's α=0.85 in Choi's study [15] and Cronbach's α=0.81 in this study.

Data collection

Data were collected from October 20 to November 10, 2023, from nurses working in ICUs of tertiary general hospitals in South Korea. Data were collected using an online self-administered survey. Recruitment announcements describing the purpose of the study and inclusion criteria were posted on an online nurse-exclusive community platform (Naver Cafe: Meeting Representing Nurses). Nurses who met the eligibility criteria and voluntarily agreed to participate were recruited through convenience sampling. Participants accessed the questionnaire via an online survey link and completed the survey anonymously. In addition, a snowball sampling method was employed, whereby participants were encouraged to share the survey link with other eligible ICU nurses. Completing the questionnaire required approximately 15–20 minutes, and participants received a small token of appreciation for their time and participation.

Data analysis

Data were analyzed using SPSS/WIN version 28.0 (IBM Corp.). General characteristics of participants were analyzed using frequencies, percentages, means, standard deviations, medians, and interquartile ranges. The levels of knowledge of LST, role perception regarding LST, nursing stress related to LST, and performance of end-of-life nursing care were analyzed using descriptive statistics (mean and standard deviation). Differences in the performance of end-of-life nursing care according to participants' general characteristics were analyzed using the independent t-test, one-way analysis of variance (ANOVA), Mann–Whitney U-test, and Kruskal–Wallis test, with post-hoc comparisons performed using the Mann–Whitney U-test. Correlations among knowledge of LST, role perception regarding LST, nursing stress related to LST, and performance of end-of-life nursing care were examined using Pearson's correlation coefficient. Finally, a multiple regression analysis (enter method) was conducted to identify factors associated with the performance of end-of-life nursing care. Total work experience and end-of-life nursing experience, which showed significant differences in end-of-life nursing care performance in the univariate analyses, were entered as control variables. Knowledge of LST, role perception regarding LST, and nursing stress related to LST were entered as the main independent variables. Model adequacy was evaluated by examining the independence of residuals and multicollinearity.

Ethical considerations

This study was approved by the Institutional Review Board (IRB) of Jeonbuk National University (IRB No. JBNU 2023-09-002-001) and adhered to the Declaration of Helsinki. Participants were recruited online after receiving detailed information regarding the study's purpose, voluntary participation, and the right to withdraw without penalty. Informed consent was obtained electronically, ensuring strict anonymity and confidentiality. All personal contact information collected for compensation was securely deleted upon distribution.

RESULTS

General characteristics of participants

The participants' mean age was 29.63±3.50 years, with a majority being in their 20s (59.2%), female (86.0%), and unmarried (57.5%). Most held an associate or bachelor's degree (87.2%) and reported having no religion (77.1%). The mean total clinical and ICU experience were 5.39±3.18 and 4.39±2.28 years, respectively, with the medical ICU (40.2%) being the most common working unit. Regarding specialized education, 31.8% had received LST-related training, and 42.5% had received end-of-life care education. Over the past year, participants performed end-of-life nursing care an average of 10.46±4.97 times, with the majority (63.1%) experiencing 10 to fewer than 20 cases (Table 1).

Levels of knowledge, role perception, and nursing stress related to life-sustaining treatment, and performance of end-of-life nursing care among intensive care unit nurses

Mean scores for LST knowledge, role perception, and nursing stress were 12.71±2.82, 4.29±0.42, 4.30±0.43, respectively. Performance of end-of-life nursing care averaged 2.96±0.32.

Differences in intensive care unit nurses' performance of end-of-life nursing care according to general characteristics

There were significant differences in the performance of end-of-life nursing care according to total work experience (F=3.36, P=0.020) and the number of end-of-life nursing care experiences (H=11.51, P=0.003) among ICU nurses. Post hoc tests showed that nurses with ≥7 years of total work experience (3.05±0.21) demonstrated higher levels of performance of end-of-life nursing care than those with less than 3 years (2.85±0.28). Additionally, nurses with 20 or more end-of-life nursing care experiences (3.17±0.26) showed higher performance of end-of-life nursing care compared to those with fewer than 10 experiences (2.87±0.28) (Table 1).

Relationships among knowledge of life-sustaining treatment, role perception regarding life-sustaining treatment, nursing stress related to life-sustaining treatment, and performance of end-of-life nursing care

The performance of end-of-life nursing care showed a significant positive correlation with knowledge of LST (r=0.18, P=0.018) and role perception regarding LST (r=0.27, P<0.001), and a significant negative correlation with nursing stress related to LST (r=–0.40, P<0.001) (Table 2).

Factors associated with the performance of end-of-life nursing care among participants

To identify factors associated with the performance of end-of-life nursing care, total work experience and end-of-life nursing experience were entered as control variables, while knowledge of

https://doi.org/10.15384/kjhp.2026.00241

Table 1. Differences in performance of end-of-life nursing care according to general characteristics of participants (n=179)

Variable	Category	n (%)	Performance of end-of-life nursing care		
			Mean±SD	Statistic[a]	*P*
Age (yr), mean±SD	29.63±3.50				
Age group (yr)	20–29	106 (59.2)	2.95±0.31	−0.56	0.573
	≥30	73 (40.8)	2.98±0.32		
Sex	Male	25 (14.0)	2.90±0.33	−0.53[b]	0.598
	Female	154 (86.0)	2.98±0.31		
Marital status	Single	103 (57.5)	2.97±0.29	0.32	0.750
	Married	76 (42.5)	2.96±0.35		
Religion	None	138 (77.1)	2.94±0.31	−1.73	0.085
	Yes	41 (22.9)	3.04±0.31		
Highest education level	Associate's or bachelor's degree	156 (87.2)	2.95±0.31	0.58	0.747
	Master's or graduate degree	23 (12.8)	3.04±0.36		
Total work experience (yr)	1–<3[A]	42 (23.5)	2.85±0.28	3.36	0.020
	3–<5[B]	51 (28.5)	2.95±0.37		(D>A)
	5–<7[C]	49 (27.4)	3.01±0.32		
	≥7[D]	37 (20.7)	3.05±0.21		
ICU work experience (yr)	1–<3	65 (36.3)	2.89±0.31	3.63[c]	0.304
	3–<5	50 (27.9)	3.03±0.29		
	5–<7	42 (23.5)	2.99±0.34		
	≥7	22 (12.3)	2.98±0.32		
Department	Medical ICU	72 (40.2)	2.94±0.34	1.79	0.775
	Surgical ICU	38 (21.2)	3.01±0.30		
	Neurosurgical ICU	24 (13.4)	3.01±0.30		
	Cardiac ICU	26 (14.5)	2.90±0.30		
	Emergency ICU	19 (10.6)	2.99±0.32		
Life-sustaining education	Yes	57 (31.8)	2.98±0.29	0.37	0.715
	No	122 (68.2)	2.96±0.33		
End-of-life nursing education	Yes	76 (42.5)	2.93±0.31	−1.44	0.151
	No	103 (57.5)	2.99±0.32		
End-of-life nursing experience (times/yr)	<10[A]	50 (27.9)	2.87±0.28	11.51[c]	0.003
	10–<20[B]	113 (63.1)	2.98±0.32		(C>A)[b]
	≥20[C]	16 (8.9)	3.17±0.26		

The sum of the percentages does not equal 100% because of rounding.
ICU, intensive care unit; SD, standard deviation.
[a]Values in the Statistic column represent t, F, U, or H, as appropriate. [b]Mann–Whitney U-test; [c]Kruskal–Wallis test with post-hoc Mann–Whitney U-test.

Table 2. Relationships among knowledge of LST, role perception regarding LST, nursing stress related to LST, and performance of end-of-life nursing care (n=179)

Variable	Knowledge of LST	Role perception regarding LST	Nursing stress related to LST
Role perception regarding LST	−0.08 (0.264)		
Nursing stress related to LST	−0.10 (0.195)	0.09 (0.251)	
Performance of end-of-life nursing care	0.18 (0.018)	0.27 (<0.001)	−0.40 (<0.001)

Values are presented as r (*P*-value).
LST, life-sustaining treatment.

LST, role perception regarding LST, and nursing stress related to LST were entered as the main independent variables. Total work experience and end-of-life nursing experience were treated as dummy variables, and the enter method was used for variable selection. Assumptions for regression were met, with no autocorrelation (Durbin–Watson=2.00) or multicollinearity (tolerance, 0.61–0.94; variance inflation factor, 1.07–1.65) detected.

The overall regression model for the performance of end-of-life nursing care was significant (F=11.14, *P*<0.001). Compared to nurses with less than 3 years of total work experience, those with 5–<7 years (β=0.17, *P*=0.032) and ≥7 years (β=0.20, *P*=0.011) demonstrated higher performance. Additionally,

Table 3. Factors associated with the performance of end-of-life nursing care (n=179)

	B	SE	β	t	*P*	Tolerance	VIF
Constant	3.10	0.31		10.15	<0.001		
Total work experience (ref: 1–<3 yr)							
3–<5 yr	0.02	0.06	0.03	0.34	0.731	0.61	1.65
5–<7 yr	0.12	0.06	0.17	2.17	0.032	0.61	1.64
≥7 yr	0.16	0.06	0.20	2.56	0.011	0.62	1.62
End-of-life nursing experience (ref: <10 times/yr)							
10–<20 times/yr	0.06	0.05	0.10	1.41	0.160	0.79	1.27
≥20 times/yr	0.19	0.08	0.17	2.48	0.014	0.80	1.26
Knowledge of LST	0.01	0.01	0.11	1.70	0.092	0.93	1.08
Role perception regarding LST	0.21	0.05	0.27	4.27	<0.001	0.94	1.07
Nursing stress related to LST	−0.30	0.05	−0.41	−6.40	<0.001	0.93	1.07
Adjusted R^2=0.31, F=11.14, *P*<0.001							

B, unstandardized coefficients; LST, life-sustaining treatment; ref, reference; SE, standard error; VIF, variance inflation factor; β, standardized coefficients.

nurses with 20 or more experiences of end-of-life nursing care (β=0.17, *P*=0.014) showed higher performance compared to those with fewer than 10 experiences. Higher role perception regarding LST (β=0.27, *P*<0.001) and lower nursing stress related to LST (β=−0.41, *P*<0.001) were associated with higher performance of end-of-life nursing care. These variables collectively explained 31.3% of the variance in the model (Table 3).

DISCUSSION

This study identified several factors associated with ICU nurses' performance of end-of-life nursing care. In the final model, higher role perception regarding LST and lower nursing stress related to LST were significantly associated with better performance, whereas knowledge of LST was not a significant predictor. In addition, nurses with greater total clinical experience and more frequent end-of-life nursing care experience showed higher performance. These findings suggest that, in ICU settings, modifiable psychological and practice-related factors may be more directly relevant to end-of-life nursing care performance than knowledge alone.

The level of end-of-life nursing care performance observed in this study was comparable to that reported in previous studies involving ICU nurses using the same measurement tool [15], and higher than that reported among nurses working in general wards of tertiary hospitals [16]. This pattern may reflect the ICU context, in which nurses more frequently encounter patients who deteriorate despite intensive treatment and require ongoing end-of-life nursing care [8]. Although ICUs are not specialized end-of-life care units, ICU nurses often remain closely involved in caring for critically ill patients throughout the dying process. In this regard, the relatively higher performance observed in this study may suggest that repeated exposure to end-of-life situations in ICU settings contributes to greater familiarity with and responsiveness to end-of-life nursing needs.

In this study, nursing stress related to LST was moderate to high, consistent with findings from previous studies involving ICU nurses in general and tertiary hospitals using the same measurement tool [3,17], and higher than that reported among general ward nurses [18,19]. This pattern may reflect the distinctive ICU environment, where nurses are required to manage critically ill patients, complex LSTs, and rapidly changing clinical situations. In such settings, the need for advanced technical competence and immediate responses to emergencies may intensify psychological burden and emotional exhaustion, thereby increasing LST-related nursing stress [20].

Nursing stress related to LST was significantly associated with end-of-life nursing care performance in this study, though prior findings have been inconsistent [7,9]. This discrepancy may reflect differences in participant characteristics, hospital settings, and model composition. For example, a prior study [9] included nurses from both tertiary and general hospitals with shorter experience requirements, whereas this study focused exclusively on tertiary general hospital ICU nurses with at least 1 year of ICU experience. Moreover, because nursing stress may be shaped by multiple factors [21], its relationship with performance may vary across settings. By focusing specifically on LST-related factors, this study may have captured a more direct association. In ICU settings, where communication surrounding LST decisions may be challenging [19], clearer role delineation, clear and supportive communication, and multidisciplinary collaboration may help reduce LST-related nursing

 https://doi.org/10.15384/kjhp.2026.00241

stress and support end-of-life nursing care performance [4,19].

Participants' role perception regarding LST was comparable to, or slightly higher than, that reported in previous studies involving general hospital nurses [18,19] and ICU nurses [22,23]. In this study, higher role perception regarding LST was significantly associated with better end-of-life nursing care performance. This finding suggests that a clearer understanding of nurses' roles in the context of LST decision-making may be an important factor supporting end-of-life nursing care performance in ICUs. Previous research has shown that nurses' active involvement in LST decision-making is important for providing informational and emotional support to patients and families [3]. However, despite the legal framework for LST decisions in South Korea, insufficient role-specific guidance and standardized institutional protocols may still lead to confusion regarding nurses' roles in practice [24]. Therefore, clear clinical guidelines, systematic education, and support for counseling and advocacy roles may help strengthen nurses' role perception regarding LST and, in turn, support end-of-life nursing care performance [24,25].

Knowledge of LST was not significantly associated with end-of-life nursing care performance in this study. To our knowledge, few studies have directly examined this association among ICU nurses. One possible explanation is that the knowledge instrument primarily assessed legal and decision-making aspects of LST, whereas end-of-life nursing care performance encompassed physical, psychological, and spiritual domains. This difference in construct coverage may have limited the extent to which LST-related knowledge translated directly into broader end-of-life nursing care performance. In addition, recent ICU research suggests that knowledge relevant to end-of-life care may vary by domain, with psychosocial and spiritual aspects often remaining limited despite overall clinical experience and education [26]. Future studies should therefore use more refined and up-to-date instruments to examine how different domains of LST- and end-of-life care-related knowledge are linked to end-of-life nursing care performance in ICU nurses.

The present study also showed that total work experience and the frequency of end-of-life nursing care experiences were significantly associated with end-of-life nursing care performance, partially differing from previous findings [8]. In particular, nurses with 5 years or more of clinical experience showed higher performance than those with less than 3 years. This may reflect progression in clinical competence and role development across career stages; in a clinical ladder framework for tertiary hospital nurses, the period after 5 years of experience corresponds to more advanced levels of practice characterized by greater ability to manage complex situations and coordinate care [10]. These findings support the need for structured educational support tailored to less experienced nurses, particularly to help them develop confidence and preparedness in providing end-of-life nursing care.

From a health-promotion perspective, strengthening nurses' role perception regarding LST and reducing LST-related nursing stress [3,18] may help foster a more supportive end-of-life care environment in ICUs [24]. Such efforts may also better support patients and families during the dying process.

This study has several limitations. First, because participants were recruited through convenience and snowball sampling, the sample may not be fully representative of ICU nurses in South Korea, which limits the generalizability of the findings. Second, the instrument used to measure knowledge of LST showed modest internal consistency. Because this scale is composed of dichotomously scored items, its KR-20 may be relatively modest compared with that of instruments with more response categories, even when the number of items is the same [27]. Nevertheless, this remains a limitation of the present study, and further refinement and validation of the instrument are needed. In addition, self-reported data may be subject to social desirability bias, and the use of structured instruments may not fully capture the complexity of clinical practice. Future research should employ more diverse and representative sampling methods, use objective data collection approaches, and further validate measurement tools.

In conclusion, role perception regarding LST, nursing stress related to LST, and clinical experience were associated with ICU nurses' performance of end-of-life nursing care. Nurses with at least 5 years of experience and frequent end-of-life encounters showed higher performance. These findings suggest that structured and continuous support programs tailored to less experienced nurses, particularly those addressing role perception, communication, and LST-related stress, may be useful for supporting the quality of end-of-life nursing care and fostering a more health-promoting care environment in ICUs.

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AUTHOR CONTRIBUTIONS

Dr. Jihyun BAEK had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: SM and JB. Data curation: SM and JB. Formal analysis: SM and JB. Investigation: SM and JB. Methodology: SM and JB. Project administration: JB. Resources: SM and JB. Supervision: JB, JHK, and HYK. Validation: all authors. Visualization: SM and JB. Writing–original draft: SM and JB. Writing–review & editing: all authors.

CONFLICTS OF INTEREST

Jeong Hee KANG is the Editor of this journal and was not involved in the peer review or editorial decision-making process for this article. No other potential conflicts of interest relevant to this article were reported.

FUNDING

None.

DATA AVAILABILITY

The dataset supporting the conclusions is available from the corresponding author on reasonable request.

ACKNOWLEDGMENTS

This article is based on a part of the first author's master's thesis from Jeonbuk National University.

We thank all participants for their voluntary participation. The authors used ChatGPT (OpenAI) to refine the language for clarity and readability. The authors take full responsibility for the content.

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Original Article

Korean J Health Promot 2026;26(2):72-81
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2026.00262

Korean Journal of Health Promotion
KJHP

Factors Associated with Clinical Adaptation among Newly Graduated Nurses: The Roles of Reality Shock and Resilience

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ABSTRACT

Background: This study was conducted to identify factors associated with clinical adaptation among newly graduated nurses, with particular focus on reality shock and resilience.
Methods: A cross-sectional study was conducted on 191 newly graduated nurses working at general hospitals in the Incheon area. Data were collected through an online survey. The collected data were analyzed using descriptive statistics, t-tests, correlation analysis, and multiple regression analyses.
Results: The mean clinical adaptation score was 5.77±1.80 on a 0–10 Visual Analogue Scale. Clinical adaptation was positively correlated with job satisfaction and resilience and negatively correlated with reality shock. Job satisfaction (β=0.17, *P*=0.017), adaptability (β=0.24, *P*=0.008), and lack of confidence (β=–0.43, *P*<0.001) were significantly associated with clinical adaptation, accounting for 45.9% of the variance (adjusted R^2=0.459).
Conclusions: Interventions aimed at enhancing resilience, strengthening confidence in clinical practice, and promoting positive work experiences may facilitate successful clinical adaptation among newly graduated nurses. These findings provide evidence for the development of targeted support strategies to promote a successful transition to professional nursing practice.

Keywords: Nurses, Psychological adaptation, Clinical competence, Occupational stress

INTRODUCTION

One of the key factors determining the quality of medical services and a hospital's competitiveness is the retention of skilled nursing staff [1]. However, the high turnover rate among newly graduated nurses has been identified as a significant challenge in human resource management for healthcare institutions.

According to data from the Hospital Nurses Association [2], 47.7% of the 23,064 newly graduated nurses hired in 2020 resigned within 3 years, and among them, 3,599 nurses (15.6%) resigned within 1 year of hire. The primary reason for resignation was inability to adapt to the job (36.5%). This findings suggest that the clinical adaptation among newly graduated nurses is a critical challenge in nursing workforce management [3,4].

Newly graduated nurses face complex demands including role burden, time pressure, responsibility for patient safety, and interpersonal relationships, as they provide patient care while collaborating with various healthcare staff in a new hospital environment [4-6]. In particular, they experience reality shock [5,7], defined as a psychological conflict characterized by feel-

Received: May 14, 2026; **Revised:** June 19, 2026; **Accepted:** June 21, 2026
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ings of helplessness and emptiness arising from the discrepancy between the professional role expected during nursing education and the realities of clinical practice. This phenomenon is a major stressor associated with the clinical adaptation of newly graduated nurses [6].

Individual psychological resources have also been identified as important factors in the clinical adaptation of newly graduated nurses [8]. Resilience refers to an individual's psychological capacity to maintain psychological balance, adapt positively, and achieve growth in the face of stressful situations or difficult environments [9]. Individuals with high resilience are more likely to cope more effectively with various difficulties experienced in the work environment and demonstrate positive outcomes in the process of organizational adaptation [10,11].

However, the adaptation of newly graduated nurses should be understood as a multidimensional process that results from continuous interactions between individuals and their environments. To provide a theoretical explanation for this process, the present study was guided by Roy's Adaptation Model (RAM) [12]. According to RAM, individuals are adaptive systems that continuously respond to environmental stimuli through coping processes, resulting in adaptive or ineffective responses [12,13]. Environmental stimuli may challenge an individual's adaptive capacity, whereas coping mechanisms facilitate adjustment and adaptation. Within this framework, reality shock can be conceptualized as an environmental stimulus arising from discrepancies between educational expectations and clinical realities [7,14], while resilience represents an internal coping mechanism that enables individuals to respond effectively to such challenges [9,15]. Clinical adaptation, therefore, can be viewed as an adaptive response resulting from the interaction between reality shock and resilience. Applying RAM provides a useful framework for understanding how newly graduated nurses adjust to professional practice and for identifying factors that promote successful adaptation.

Therefore, this study aimed to identify factors associated with clinical adaptation among newly graduated nurses, focusing on reality shock and resilience. The findings of this study may provide useful evidence for developing interventions and nursing management strategies to support the clinical adaptation of newly graduated nurses.

METHODS

Design

This cross-sectional study was conducted to identify factors associated with clinical adaptation among newly graduated nurses, with a particular focus on reality shock and resilience.

Participants

The study participants were newly graduated nurses with less than 1 year of clinical experience working in general hospitals. Participants were recruited through convenience sampling from newly graduated nurses employed at general hospitals in the Incheon region. The required sample size was calculated using the G*Power 3.1.9.7 program for multiple linear regression analysis. Assuming an effect size of 0.15 [16], a significance level of 0.05, and a statistical power of 0.80, the minimum sample size was determined to be 169. Considering a potential dropout rate of 15%, the online survey was designed to collect a total of 200 responses. After excluding nine incomplete questionnaires, data from 191 participants were included in the final statistical analysis.

Measurement

In this study, a structured questionnaire was used to assess general characteristics, job-related characteristics, reality shock, resilience, and clinical adaptation.

General and job-related characteristics

To identify the participants' general and job-related characteristics, the following variables were collected: sex, age, living arrangement, prior experience working at other hospitals, working department, duration of clinical experience, placement in the desired department, experience with preceptor training, and job satisfaction. Job satisfaction was assessed on a 5-point Likert scale and subsequently categorized into two groups: not satisfied (1–3 points) and satisfied (4–5 points).

Reality shock

Reality shock was measured using the Reality Shock Measurement Tool for Newly Graduated Nurses developed by Yun [17]. This tool consists of 26 items and includes five subdomains: disappointment to reality, overwhelming task, lack of confidence, heavy responsibility, and lack of support. Each item is measured on a 5-point Likert scale ranging from 1 ("not at all") to 5 ("very much so"), with higher scores indicating greater levels of reality

shock. In Yun's [17] study, Cronbach's α was 0.93, with subscale reliabilities ranging from 0.73 to 0.89. In this study, Cronbach's α was 0.94, and the subscale reliabilities ranged from 0.93 to 0.94.

Resilience

Resilience was measured using the Korean version of the Connor-Davidson Resilience Scale (K-CD-RISC) [9], translated by Lee [18] from the original scale developed by Connor and Davidson [9]. This tool consists of 25 items and comprises seven subdomains: hardiness, optimism, coping, adaptability, meaningfulness/purpose, regulation of emotion and cognition , and self-efficacy. Each item is measured on a 5-point Likert scale ranging from 0 ("not at all") to 4 ("very much so") with higher scores indicating greater resilience. In the study by Connor and Davidson [9], Cronbach's α was 0.89, whereas in this study, it was 0.93.

Clinical adaptation

Adaptation is defined as a dynamic process and outcome resulting from the interaction between individuals and their environment [12]. In this study, the level of clinical adaptation among newly graduated nurses was measured using a single-item Visual Analogue Scale (VAS) from 0 to 10. Single-item measures, such as the VAS, may be appropriate for assessing global and holistic constructs that individuals can clearly recognize and evaluate. Previous studies have demonstrated that this approach has acceptable reliability and validity for measuring constructs such as adaptation [13,19,20]. Unlike adaptability, which reflects an individual's coping capacity, clinical adaptation in this study refers to the perceived outcome of adjustment to the clinical environment.

Ethical considerations

This study was conducted after obtaining approval (No. 1044396-202209-HR-178-01) from the Institutional Review Board of Gachon University prior to data collection. The study was conducted in accordance with the ethical principles set forth in the Declaration of Helsinki. The instruments used in this study were applied with permission from the original authors. Data collection was carried out after explaining the purpose and methods of the study to the nursing departments of the participating hospitals and obtaining their cooperation. Participants voluntarily completed the survey after providing informed consent, having been informed online about the purpose and procedures of the study, assurance of anonymity, and the right to withdraw at any time. Participants who completed the online survey were provided with a small incentive. The collected data were coded and analyzed anonymously and were used solely for the purposes of this study.

Data collection procedure

To collect data, the purpose and methods of the study were explained to the nursing departments of five general hospitals in the Incheon region, and their cooperation was obtained. Data collection was conducted over a 4-week period from October 21 to November 16, 2022. Recruitment of study participants was conducted through internal hospital announcements, and a guide containing the purpose and procedures of the study was posted online. Newly graduated nurses voluntarily accessed the online survey link, reviewed the informed consent form, and completed the survey upon providing consent. The survey was configured so that the link would be automatically closed once the target sample size was reached.

Statistical analysis

Data analysis was performed using IBM SPSS Statistics version 26.0 (IBM Corp.). The general and job characteristics of the study participants were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations. Reality shock, resilience, and clinical adaptation were analyzed using descriptive statistics, such as means and standard deviations. Differences between groups were analyzed using t-tests, ANOVA, and chi-square tests, while post hoc testing was performed using the Scheffé test. The relationships between reality shock, resilience, and clinical adaptation were analyzed using Pearson's correlation coefficients. Prior to the multiple regression analysis, the assumptions of normality, homoscedasticity, independence of residuals, and multicollinearity were examined. Multicollinearity was assessed using tolerance and variance inflation factor (VIF) values. Multiple regression analysis was conducted to identify factors associated with clinical adaptation among newly graduated nurses, with the statistical significance level set at $P<0.05$.

RESULT

General and job-related characteristics of participants

The general and job-related characteristics of the participants are presented in Table 1. Approximately 82% of the participants were female, and the mean age was 24.27±2.22 years. Regarding

 https://doi.org/10.15384/kjhp.2026.00262

living arrangements, living alone was the most common (44.5%), followed by living with family (38.2%) and living with friends or colleagues (17.3%). Approximately 88.5% of participants had no prior work experience at other hospitals. In terms of working department, surgical wards were the most common (33.0%), followed by internal medicine (27.7%), other specialized departments (22.5%), and intensive care units (16.8%). The mean duration of clinical experience was 6.08±2.63 months. A total of 90.1% of participants received preceptor training, and among them. The average level of job satisfaction was 3.31±0.75 out of 5 points.

Regarding clinical adaptation, 78.0% of participants were classified as adapted, while 22.0% were classified as non-adapted.

Reality shock, resilience, and clinical adaptation

The mean score for reality shock among participants was 2.98±0.66. By subdomain, 'lack of confidence (3.27±0.80)' and 'overwhelming task (3.22±0.87)' were relatively high, whereas 'lack of support (2.17±0.74)' was the lowest. The mean resilience score was 2.35±0.53. Among the subdomains, 'coping (2.56±0.57)' and 'self-efficacy (2.52±0.76)' were high, whereas 'regulation of emotion and cognition (2.01±0.80)' was low. The mean clinical adaptation score measured was 5.77±1.80 (Table 2). Clinical adaptation levels differed significantly according to duration of clinical experience (P=0.012) and nursing job satisfaction (P=0.001) (Table 3).

Clinical adaptation was positively correlated with job satisfaction (r=0.43, P<0.01) and all subdomains of resilience, including hardiness (r=0.43, P<0.01), optimism (r=0.32, P<0.01), coping (r=0.45, P<0.01), adaptability (r=0.55, P<0.01), meaningfulness/purpose (r=0.39, P<0.01), regulation of emotion and cognition (r=0.40, P<0.01), and self-efficacy (r=0.45, P<0.01). In contrast, clinical adaptation was negatively correlated with the reality shock subdomains of lack of confidence (r=–0.62, P<0.01), heavy responsibility (r=–0.43, P<0.01), lack of support (r=–0.37, P<0.01), and overwhelming (r=–0.42, P<0.01). Among these variables, lack of confidence showed the strongest negative correlation, whereas adaptability demonstrated the strongest positive correlation with clinical adaptation (Table 4).

Factors associated with clinical adaptation

Duration of clinical experience and job satisfaction, which showed significant differences in clinical adaptation in the univariate analyses, were included as covariates in the multiple regression model along with the subdomains of reality shock and resilience. Prior to conducting the multiple linear regres-

Table 1. Demographic and job-related characteristics of participants (N=191)

Characteristic	Categories	n (%)	M±SD
Sex	Male	34 (17.8)	
	Female	157 (82.2)	
Age (yr)	≤25	154 (80.6)	24.27±2.22
	≥26	37 (19.4)	
Living arrangement	With family	73 (38.2)	
	With friends or colleagues	33 (17.3)	
	Living alone	85 (44.5)	
Prior experience working at other hospitals	Yes	22 (11.5)	
	No	169 (88.5)	
Working department	Medical ward	53 (27.7)	
	Surgical ward	63 (33.0)	
	ICU	32 (16.8)	
	ER, HDU, COVID-19 ward, OPD	43 (22.5)	
Duration of clinical experience (mo)	0–3	43 (22.5)	6.08±2.63
	4–6	47 (24.6)	
	7–11	101 (52.9)	
Placement in the desired department	Yes	116 (60.7)	
	No	75 (39.3)	
Experience with preceptor training	Yes	172 (90.1)	
	No	19 (9.9)	
Job satisfaction (1–5)	Satisfied (4–5)	69 (36.1)	3.31±0.75
	Not satisfied (1–3)	122 (63.9)	

COVID-19 ward, COVID-19 dedicated ward; ER, emergency department; HDU, hemodialysis unit; ICU, intensive care unit; M, mean; OPD, outpatient department; SD, standard deviation.

Table 2. Descriptive statistics of reality shock, resilience, and adaptation (N=191)

Variable	Subdomains	Range	Min	Max	M±SD
Reality shock	Total	1–5	1.00	4.38	2.98±0.66
	Disappointment to reality		1.00	4.71	2.97±0.79
	Overwhelming task		1.00	5.00	3.22±0.87
	Lack of confidence		1.00	4.83	3.27±0.80
	Heavy responsibility		1.00	5.00	3.04±0.81
	Lack of support		1.00	4.25	2.17±0.74
Resilience	Total	0–4	1.12	4.00	2.35±0.53
	Hardiness		1.00	4.00	2.41±0.58
	Optimism		0.00	4.00	2.14±0.80
	Coping		1.20	4.00	2.56±0.57
	Adaptability		0.33	4.00	2.24±0.66
	Meaningfulness/purpose		0.75	4.00	2.23±0.60
	Regulation of emotional and cognition		0.00	4.00	2.01±0.80
	Self-efficacy		0.50	4.00	2.52±0.76
Clinical adaptation score		0–10	0.00	10.00	5.77±1.80

M, mean; Max, maximum; Min, minimum; SD, standard deviation.

Table 3. Differences in clinical adaptation status according to participant characteristics (N=191)

Variable	Categories	Participant (n)	M±SD	t or F	*P*-value
Sex	Male	34	6.00±1.58	0.83	0.410
	Female	157	5.72±1.84		
Age (yr)	≤25	154	5.89±1.77	1.90	0.059
	≥26	37	5.27±1.85		
Living arrangement	With family	73	5.55±1.97	1.06	0.348
	With friends or colleagues	33	5.76±1.68		
	Living alone	85	5.96±1.67		
Prior experience working at other hospitals	Yes	22	5.32±2.08	1.26	0.211
	No	169	5.83±1.75		
Working department	Medical ward	53	5.87±1.94	0.26	0.854
	Surgical ward	63	5.62±1.67		
	ICU	32	5.91±1.96		
	ER, HDU, COVID-19 ward, OPD	43	5.77±1.70		
Duration of clinical experience (mo)	0–3[a]	43	5.12±1.85	4.55	0.012
	4–6[b]	47	5.70±1.83		(a<c)
	7–11[a]	101	6.08±1.70		
Placement in the desired department	Yes	116	5.87±1.90	−0.97	0.334
	No	75	5.61±1.62		
Experience with preceptor training	Yes	172	5.72±1.78	−1.13	0.260
	No	19	6.21±1.93		
Job satisfaction (0–5)	Satisfied (4–5)	69	5.91±1.80	3.30	0.001
	Not satisfied (1–3)	122	4.55±1.23		

COVID-19 ward, COVID-19 dedicated ward; ER, emergency department; HDU, hemodialysis unit; ICU, intensive care unit; M, mean; OPD, outpatient department; SD, standard deviation.

sion analysis, the assumptions of normality, homoscedasticity, independence of residuals, and multicollinearity were examined. Residual normality was assessed using histograms and normal probability plots, and homoscedasticity was evaluated through standardized residual scatterplots. Multicollinearity was assessed using tolerance and variance VIF values. Tolerance values ranged from 0.299 to 0.924 and VIF values ranged from 1.083 to 3.346, indicating no evidence of problematic multicollinearity.

Multiple linear regression analysis revealed that job satisfaction (β=0.17, P=0.017), adaptability, a subdomain of resilience (β=0.24, P=0.008), and lack of confidence, a subdomain of reality shock (β=−0.43, P<0.001), were significant factors associated with clinical adaptation. Specifically, higher levels of job

 https://doi.org/10.15384/kjhp.2026.00262

Table 4. Correlations among the major study variables (N=191)

Variable	DCE	JS	Reality shock					Resilience							CA
			DR	OW	LC	HR	LS	Hardiness	Optimism	Coping	Adaptability	M/P	REC	SE	
DCE	1														
JS	−0.02	1													
DR	−0.06	−0.49**	1												
OW	−0.09	−0.51**	0.70**	1											
LC	−0.18*	−0.44**	0.51**	0.66**	1										
HR	−0.09	−0.32**	0.50**	0.58**	0.68**	1									
LS	−0.12	−0.30**	0.51**	0.55**	0.45**	0.43**	1								
Hardiness	−0.00	0.39**	−0.32**	−0.34**	−0.45**	−0.28**	−0.27**	1							
Optimism	−0.04	0.37**	−0.28**	−0.32**	−0.42**	−0.30**	−0.21**	0.68**	1						
Coping	0.01	0.43**	−0.37**	−0.38**	−0.42**	−0.29**	−0.32**	0.69**	0.59**	1					
Adaptability	0.08	0.44**	−0.38**	−0.45**	−0.55**	−0.41**	−0.45**	0.63**	0.57**	0.70**	1				
M/P	0.09	0.40**	−0.27**	−0.36**	−0.41**	−0.29**	−0.29**	0.69**	0.55**	0.64**	0.69**	1			
REC	0.09	0.37**	−0.37**	−0.40**	−0.54**	−0.42**	−0.32**	0.61**	0.55**	0.60**	0.61**	0.57**	1		
SE	0.01	0.44**	−0.24**	−0.32**	−0.41**	−0.29**	−0.29**	0.75**	0.62**	0.71**	0.65**	0.65**	0.60**	1	
CA	0.19**	0.43**	−0.34**	−0.42**	−0.62**	−0.43**	−0.37**	0.43**	0.32**	0.45**	0.55**	0.39**	0.40**	0.45**	1

CA, clinical adaption; DCE, duration of clinical experience; DR, disappointment to reality; HR, heavy responsibility; JS, job satisfaction; LC, lack of confidence; LS, lack of support; M/P, meaningfulness/purpose; OW, overwhelming; REC, regulation of emotional and cognition; SE, self-efficacy.
Asterisk indicates a statistically significant (*P<0.05, **P<0.01).

satisfaction and adaptability were associated with better clinical adaptation, whereas greater lack of confidence was associated with poorer clinical adaptation. The regression model explained 45.9% of the variance in clinical adaptation (adjusted R^2=0.459) and was statistically significant (F=12.50, P<0.001) (Table 5).

DISCUSSION

Implication for nursing management

This study was conducted to identify factors associated with clinical adaptation among newly graduated nurses, focusing on reality shock and resilience. The findings of this study showed that adaptability, a sub-domain of resilience, and job satisfaction had a significant positive association with the clinical adaptation, while lack of confidence, sub-domains of reality shock, showed a significant negative association with clinical adaptation of newly graduated nurses. These findings are consistent with previous studies showing that resilience positively related to the organizational socialization and adaptation of newly graduated nurses. Recent studies have demonstrated that resilience is a significant factor enhancing organizational socialization and job performance among new nurses, thereby facilitating their adaptation to clinical settings [17,21]. Furthermore, resilience has been identified as an important personal resource that supports nurses' psychological functioning and adaptation in stressful work environments [15]. It is also associated with improved clinical competence and retention-related outcomes in newly graduated nurses [11,12,22].

In particular, the fact that adaptability was found to be a significant factor associated with clinical adaptation among the sub-domains of resilience suggests that it plays a key role in achieving functional adaptation by flexibly regulating one's emotions and behaviors amidst the various stresses and environmental changes experienced by newly graduated nurses in the clinical setting [20]. Rather than simply coping, adaptability appears to support more flexible regulation of emotions and behaviors, as well as the ongoing adjustment of coping strategies to fit situational demands. Therefore, to improve the clinical adaptation of newly graduated nurses, it is necessary to develop educational programs that can strengthen resilience, along with establishment of a systematic coaching and mentoring system [23].

The results of this study, which identified lack of confidence as a major factor related to clinical adaptation among the sub-domains of reality shock, suggest that individual psychological resource play important role in the clinical adaptation

Table 5. Multiple linear regression analysis of factors associated with clinical adaptation (N=191)

Variable (reference)	B	β	t	*P*-value
Duration of clinical experience	0.07	0.11	1.90	0.059
Job satisfaction	0.40	0.17	2.40	0.017
Reality shock				
Disappointment to reality	0.11	0.05	0.60	0.550
Overwhelming	0.17	0.08	0.88	0.381
Lack of confidence	−0.96	−0.43	−4.78	<0.001
Heavy responsibility	−0.09	−0.04	−0.51	0.611
Lack of support	−0.19	−0.08	−1.13	0.261
Resilience				
Hardiness	0.31	0.10	1.03	0.307
Optimism	−0.28	−0.12	−1.58	0.116
Coping	0.25	0.08	0.88	0.379
Adaptability	0.65	0.24	2.68	0.008
Meaningfulness/purpose	−0.27	−0.09	−1.05	0.296
Regulation of emotional and cognition	−0.20	−0.09	−1.11	0.270
Self-efficacy	0.24	0.10	1.07	0.287
R^2 (adjusted R^2)		0.499 (0.459)		
F (*P*)		12.50 (<0.001)		
Durbin-Watson		1.845		
Tolerance		0.299–0.924		
Variance inflation factor		1.083–3.346		

Duration of clinical experience (months) and job satisfaction were treated as continuous variables.

process of newly graduated nurses. This finding is consistent with previous studies indicating that the reality shock experienced by newly graduated nurses stems from the gap between nursing education and actual clinical practice [7], and that this gap acts as a factor hindering adaptation [5,6,21]. In particular, these findings are closely linked to the concept of 'transition shock' experienced by newly graduated nurses upon entering the clinical field [14]. Transition shock is a complex stress arising from role changes, increased responsibilities, and the gap between expectations and reality, which can has been associated with difficulties in initial adaptation and turnover [14]. In this context, lack of confidence can be understood as a factor that intensify this transition process. Furthermore, a lack of confidence signifies psychological vulnerability associated with a lack of self-efficacy regarding clinical performance, which can be related to be delayed clinical adaptation by inducing passive responses in decision-making and problem-solving processes in new environments.

In addition, support provided by preceptors and fellow nurses is reported to be a key factor in promoting job adaptation by facilitating the emotional stability and learning of new nurses and reinforcing confidence in performing their roles within the organization [8,24,25]. Therefore, to reduce the reality shock of newly graduated nurses and support their successful clinical adaptation, it is essential to implement education and feedback-based interventions that can strengthen individual confidence.

Although the association between clinical experience and clinical adaptation did not reach statistical significance, the direction of the relationship suggested that nurses with longer clinical experience tended to report higher levels of clinical adaptation. This pattern is in line with previous research indicating that adaptation experiences during the early employment period may influence later organizational adaptation and turnover [3,4]. The tendency observed in this study may be attributable to the accumulation of clinical experience, which can facilitate professional competence, role clarity, and confidence in navigating the clinical environment. Therefore, continued efforts to provide structured educational support and ongoing adaptation assistance for newly graduated nurses may be beneficial. The present study also identified nursing job satisfaction as a significant factor associated with clinical adaptation.

The present study identified nursing job satisfaction as a significant factor associated with clinical adaptation among newly graduated nurses. Nurses who reported higher levels of job satisfaction demonstrated better adaptation to the clinical environment. This finding is consistent with previous studies suggesting that positive work experiences facilitate organizational socialization, professional growth, and successful role transition

among newly graduated nurses [4,14,23]. Job satisfaction may enhance motivation, professional commitment, and engagement in learning and clinical practice, thereby promoting adaptation to the demands of the clinical setting. Conversely, dissatisfaction may increase stress and be associated with difficulties in adjustment during the transition from student to professional nurse. Given that successful adaptation is closely linked to organizational socialization processes [25,26], healthcare organizations should not only provide clinical competency training but also foster supportive work environments that promote job satisfaction among newly graduated nurses.

Meanwhile, although this study measured and analyzed adaptation as a single concept, according to RAM, adaptation is understood as a multidimensional process achieved through the interaction between the individual and the environment [12]. In particular, the four modes of adaptation—physiological, self-concept, role-function, and interdependence—provide a framework that can more comprehensively explain nurses' clinical adaptation. From this perspective, lack of confidence may reflect challenges in the self-concept mode, whereas greater clinical experience may contribute to role-function stabilization. Adaptability may support balance across multiple adaptive modes by facilitating effective responses to changing clinical demands. Furthermore, these findings support Roy's proposition that adaptation is influenced by the interaction between stimuli and coping mechanisms. In the present study, lack of confidence may function as a stimulus that challenges adaptation, while adaptability may represent an individual's coping capacity that enables effective responses to such challenges, which may be associated with successful clinical adaptation.

It is important to note that lack of confidence, adaptability, and clinical adaptation represent conceptually distinct constructs within Roy's adaptation process. Lack of confidence reflects a psychological perception of environmental demands and may function as a contextual stimulus, whereas adaptability represents an internal coping capacity that facilitates flexible responses to changing situations. In contrast, clinical adaptation reflects the outcome of these adaptive processes and indicates the extent to which newly graduated nurses have successfully adjusted to and integrated into the clinical work environment [12,13].

In summary, the clinical adaptation of newly graduated nurses can be understood as a complex process involving the interaction of personal and organizational environmental factors, which can be explained as a process of organizational socialization in which individuals learn and internalize the norms and roles of the organization [26]. Overall, these findings underscore the need to address both individual and organizational factors in an integrated manner. Therefore, to improve the clinical adaptation of newly graduated nurses, a multi-layered approach is required that establishes systematic socialization strategies and a supportive environment at the organizational level, along with interventions that strengthen individual competencies and psychological resources.

Limitation and future directions

This study has several limitations. First, because the study was conducted among newly graduated nurses working in general hospitals located in specific regions, caution is needed when generalizing the findings to all newly graduated nurses. Second, data were collected through self-reported online questionnaires, which may have introduced social desirability bias and limited the extent to which responses reflected actual experiences. Third, the cross-sectional design precludes the establishment of causal relationships among the study variables. In addition, clinical adaptation was measured using a single-item VAS. Although previous studies have supported the usefulness and practicality of single-item measures for assessing overall perceptions and attitudes [20], such measures may not fully capture the multidimensional nature of clinical adaptation. Clinical adaptation encompasses various domains, including professional competence, role adjustment, interpersonal relationships, and organizational integration. Future research should therefore employ standardized multidimensional instruments that can more comprehensively assess the complexity of clinical adaptation among newly graduated nurses. Furthermore, future studies should include a broader range of hospital settings and geographic regions to better reflect diverse clinical environments. Longitudinal research is also needed to examine changes in clinical adaptation over time and to clarify the causal relationships among factors influencing adaptation.

Conclusions

This cross-sectional study examined the relationships of reality shock and resilience with clinical adaptation among newly graduated nurses and identified factors associated with adaptation. The results showed that reality shock was negatively associated with clinical adaptation, whereas resilience was positively associated. In particular, adaptability, a subfactor of resilience, and job satisfaction were positively associated with adaptation,

while lack of confidence, a subfactor of reality shock, was negatively associated with adaptation. These findings suggest that successful clinical adaptation among newly graduated nurses is related to both individual psychological resources and work-related experiences. In particular, adaptability appears to facilitate adaptation during the transition to professional practice, whereas lack of confidence may hinder this process. Therefore, efforts to enhance resilience, strengthen confidence in clinical practice, and promote job satisfaction may contribute to improving clinical adaptation among newly graduated nurses. Therefore, organizational efforts to enhance job satisfaction and support resilience development may help facilitate successful clinical adaptation among newly graduated nurses.

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AUTHOR CONTRIBUTIONS

Dr. Young KO had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: all authors. Data collection SHK. Formal analysis: all authors. Investigation: SHK. Methodology: all authors. Writing–original draft: SHK. Writing–review & editing: YK.

CONFLICTS OF INTEREST

Young KO is the Associate Editor of this journal and was not involved in the peer review or editorial decision-making process for this article. No other potential conflicts of interest relevant to this article were reported.

FUNDING

None.

DATA AVAILABILITY

The datasets presented in this study are available upon reasonable request from the corresponding author.

ACKNOWLEDGMENTS

This article is based on a part of the first author's master's thesis (or doctoral dissertation) from Gachon University.

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Revised in January, 2024 (6th)
Revised in January, 2016 (5th)
Revised in June, 2011 (4th)
Revised in June, 2009 (3rd)
Revised in June, 2007 (2nd)
Revised in March, 2003 (1st)
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Findings: In this meta-analysis of 15 randomized controlled trials, intermittent high-dose vitamin D supplementation showed no beneficial effect in the prevention of falls and fractures and even showed a harmful effect in the high-quality trials.

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Acknowledgments

If necessary, persons who have contributed to the article but whose contributions do not meet authorship standards may be appreciated through acknowledgment section. Clearly state their contributing role for acknowledgement. For example, data collection, financial support, statistical analysis, analysis of experiment, and so forth. Authors should notify that their names will be in the Acknowledgement and are responsible for obtaining permission from persons acknowledged.

Author Contributions

What authors have done for the study should be described in this section. To qualify for authorship, all contributors must meet at least one of the seven core contributions by CRediT (conceptualization, methodology, software, validation, formal analysis, investigation, data curation), as well as at least one of the writing contributions (original draft preparation, review, and editing).

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<Example>

Dr. MYUNG had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy

of the data analysis. All authors reviewed this manuscript and agreed to individual contributions.

Conceptualization: SKM.
Data curation: SWO and YJC.
Formal analysis: YJC.
Methodology: SKM, SWO, and YJC.
Software: SKM and YJC.
Writing - original draft: YJC.
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Figure Titles and Legends (Captions)

After references, include a title for each figure. The figure title should be a brief descriptive phrase, preferably no longer than 10 to 15 words. A figure legend (caption) can be used for a brief explanation of the figure or markers if needed and expansion of abbreviations.

Tables

All tables should be inserted after figure legends in the manuscript text. Restrict tables and figures to those needed to explain and support the argument of the article and to report all outcomes identified in the Methods section. Number each table and figure and provide a descriptive title for each. Every table and figure should have an in-text citation. Verify that data are consistently reported across text, tables, figures, and supplementary material. The number of tables and /or figures should not exceed 10.

Within a table, if an abbreviation is used or a description may be necessary, then list them under annotation below. Use the alphabet in the order of a, b, c by superscript on the right side of the part that needs explanation and the annotation should be recorded according to the symbols listed below the table. For each annotation marked, the first letter of the first word should be capitalized. The *P* of the *P*-value should also be capitalized. The title of the table should be on the top placed at the right end of the table. The title of the figure should also be on the top placed at the right end of the figure. The numbering of the table or figure should be in the order of entry in the main text, and Arabic numeral should be used after a space of the word 'Table (Figure)' followed by a period. The first letter of the first word should be capitalized. In making a table, the average and stan-

dard deviation, the number of participants and other figures should be given and on the annotated part of the table, the applied statistical method should be noted. For ratio, the number of responders and the ratio, and for correlation coefficient, the value of correlation coefficient should be given, respectively.

Figures

Number all figures (graphs, charts, photographs, and illustrations) in the order of their citation in the text. When illustrating a figure, use a bar or a line graph for average or proportion, and list measures using standard deviation or standard error and must show their *P*-values. Identify the applied statistical methods at the footnote of each figure. Primary outcome data should not be presented in figures alone. Exact values with measure of variability should be reported in the text or table as well as in the abstract. All symbols, indicators (including error bars), line styles, colors, and abbreviations should be defined in a legend. Each axis on a statistical graph must have a label and units of measure should be labeled. Error bars should be included in both directions, unless only 1-sided variability was calculated.

Acceptable file formats are .jpg, .tif, .pdf, .ppt, .psd, and .eps. Required minimum resoultion for publication is 300 ppi.

Abbreviations

Overindulgence with the use of abbreviations is forbidden, and the use of abbreviations must be minimized. Only standardized abbreviations may be used and abbreviations should not be used in titles or abstracts. With the exception of measurement units, abbreviation should be specified when first introduced in the text and then may be used independently.

Units of Measurement

Laboratory values are expressed using conventional units of measure, with relevant Systeme International (SI) conversion factors expressed secondarily (in parentheses) only at first mention. Figures and tables should use conventional units, with conversion factors given in legends or footnotes. The metric system is preferred for the expression of length, area, mass, and volume.

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Generic names should be used. When proprietary brands are used in research, include the brand name and the name of the manufacturer in parentheses after the first mention of the generic name in the Methods section.

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Research Ethics Committee Regulations

Korean Journal of Health Promotion
KJHP

Enacted April 22, 2026

Article 1 (Aims): These regulations provide rules for the matters of composition and operation of the Ethics Committee (referred to as "Committee") of the Korean Journal of Health Promotion (referred to as 'KJHP'), an official journal of the Korean Society for Health Promotion and Disease Prevention.

Article 2 (Composition):

1. The chairperson of the Committee is the Director of Publication from the Korean Society for Health Promotion and Disease Prevention (Editor-in-Chief of the KJHP).
2. The Committee consists of within 10 members including two directors of Korean Society for Health Promotion and Disease Prevention (Director of General Affairs and Director of Academic Affairs) and four associate (section) editors and an Ethics editor of the editorial committee.

Article 3 (Term): The term of the chairperson and members is three years from the appointment date and may be reappointed.

Article 4 (Mission): The Committee is responsible for the following matters:

1. Matters concerning research ethics and publication ethics of articles submitted or published in the KJHP.
2. Research activities to enhance ethical awareness in academic journals.
3. Consultation on the research ethics and publication ethics of the Korean Society for Health Promotion and Disease Prevention or member associations.
4. Other matters deemed necessary by the chairperson or two or more members.

Article 5 (Meeting): The committee meetings will be convened when the chairperson deems their necessity.

Article 6 (Decision): The committee meetings require the attendance of a majority of the incumbent members. Decisions is made with the approval of a majority of the members present, and rejected if there is a tie in votes.

Article 7 (Supplementary Provision): Matters not discussed in these regulations shall be proposed by the Committee and determined by the Board of Directors of the Korean Society for Health Promotion and Disease Prevention.

ADDITIONAL CLAUSE

Article 1 (Enforcement Date): This regulation shall be enforced on the date of approval by the Board of Directors of the Korean Society for Health Promotion and Disease Prevention.