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ORIGINAL RESEARCH

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Adaptation of the Korean version of the EURO-D scale for middle-aged men with depression

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Abstract

Middle-aged men are at high risk of depression and related mental health problems. The purpose of this study is to develop a Korean version of the European Union initiative to compare symptoms of depression (EURO-D) scale and verify its reliability and validity to assess the severity of depression in middle-aged men. The Korean version of the EURO-D tool, and Patient Health Questionnaire-9 were employed. Item difficulty was evaluated by item response theory, and we found that there were neither very easy nor difficult items. Test-retest reliability was high. Convergent validity and discriminant validity were both confirmed. The application of the Korean version of the EURO-D scale can guide the screening, diagnosis and treatment of depression in middle-aged men and provide insights for mental health research, as well as clinical practice.

Keywords

Male menopause; Depression; Factor analysis; Statistical; Validation study; EURO-D scale

1. Introduction

Depression is a highly prevalent worldwide serious mental health disorder and is the fourth leading contributor to the global burden of disease. According to the World Health Organization [1], approximately 3.8% of the global population suffers from depression. In South Korea, depression is estimated to affect approximately 5.7% of the population, contributing to some of the highest suicide rates globally [2]. Increased attention has been paid to psychiatric morbidity and the health needs of the general population with depression, and recent studies have extensively investigated age-related differences in depression. One of the interesting findings from these studies is the high prevalence of depression among middle-aged populations (aged 40–64 years). A large population-based study revealed that the prevalence of clinically significant depression among middle-aged populations ranges from 9%–14% [3]. Furthermore, a study investigating the prevalence and age patterns of depression reported that the occurrence of depression is the highest among middle-aged individuals in high-income countries [4].

Particularly for men, middle-age is a stage in life where they often face a significant psychophysiological burden as they strive to maintain their high status in the workplace and fulfill family responsibilities amidst demanding expectations. This stage may also bring about heightened stress related to competition with younger individuals, which can threaten their quality of life [5]. According to the Korean Ministry of Health and Welfare, 80% of middle-aged men in South Korea undergo a period of crisis marked by emotional turmoil, frustration and a sense of aimlessness. They are also 2.65 times more prone to suicide compared to women in the same age group [6].

Middle-aged men's vulnerability to depression also includes abrupt biological events that trigger emotional changes. Male menopause (referred to as androgen deficiency in the aging male (ADAM)) is a clinical and biochemical syndrome associated with age characterized by typical symptoms and a deficiency in serum testosterone [7]. Typical symptoms include decreased sexual desire, erectile dysfunction, reduced muscle strength, and mood disturbances such as depression [8]. These symptoms negatively affect various bodily functions and significantly impair men's quality of life [5, 9]. In South Korea, the National Health Insurance Corporation reported ADAM prevalence rates of 27.4% and 31.2% in men in their 40s and 50s, respectively. Factors such as aging, chronic diseases, osteoporosis, smoking, alcohol consumption, low self-efficacy and high-stress levels were associated with reduced male hormone levels or increased ADAM symptoms [9, 10].

Despite experiencing severe depression with biological vulnerability, studies on the mental health of middle-aged men have been scarce, highlighting a significant gap in understanding the mental health aspects overlooked in this population. Although alleviation of depression can be facilitated by early detection and screening, effective treatment is possible at any stage of the condition. However, there is no instrument that has been developed to measure depression specific to middle-aged men in Korea [11]. In Korea, primarily the Center for Epidemiologic Studies-Depression Scale (CES-D [12]) and The Patient Health Questionnaire-9 (PHQ-9; [13]) have been used to measure depression. These are instruments developed for the general population of all ages [12, 13] and cover a

wide range of symptoms associated with depression. However, middle-aged men place a high value on motivation, focusing on their growth and self-development [14]. The EURO-D scale [15] is an instrument that measures depression by focusing on affective suffering and motivation and has been used in studies with middle-aged men [16, 17].

The EURO-D scale [15] was originally developed as a structured and standardized tool to assess depression in older adults. The scale has demonstrated satisfactory concurrent and criterion validity with diverse European populations in previous validation studies. The EURO-D comprises two factors: affective suffering and motivation [15, 18, 19]. It has been adapted and used in low- and middle-income countries, including Latin American and Indian populations, providing support for its cross-cultural applicability [19, 20]. Although the EURO-D scale has been used with samples of middle-aged men, such studies have been relatively limited. Adaptation and validation of the scale for this specific population could contribute to a better understanding of depression among middle-aged men, who may face unique challenges both as a cause and consequence of their depression. Its use as a screening tool can help identify individuals who may require further clinical evaluation and support, thereby improving the detection and subsequent treatment of depression.

Therefore, the aim of this study was to develop a Korean version of the EURO-D scale that can be used with middle-aged men to assess the severity of their depression. The psychometric properties of the scale were evaluated in a sample of middle-aged men in South Korea. These findings will contribute to improving our understanding and the early detection of depression in this population and help in the development of appropriate interventions to enhance their mental well-being and quality of life.

2. Materials and methods

2.1 Design

This methodological study evaluated the reliability and validity of a Korean version of the EURO-D scale to assess depression severity in middle-aged men.

2.2 Participants

The participants were men aged 40–64 years who indicated they understood the research objectives and agreed to participate in the study. Convenience sampling was used to recruit participants in selected areas. An online survey link was distributed via MacroMill Embrain, a specialized online research company. Prior to participation, the men were provided with an explanation of the study's purpose and method. The survey emphasized safeguarding individual information during data collection to ensure personal privacy and confidentiality. After providing information on informed consent, only those men who indicated their agreement were able to proceed to the survey questionnaire.

According to DeVellis [21], the required sample size for exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) should be at least ten times the number of items. Given that the EURO-D scale consists of 12 items, we calculated a necessary sample size of at least 180 participants. Considering a dropout rate of 30%, 315 middle-aged men were recruited. Excluding 22 participants who responded insincerely, the analysis was conducted with 127 participants for the EFA and 166 participants for the CFA. In order to evaluate test-retest reliability, the scale was administered to those participants who agreed to complete the scale a second time after a two-week period. CFA was conducted with 220 participants to further confirm validity.

2.3 Measures

2.3.1 EURO-D

The EURO-D scale [15] is a self-report questionnaire developed to assess depression among older adults. The EURO-D scale was created through a collaborative effort that involved 14 European centers and has been widely used in research and clinical settings. In this study, the scale was adapted to screen for depression in middle-aged Korean men.

The scale consists of 12 items that capture different aspects of depressive symptoms experienced by individuals. These items cover various domains, including affective suffering (*e.g.*, depression, tearfulness and thoughts of death) and motivation (*e.g.*, loss of interest, poor concentration, and lack of enjoyment). Participants rate the frequency of each symptom over the past month. Each item is scored as either 0 or 1, with 1 representing a negative valence (*i.e.*, 1 = more depressed). The scores are summed to yield a total score ranging from 0–12, where a score $\geq$4 indicates major depression.

The psychometric properties of the EURO-D scale have been extensively investigated, showing moderate reliability (average Cronbach's alpha = 0.694 across 14 European centers) and satisfactory cross-cultural criterion validity across various European settings [18].

2.3.2 PHQ-9

The PHQ-9 [13] is a self-report questionnaire that has been widely used to assess depressive symptoms. It consists of nine items that correspond to the nine diagnostic criteria for major depressive disorder in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*. The PHQ-9 has been validated through numerous studies and is known for its high sensitivity and specificity, making it a reliable tool for depression screening in various populations [22]. Each item assesses the frequency of a specific depressive symptom experienced over the past two weeks, including depressed mood, loss of interest or pleasure, sleep disturbances, changes in appetite or weight, fatigue, feelings of worthlessness or guilt, difficulty concentrating, psychomotor agitation or retardation, and suicidal ideation. Participants rate the frequency on a 4-point Likert scale that ranges from 0 (not at all) to 3 (nearly every day). Scores are summed up to obtain a total score that ranges from 0–27. Higher scores indicate more severe depressive symptoms.

The PHQ-9 can be used to screen, diagnose and monitor treatment response. The PHQ-9 has demonstrated good reliability and validity in various populations, including clinical and nonclinical samples. The measure has been translated and adapted into different languages and cultural contexts, which

allows for cross-cultural comparisons. The questionnaire is relatively easy to administer and score, which makes it a practical tool for health care professionals and researchers. It provides a standardized measure of depression severity and aids in the identification and monitoring of depressive symptoms in both clinical and research settings. Overall, the PHQ-9 is a widely recognized and validated instrument that assesses the severity of depressive symptoms and contributes to its understanding and management.

2.4 Translation process

First, we obtained permission to adapt the EURO-D scale from the original developers of the scale. The EURO-D scale was chosen for cross-cultural adaptation because it has demonstrated satisfactory psychometric properties in previous studies with diverse European populations. The scale's robustness and empirical validation provide a strong foundation for cross-cultural adaptation, facilitating meaningful comparisons and enhancing the generalizability of its findings. The adaptation process involved rigorous translation and back-translation procedures, supplemented by consultation with experts, to ensure linguistic accuracy and cultural relevance for the Korean context.

The translation process included the following steps. The first step involved translating the EURO-D scale from English to Korean, which was performed by two independent bilingual translators whose first language was Korean. Both translators had a doctoral degree in nursing and extensive experience in the assessment and treatment of depression. Each translator produced an initial Korean version of the scale. The two forward-translated versions were compared and synthesized into a single reconciled version by a committee of researchers and translators. Any discrepancies or differences in the translated versions were resolved.

Next, a backward translation was performed by two independent bilingual translators fluent in both English and Korean who had not seen the original English version.

The two back-translated versions were reviewed by an expert committee that included researchers, translators and content experts. The five-member committee included the four individuals involved in the forward and backward translations and a psychiatrist with over 15 years of experience in diagnosing and treating depressive disorders in Korean populations. They evaluated the linguistic and conceptual equivalence of the two versions and made the necessary adjustments to ensure cultural relevance and accuracy.

The next step involved administering the preliminary version of the Korean version of the scale to a sample of the target population (middle-aged men with depression) to assess its comprehensibility, clarity and acceptability. Participants provided feedback on any difficulties they encountered with responding to the items and suggested modifications to improve clarity and relevance. Based on their feedback and the expert committee's recommendations, a final version of the Korean EURO-D scale was developed. This version captured the cultural nuances and semantic equivalence required for its use in the Korean context.

The cross-cultural adaptation process ensured that the Korean EURO-D scale maintained its conceptual and psychometric equivalence to the original scale and was also culturally sensitive and relevant to the Korean population. The rigorous translation process enhanced the scale's applicability and validity to assess depression among middle-aged Korean men. The translation and cross-cultural adaptation were conducted in accordance with established guidelines for cross-cultural instrument adaptation to ensure linguistic and cultural equivalence.

A discussion of these cultural differences is essential to assess the validity of the scale within the Korean context. This involves examining how cultural norms about mental health, emotional expression and social support influence the reporting of depressive symptoms. For example, in Korean culture, somatic symptoms, such as fatigue or sleep disturbances, are often expressions of psychological distress, whereas in European cultures, psychological symptoms are often expressions of psychological distress. Identifying and discussing these variations would help in understanding any potential biases introduced by the cultural context, ensuring that the adapted scale accurately reflects the experiences of middle-aged Korean men.

2.5 The EURO-D Scale validation process

The content validity of the Korean version was evaluated by a panel of six experts that included nursing professors specializing in mental health. The panel reviewed the forward-backward translated questionnaire to ensure its appropriateness in the Korean context. Pretesting and cognitive interviews were conducted to assess item clarity, flow and cultural relevance. Following verification, the scale consisted of 12 items.

An exploratory factor analysis with varimax rotation was performed to explore the underlying factor structure of the scale. A Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was used to assess data factorability with an ideal threshold of ≥ 0.80. Bartlett's test of sphericity was performed to evaluate the inter-correlations and sampling adequacy. A scree plot of eigenvalues was used to determine the number of factors. Additionally, the cumulative proportion (%) of variance explained by each factor was examined. The pattern matrix containing the factor loadings was reviewed to identify the primary factors of interest.

A confirmatory factor analysis (CFA) was performed on the factors extracted from the EFA. All items that loaded onto their respective factors and had factor loadings above 0.30 were considered acceptable. Model fit indices were assessed, including the chi-squared, degrees of freedom (*df*), *p*-value (non-significant), comparative fit index (CFI >0.95 indicated good fit), Tucker-Lewis index (TLI >0.90 indicated good fit), and root mean square error of approximation (RMSEA <0.05 indicated good fit).

Internal consistency reliability was assessed using Kuder-Richardson formula 20 (KR-20) and Gwet's agreement coefficient (AC1). Test-retest reliability was evaluated to assess the stability of the scale. A subset of the participants from the initial sample was invited to complete the scale a second time after a minimum of two weeks.

The scale's stability was examined using KR-20 and Gwet's

AC1. A high correlation between the test and retest scores indicated good stability, suggesting that the scale produced consistent results over time. To ensure the accuracy of the test-retest reliability assessment, participants completed the scale under similar conditions and provided honest and consistent responses during both administrations. Lastly, the Korean EURO-D scale scores were correlated with PHQ-9 scores to evaluate criterion-related validity.

2.6 Statistical analyses

SPSS version 27.0 (IBM Corp., Armonk, NY, USA) for Windows was used for the analyses. Descriptive statistics were calculated to determine participants' demographic characteristics. Item discrimination was evaluated using a frequency analysis by item and item-correlation procedure. A content validity index was used to evaluate the appropriateness, clarity and comprehensibility of the translated tool. Scores were assigned by an expert panel of six nursing professors. A score of three or higher on each item, which indicated an agreement rate of 80% or above, was interpreted as high content validity. CFA was used to evaluate construct, convergent and discriminant validity. The reliability of the scale was evaluated using KR-20 and Gwet's AC1, where a coefficient of 0.70 or higher indicated acceptable reliability. Criterion-related validity was evaluated by correlating the Korean EURO-D with the PHQ-9.

3. Results

3.1 Demographic characteristics

The demographic characteristics of the participants are presented in Table 1. The average age was 48.13 years. There were statistically significant differences in EURO-D scale scores according to monthly income ($F = 3.247$, $p = 0.023$), stress level ($F = 21.827$, $p < 0.001$), and health status ($F = 14.882$, $p < 0.001$). The group with a monthly income of less than 1000 Korean won (KRW) had the highest EURO-D scale score, showing a statistically significant difference from the group with a monthly income of 5000 KRW or higher. The group that indicated they were experiencing a highly or severely stressful life had higher EURO-D scale scores compared to those indicating a low level of stress. The group who reported having poor subjective health exhibited higher EURO-D scale scores than those who reported having good or average subjective health.

3.2 Item discrimination and difficulty

The results of the item analysis are presented in Table 2. The frequency analysis by item results ranged from 15.0%–61.4%, indicating that there were no items that were too difficult (less than 10%) or too easy (more than 90%). The item-total correlation coefficients ranged from 0.346 to 0.633; thus, no item had a correlation coefficient ≤ 0.30 or ≥ 0.90. The difficulty of each item was evaluated using the Rasch model of item response theory [23] and ranged from −0.474 to 1.750, indicating that there were no misfitting items.

3.3 Exploratory factor analysis

The KMO value to evaluate the adequacy of the number of data compared to the number of items was 0.793, and Bartlett's test of sphericity was deemed appropriate for factor analysis ($p < 0.001$). The results of the EFA are presented in Table 3. Two factors were extracted, and two items that had factor loadings below 0.45 were removed. The items on "appetite" and "concentration" were excluded because of their loadings but also their lack of relevance to the factors. The first factor represented affective suffering and consisted of seven items with factor loadings ranging from 0.467–0.751. The second factor represented loss of motivation and consisted of three items with factor loadings ranging from 0.551–0.787.

3.4 Confirmatory factor analysis

CFA was performed on the data from 220 participants for the 10 items from the EFA. The factor loadings are illustrated in Fig. 1. The goodness of fit results are presented in Table 4. The Q-value was 1.440. The CFI was 0.962 and TLI was 0.948, indicating good fit. The RMSEA was 0.045, which also indicated good fit.

3.5 Validity

In the CFA, the convergent and discriminant validity of the two factors were evaluated. The results of the analysis are presented in Table 5. The average variance extracted (AVE) value ranged from 0.650–0.678. The value for construct reliability (CR) ranged from 0.847–0.932, indicating convergent validity. The AVE value of the factor was higher than the square of the correlation coefficient, indicating discriminant validity. Criterion validity was verified by the significant correlations between the Korean version of the EURO-D scale and PHQ-9: total scale, $r = 0.753$; affective suffering, $r = 0.345$; and loss of motivation, $r = 0.729$.

3.6 Reliability

The KR-20 internally consistency reliability coefficient was 0.733 for the total scale, 0.758 for affective suffering, and 0.543 for loss of motivation. Gwet's AC1 [24] coefficient was 0.737 for the total scale, 0.768 for affective suffering, and 0.555 for loss of motivation. The KR-20 test-retest reliability coefficient was 0.695 for the total scale, 0.741 for affective suffering, and 0.514 for loss of motivation. Gwet's AC1 coefficient was 0.694 for the total scale, 0.745 for affective suffering, and 0.530 for loss of motivation.

4. Discussion

Depression is a serious mental health disorder affecting middle-aged individuals' health and quality of life, and screening instruments are required to identify individuals at risk.

The EURO-D underwent cross-cultural adaptation and validation in studies conducted in various countries, making it suitable for use in diverse cultural contexts [19, 25–27]. Although the EURO-D has been adapted and validated mainly for use with older adults [25, 27], the present study validated and

TABLE 1. Demographic characteristics (N = 127).

Variable	Categories	Sample n (%)	EURO-D score M ± SD	*t* or *F*	*p*
Age			48.13 ± 6.18		
Marital status					
	Married	96 (75.6)	4.68 ± 2.82	0.048	0.961
	Single	31 (24.4)	4.66 ± 2.66		
Household type					
	Person living alone	25 (19.7)	4.84 ± 2.93	0.435	0.664
	Family	102 (80.3)	4.64 ± 2.75		
Education level					
	High school	18 (14.2)	4.52 ± 3.12		
	College	86 (67.7)	4.76 ± 2.80	0.250	0.779
	Graduate school	23 (18.1)	4.43 ± 2.49		
Occupation					
	Clerks	71 (55.9)	4.23 ± 2.84		
	Managers	6 (4.7)	4.47 ± 3.07		
	Professionals	13 (10.2)	4.89 ± 2.52		
	Service workers	7 (5.5)	5.11 ± 2.08	2.042	0.051
	Agricultural and fishery workers	3 (2.4)	5.33 ± 4.51		
	Technicians	10 (7.9)	4.33 ± 2.87		
	Elementary occupations	7 (5.5)	6.91 ± 2.81		
	Other	10 (7.9)	5.81 ± 2.64		
Religion					
	Yes	61 (48.0)	4.49 ± 2.70	−0.848	0.398
	No	66 (52.0)	4.82 ± 2.85		
Recreational activities					
	Yes	70 (55.1)	4.46 ± 2.74	−1.363	0.174
	No	57 (44.9)	4.98 ± 2.83		
Income (1000 won/month)					
	$<1000^{a}$	5 (3.9)	6.63 ± 4.00		
	$1000–2999^{b}$	19 (15.0)	4.96 ± 2.69	3.247	0.023
	$3000–4999^{c}$	51 (40.2)	5.09 ± 2.92		a > d
	$\geq 5000^{d}$	52 (40.9)	4.17 ± 2.52		
Smoke cigarette					
	Yes	83 (65.4)	4.80 ± 2.83	0.946	0.345
	No	44 (34.6)	4.41 ± 2.67		
Drink alcohol					
	Yes	81 (63.8)	4.91 ± 2.81	2.036	0.043
	No	46 (36.2)	4.05 ± 2.64		

TABLE 1. Continued.

Variable	Categories	Sample n (%)	EURO-D score M ± SD	*t* or *F*	*p*
Stress level					
	Normal[e]	1 (0.8)	1.40 ± 0.89		
	Mild[f]	23 (18.1)	3.25 ± 2.16		<0.001
	Moderate[g]	46 (36.2)	3.71 ± 2.42	21.827	i > e, f, g
	High[h]	47 (37.0)	5.86 ± 2.55		h > e, f
	Severe[i]	10 (7.9)	7.88 ± 1.83		
Stress					
	Yes	103 (81.1)	6.22 ± 2.55	8.266	<0.001
	No	24 (18.9)	3.48 ± 2.34		
Health status					
	Very good[j]	0 (0)	2.75 ± 2.99		
	Good[k]	12 (9.4)	3.15 ± 2.31		<0.001
	Fair[l]	93 (73.2)	4.44 ± 2.52	14.882	n > j, k, l
	Poor[m]	22 (17.3)	6.49 ± 2.55		m > j
	Very poor[n]	0 (0)	8.80 ± 2.17		
Health status					
	Good	105 (83.7)	3.12 ± 2.34	−4.714	<0.001
	Poor	22 (17.3)	5.14 ± 2.74		

EURO-D: European Union initiative to compare symptoms of depression; M: Mean; SD: Standard deviation.
^{a,b,c,d,e}: Notation for each subgroup of Income; ^{e,f,g,h,i}: Notation for each subgroup of Stress level; ^{j,k,l,m,n}: Notation for each subgroup of Health status.

TABLE 2. Item discrimination and difficulty (N = 127).

	Frequency		Correlation	Rasch	
	n	%	*r* (*p*)	Difficulty	SE
Depression	73	57.5	0.582 (<0.001)	−0.305	0.188
Pessimism	35	27.6	0.433 (<0.001)	0.997	0.213
Wishing death	19	15.0	0.517 (<0.001)	10.750	0.272
Guilt	67	52.8	0.633 (<0.001)	−0.106	0.185
Sleep	72	56.7	0.561 (<0.001)	−0.271	0.187
Interest	54	42.5	0.384 (<0.001)	0.320	0.187
Irritability	77	60.6	0.599 (<0.001)	−0.440	0.191
Appetite	51	40.2	0.589 (<0.001)	0.421	0.189
Fatigue	78	61.4	0.616 (<0.001)	−0.474	0.192
Concentration	55	43.3	0.550 (<0.001)	0.287	0.186
Enjoyment	52	40.9	0.346 (<0.001)	0.387	0.188
Tearfulness	38	29.9	0.531 (<0.001)	0.881	0.207
Total	5.28	±3.03			

SE: Standard Error.

TABLE 3. Exploratory factor analysis (N = 127).

Item	Factor 1	Factor 2	Communality	Reliability	
				KR-20	Gwet's AC1
Total				0.695†	0.694
A1 Depression	0.751	0.042	0.566		
A7 Irritability	0.726	−0.031	0.528		
A4 Guilt	0.716	0.021	0.514		
A9 Fatigue	0.627	0.227	0.445	0.741	0.745
A3 Wishing death	0.509	0.245	0.32		
A5 Sleep	0.504	0.108	0.266		
A12 Tearfulness	0.467	0.062	0.222		
A11 Enjoyment	0.010	0.787	0.620		
A6 Interest	0.027	0.743	0.552	0.514	0.530
A2 Pessimism	0.256	0.551	0.369		
Eigenvalue	2.798	1.605			
Var %	27.979	16.049			
C.Var %	27.979	44.028			

Note. n = 127; KMO = 0.793; Bartlett's χ^2 (p) = 564.318 (<0.001).
†*Test-retest reliability.*
KR-20: Kuder-Richardson formula 20; AC1: agreement coefficient.

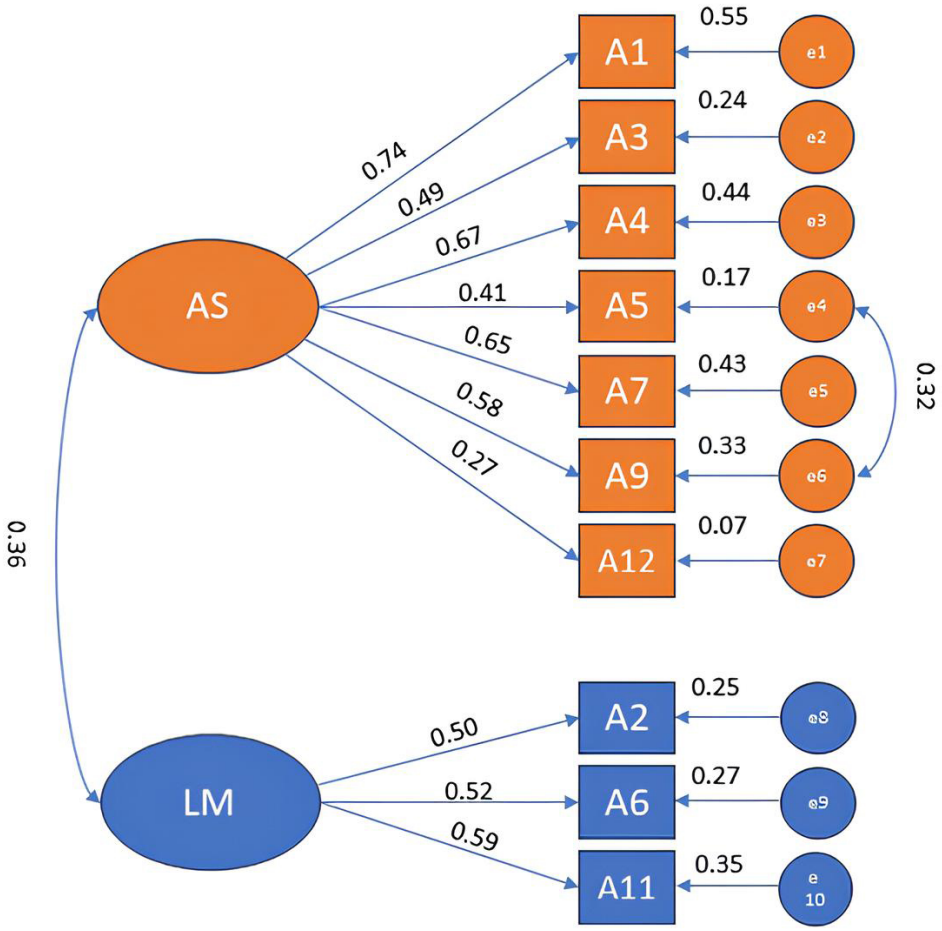

FIGURE 1. Factor loading of the Korean EURO-D. Note. AS: Affective suffering; LM: Lack of motivation.

TABLE 4. Confirmatory factor analysis (N = 220).

	χ^2	*df*	Normed χ^2 (χ^2/df)	CFI	TLI	RMSEA
Korean EURO-D	47.535	33.000	1.440	0.962	0.948	0.045

EURO-D: European Union initiative to compare symptoms of depression; CFI: Comparative fit index; TLI: Tucker-Lewis index; RMSEA: Root mean square error of approximation.

TABLE 5. Validity and reliability.

	Factor 1	Factor 2	CR	KR-20	Gwet's AC1	Correlation with PHQ-9
Total item	-	-		0.733	0.733	0.755**
Factor 1 Affective suffering	0.678		0.932	0.758	0.768	0.345**
Factor 2 Loss of motivation	0.356	0.650	0.847	0.543	0.555	0.729**

*Note. n = 220; **p < 0.001; CR: construct reliability; KR-20: Kuder-Richardson formula 20; AC1: Agreement coefficient; PHQ-9: The Patient Health Questionnaire-9.*

confirmed its applicability for middle-aged men. This study is meaningful in that it paves the way for early detection of depressive symptoms in middle-aged men and the provision of appropriate interventions.

In this study, higher EURO-D scale scores were associated with poorer subjective health status and higher levels of perceived stress. Among the demographic factors, higher EURO-D scale scores were associated with lower monthly income, which is consistent with the findings of a study of middle-aged and older adults in 21 countries [28]. Furthermore, high EURO-D scale scores were related to low economic power (*i.e.*, low monthly income). Socioeconomic status, especially income, has been found to be a strong predictor of depression in Korean men [29]. Because few studies in the literature report EURO-D scale scores according to income, it is difficult to make comparisons with our study. However, in Mendorf *et al.*'s [30] cross-national study of men and women aged 50 years and older, the mean score on the EURO-D scale was 2.59, whereas the score in the present study was much higher at 6.63 for those earning less than 1000 KRW/month. This suggests that socioeconomic status has a significant impact on depression among middle-aged Korean men. Based on these results, the Korean version of the EURO-D scale demonstrated its utility for the assessment of depressive symptoms in middle-aged men in Korea.

The structure of the Korean version of the EURO-D scale was examined using factor analysis, which resulted in 10 items and two factors: affective suffering and lack of motivation. A factor structure with a high model fit was obtained. Additionally, the items mapped well onto the two factors identified in previous studies [15, 19, 26, 27], although there were slight differences in the individual items included in each factor. Two items regarding appetite and concentration were deleted in our study. Appetite was also excluded in a previous study, as it is challenging and complex to attribute it to psychological measurement categories [19]. Additionally, the traditional Korean custom of commensality may have influenced the results in the present study. In a study that examined factors associated with depression in Korean men [31], commensality was found to be a significant factor. Commensality is the act of eating together [32]; however, it also refers to communicating while eating together, which contributes to emotional stability and positively affects mental health [31]. For middle-aged men in Korea, social exchange with others through commensality is thought to be a more critical factor in depression than appetite, which is why the appetite item may not have captured the experience of depression. Future studies are needed to further investigate the relationship between appetite and depression in Korean middle-aged men.

Concentration was excluded from the EURO-D scale in this study, which may be due to the differences in the sample populations; the original EURO-D scale was developed for older adults. Concentration is categorized as a cognitive function [33], and cognitive function is associated with depression in older adults [34]. However, middle-aged men in South Korea are a socioeconomically central age group [35], and most of them generally have no significant problems with cognitive function. Therefore, the findings might be influenced by middle-aged Korean men being at an age where they are not likely to experience many cognitive difficulties that could affect depression. In future studies, it would be important to explore whether it is appropriate to assess cognitive symptoms caused by mood disturbance with the expression "difficulty concentrating" and consider Korean cultural nuances to maintain conceptual equivalence.

The distribution of depressive symptoms may vary depending on individual and cultural differences [36]. Consistent with a study on the development of a Thai version of the EURO-D scale [37], a high frequency of fatigue was identified in our sample. This finding may be related to the amount of work required to make a living, responsibilities of the head of the household, and global economic recession. In South Korea, which has become an aging society, resource issues are a burden for families, caregivers, and the working population. This family burden has been expressed as a sense of responsibility toward family [28], which is a cultural trait that may have contributed to the high frequency of fatigue. Further research is needed to identify factors that contribute to fatigue and associated depressive symptoms in middle-aged men in Korea.

Criterion-related validity was assessed using the PHQ-9. The PHQ-9 and EURO-D scale are two commonly used tools

to screen depression. The PHQ-9 does not have a specific age focus; as such, it can be used with different age groups, including middle-aged individuals. Therefore, the positive correlation between the PHQ-9 and the Korean version of the EURO-D scale confirmed the validity of the instrument as a measure that can be used to screen for depression in middle-aged Korean men.

The Korean version of the EURO-D scale has utility for the assessment of depressive symptoms and screening for depression in community settings, clinical settings, specialized services and primary care in South Korea, as well as research on depressive pathology. It considers age-related factors and experiences unique to middle-aged men in South Korea. Middle-aged Korean men encounter a distinct set of challenges and life experiences that can significantly impact their mental health, such as career an employment stress, family responsibilities, health concerns, social changes, cultural expectations, and economic pressures. Therefore, the adapted EURO-D scale may be ideal for assessing depression in middle-aged men. In addition, in South Korea, consulting, diagnosing and treating mental disorders is typically not performed by mental health experts [38]. Therefore, the EURO-D scale is a valid and easy-to-use tool for measuring depressive symptoms in middle-aged men in Korean healthcare settings.

The adaptation of the EURO-D scale for middle-aged Korean men with depression has implications for research and clinical practice. It is a reliable and valid tool for assessing depressive symptoms in this population. Health care professionals can effectively identify and evaluate depression in middle-aged men using this scale, which can aid in providing appropriate treatment interventions.

5. Limitations

This study has several limitations. First, the sample was conveniently chosen from selected areas, which may introduce selection bias. This limits the generalizability of the findings to the broader population. The items may not accurately reflect the characteristics or behaviors of men outside of the selected areas, which concerns the external validity of the results. Future studies should use random sampling methods to enhance external validity and ensure the findings are more broadly applicable. Second, this study did not meet the required sample size, which could have an effect on the statistical power of the findings. Research should be conducted with a larger and more diverse sample to enhance the statistical power and reliability of the findings. Increasing the sample size would help to ensure that the results are more representative of the broader population and provide more robust evidence of the observed effects. Third, this study collected data through a one-time online survey. Therefore, the EURO-D scale and PHQ-9 were completed simultaneously, which may have contributed to common method variance causing collinearity between the two.

Lastly, ongoing evaluation and refinement of the scale's psychometric properties are required to confirm its effectiveness and applicability. We acknowledge the importance of cultural considerations in psychological assessment and the potential benefits of using a depression scale developed within the Korean cultural framework. However, the primary aim of this study was to leverage an established and standardized tool to identify core depression indicators that can be compared across different cultural contexts. This approach allows for a preliminary understanding of depression in a Korean context while maintaining a link to broader international research. Future research should focus on conducting cultural comparisons and potentially developing or adapting depression scales that are inherently representative of Korean culture. By addressing these gaps, subsequent studies can enhance the cultural sensitivity and applicability of the findings, providing a more nuanced understanding of depression within the Korean population.

6. Conclusions

The Korean version of the EURO-D scale for middle-aged men with depression provides a valuable tool for assessing and monitoring depression symptoms in this specific population. While this study demonstrated the scale's potential utility for assessing depressive symptoms and screening for depression among middle-aged men, it did not provide evidence of its ability to aid in the diagnosis and treatment of depression. Future research should investigate whether using the adapted EURO-D scale is associated with treatment outcomes for middle-aged men with depression. Through these efforts, it might improve the identification, diagnosis, and treatment of depression in middle-aged men and promote their mental well-being. Additionally, the convenience sample used in this study limits the generalizability of the findings to all middle-aged men in Korea. Future studies should involve larger and more diverse samples to validate these findings.

AVAILABILITY OF DATA AND MATERIALS

The dataset used and analyzed during the current study are available from the corresponding author on reasonable request.

AUTHOR CONTRIBUTIONS

KL, HJA, JL—conceptualization. KL, JL—data curation; formal analysis; methodology; project administration. JL—funding acquisition. KL—validation; visualization. KL, HJA, SHN, JL—roles/writing-original draft; writing-review & editing. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Institutional Review Board at Hallym University (HIRB-2023-011). All participants provided informed consent online prior to participation.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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