Korean Journal of Health Promotion
KJHP

https://e-kjhp.org

pISSN 2234-2141
eISSN 2093-5676

Korean Journal of Health Promotion

KJHP

VOL. 25 / NO. 3 / September 2025

Korean Society for Health Promotion and Disease Prevention

Korean Journal of Health Promotion

VOL. 25 / NO. 3 / September 2025

pages 75-110

Korean Society for Health Promotion and Disease Prevention

Korean Journal of Health Promotion
KJHP

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

VOL. 25 / NO. 3 / September 2025

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.

Open Access

Article processing charge
No review fees are charged for all the submitted articles. Article processing charges are required for publication in the *KJHP*. Publication fees for all the accepted original or review articles are 300,000 Korean Won (250 US dollars). Additionally, if the article exceeds 6 pages of the journal, additional fees (50,000 Korean Won or 40 US dollars per extra page) will be charged.

Publisher: President, Sung SUNWOO, MD, MPH, PhD
Department of Family Medicine, Asan Medical Center
Korean Society for Health Promotion and Disease Prevention

Editor-in-Chief: Seung-Kwon MYUNG, MD, PhD
Department of Family Medicine, National Cancer Center
Department of Public Health & AI, National Cancer Center Graduate School of Cancer Science and Policy

Editorial Office
Korean Society for Health Promotion and Disease Prevention
Department of Family Medicine, Asan Medical Center, 88 Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea
Tel: +82-2-3010-3820 Fax: +82-2-3010-3815 E-mail: kshpdp@amc.seoul.kr

Printing Office
M2PI
#805, 26 Sangwon 1-gil, Seongdong-gu, Seoul 04779, Korea
Tel: +82-2-6966-4930 Fax: +82-2-6966-4945 E-mail: support@m2-pi.com

Korean Journal of Health Promotion
KJHP

Editors

Korean Journal of Health Promotion
KJHP

Contents

VOL. 25 / NO. 3 / September 2025

ORIGINAL ARTICLES

ERRATUM

Original Article

Korean J Health Promot 2025;25(3):75-83
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2025.00108

Korean Journal of Health Promotion
KJHP

Identifying the Optimal Waist Circumference-Based Body Adiposity Index for Detecting Metabolically Obese but Normal-Weight Older Koreans: A Cross-Sectional Study

Bokun KIM, PhD[1,2]

[1]Sport Science Innovation Institute, Dongguk University, Seoul, Korea
[2]Faculty of Rehabilitation, R Professional University of Rehabilitation, Tsuchiura, Japan

ABSTRACT

Background: The concept of being metabolically obese but normal weight (MONW) has emerged as a significant public health concern. Individuals with MONW exhibit insulin resistance and are at elevated risk for chronic diseases, despite having a body mass index (BMI) <25 kg/m^2. Given the high prevalence of MONW among older Asian adults and the role of abdominal visceral fat in metabolic abnormalities in individuals with MONW, identifying an accurate waist circumference (WC)-based body adiposity index for older Asian adults is essential. Thus, this study aimed to determine the most accurate WC-based body adiposity index for identifying MONW in older Korean adults that are not underweight or obese.

Methods: This cross-sectional study included 7,846 participants (3,536 males and 4,310 females) aged ≥60 years with a BMI of 18.5–24.9 kg/m^2 from the Korea National Health and Nutrition Examination Survey. MONW was defined using metabolic syndrome criteria and sex-specific triglyceride–glucose Index cutoff points. Associations were analyzed using logistic regression, and discriminative ability was assessed using receiver operating characteristic curves. The analysis included BMI, WC and various WC-based adiposity indices, including the visceral adiposity index (VAI), body roundness index, waist-to-height ratio, conicity index, weight-adjusted waist index, and a body shape index.

Results: While all WC-based indices were associated with MONW, only the VAI showed a stronger association (odds ratios [ORs], 26.542 in males and 21.495 in females) and superior discriminative ability (area under the curves [AUCs], 0.826 in males and 0.802 in females) in both sexes compared with WC (ORs, 4.538 and 4.060; AUCs, 0.679 and 0.676). Other indices showed weaker associations and lower areas under the curves than did the VAI and WC, regardless of sex.

Conclusions: The VAI may serve as the most effective indicator for identifying MONW among older Korean adults that are not underweight or obese.

Keywords: Body adiposity index, Metabolically obese but normal weight, Older adults

INTRODUCTION

Recently, a new concept of obesity, "metabolically obese but normal weight (MONW)", has gained attention as a significant public health concern [1,2]. MONW individuals are characterized by insulin resistance and are highly vulnerable to chronic

Received: July 24, 2025; **Revised:** August 24, 2025; **Accepted:** August 28, 2025
Corresponding author: Bokun KIM, PhD
Sport Science Innovation Institute, Dongguk University, 30 Pildong-ro 1-gil, Jung-gu, Seoul 04620, Korea
Tel: +82-2-2260-3114 Fax: +82-2-2260-3042 E-mail: Bokunkim10@dongguk.edu

diseases, despite having a body mass index (BMI) <25 kg/m^2 [1,3]. Notably, there are substantial numbers of MONW in older Asian adults with type 2 diabetes, cardiovascular disease, or other chronic health concerns [4,5]. The incidences of cardiovascular disease and all-cause mortality for these individuals are even higher than those of their metabolically healthy counterparts with a BMI ≥25 kg/m^2 [6,7]. These findings underscore the limitations of BMI, which is a measure of body weight relative to height without considering fat distribution. Many previous reports have demonstrated the need for a more precise indicator of MONW in older Asian adults who do not meet BMI-based obesity criteria to prevent and manage health concerns related to metabolic abnormalities.

Since the accumulation of visceral fat in the abdominal region is considered a key contributor to metabolic abnormalities in MONW individuals, evaluating abdominal obesity is crucial. For years, waist circumference (WC) has been used to evaluate abdominal obesity [8,9]. However, WC is affected by differences in height and overall body size, making it less effective for evaluating abdominal adiposity [10,11]. To address the limitations of WC, several WC-based body adiposity indices, including the visceral adiposity index (VAI), body roundness index (BRI), waist-to-height ratio (WHtR), conicity index (CI), weight-adjusted-waist index (WWI), and a body shape index (ABSI), have been suggested [12-16]. All of these body adiposity indices have been reported as distinguishing indicators of various health concerns [12-16].

A cross-sectional study, involving Brazilian adults aged 20–59 years old, conducted by Ferreira et al. [17] has reported that the VAI showed a better discriminative ability of MONW, compared to BMI, WHtR, waist-to-hip ratio, and waist and neck circumference. However, given the different characteristics in anthropometry, eating and physical activity habits between Europeans and Koreans, it remains uncertain whether the VAI is an equally effective indicator of MONW for older Asian adults. Additionally, the relationship between MONW and these adiposity indices in older Korean adults who are not underweight or obese (18.5≤BMI<25.0 kg/m^2) has not yet been studied. Therefore, this study aimed to investigate the associations between WC-based adiposity indices and MONW in older Korean adults. Furthermore, we compared the performance of these indices in discriminating MONW.

METHODS

Study design and participants

This cross-sectional study analyzed data from the Korea National Health and Nutrition Examination Survey (KNHANES) collected between 2014 and 2022. The KNHANES is an ongoing, nationally representative surveillance system established in 1984 to assess the health, nutritional status, and lifestyle behaviors of the Korean population. From the initial dataset, 7,846 individuals (3,536 males and 4,310 females) aged ≥60 years with a BMI between 18.5 and 24.9 kg/m^2 were included. All participants provided written informed consent. This study was approved by the Institutional Review Board of Changwon National University (approval number: 7001066-202404-HR-056) and conducted in accordance with the principles of the Declaration of Helsinki.

Measurements and body adiposity indices

Height was measured to the nearest 0.1 cm using a stadiometer with participants standing barefoot. Weight was recorded to the nearest 0.1 kg using a calibrated digital scale while the participants wore light clothing. BMI was obtained using the following formula: weight (kg)/height (m)^2. WC was measured to the nearest 0.1 cm using a nonelastic glass fiber tape. Blood pressure was manually measured three times using a standard sphygmomanometer in a mobile examination unit, and the mean of the three readings was used in the analysis. Venous blood samples were drawn in the morning following an overnight fast of more than 8 hours. Serum concentrations of glucose, triglycerides, and high-density lipoprotein (HDL) cholesterol were determined using enzymatic or homogeneous enzymatic colorimetric methods with a Hitachi 7600–210 automatic analyzer (Hitachi). WC-based body adiposity indices, including the VAI, BRI, WHtR, CI, WWI, and ABSI, were computed as described in Table 1.

Evaluation of metabolically obese but normal weight and metabolically healthy and normal weight

In the current study, participants were classified as MONW if they met either of the two criteria based on the method proposed by Lee et al. [18]: the presence or absence of metabolic syndrome (MS), or exceeding the sex-specific triglyceride glucose (TyG) index cutoff point. Those who met neither criterion were classified as metabolically healthy and normal weight (MHNW) individuals. Because MS encompasses a constellation

 https://doi.org/10.15384/kjhp.2025.00108

Table 1. Formulas of WC-based body adiposity indices

Index	Formula
Visceral adiposity index	Males: (WC/[39.68+(1.88×BMI)])×(TG/1.03)×(1.31/HDL-C) Females: (WC/[36.58+(1.89×BMI)])×(TG/0.81)×(1.52/HDL-C)
Body roundness index	$364.2-365.5\times\sqrt{(1-(WC/(2\pi))^2/(0.5\times height)^2)}$
Waist-to-height ratio	WC/height
Conicity index	WC/[0.109×√(weight/height)]
Weight-adjusted waist index	WC/√weight
A body shape index	WC/[BMI^(2/3)×height^(1/2)]

BMI, body mass index; HDL-C, high-density lipoprotein cholesterol; TG, triglycerides; WC, waist circumference.

of metabolic abnormalities, it has been broadly used in previous studies to identify MONW. However, there is a possibility of missing early or subclinical metabolic risks in those with normal weight. Given that the TyG index is a surrogate marker of insulin resistance, it can complement MS criteria by identifying individuals with latent metabolic risk who may otherwise be overlooked. MS was confirmed on the basis of the criteria recommended in 2022 by the Korean Society for the Study of Obesity [19], which require the presence of three or more of the following components: (1) WC ≥90 cm in males and ≥85 cm in females; (2) systolic blood pressure ≥130 mmHg, diastolic blood pressure ≥85 mmHg, or use of antihypertensive medication; (3) fasting plasma triglyceride concentration >150 mg/dL or the use of lipid-lowering medication; (4) fasting HDL-cholesterol concentration <40 mg/dL in males and <50 mg/dL in females, or the use of lipid-lowering medication; and (5) fasting plasma glucose concentration ≥100 mg/dL or the use of antihyperglycemic medication. Additionally, our previous study, which investigated the association between the TyG index and MONW in 4,721 older Korean adults, proposed sex-specific TyG index cutoff points of ≥8.88 for males and ≥8.80 for females [4]. These cutoff points were applied in the current study to identify MONW. The TyG index was calculated as ln [triglyceride concentration (mg/dL)×fasting plasma glucose concentration (mg/dL)/2] [4,20].

Statistical analysis

The independent t-test or the Mann-Whitney U-test was adopted to compare continuous variables between MONW and MHNW. For categorical variables, the chi-square test was applied. The results are presented as the means±standard deviations or numbers (percentages) (Table 2). Logistic regression was performed to assess the sex-specific odds ratios (ORs) concerning the relationships between body adiposity indices and MONW. The fully adjusted model accounted for several confounding factors, such as age, education level, household income, smoking, drinking, physical activity (leisure-time or occupational physical activity, transfer time, and sedentary time), and nutrition (total, carbohydrate, protein, and fat caloric intake). The results are presented as ORs (95% confidence intervals). Statistical analyses were performed using SPSS software, ver. 26.0 (IBM, Inc.) (Table 3). To determine the optimal cutoff points for each sex-specific body adiposity index in identifying MONW individuals, we conducted receiver operating characteristic (ROC) curve analysis. The optimal cutoff points for each index were determined using the Youden index, which seeks to maximize the combined sensitivity and specificity. This analysis utilized MedCalc for Windows ver. 9.1.0.1 (MedCalc Corp.) (Table 4). For all analyses, $P<0.05$ was considered statistically significant.

RESULTS

Table 2 presents the characteristics of the study participants. The mean age was 70.0±6.4 years for males and 69.5±6.4 years for females. In both sexes, all body adiposity indices in the MONW group were greater than those in their counterparts ($P<0.001$ for all). Similarly, all MS components and the TyG index were greater in the MONW group than in the MHNW group ($P<0.05$ for all).

Table 3 presents the sex-specific ORs for the associations between body adiposity indices and MONW. Among males, in the fully adjusted models, the VAI had ORs of 2.607 (2.168–3.135) for the middle tertile and 26.542 (21.158–33.294) for the highest tertile ($P<0.001$ for both). For WC, the ORs were 1.948 (1.645–2.307) and 4.538 (3.798–5.423) for the middle and highest tertiles, respectively ($P<0.001$ for both). The BRI yielded ORs of 1.981 (1.672–2.347) and 4.013 (3.357–4.797), whereas the WHtR presented nearly identical values, with ORs of 1.981 (1.672–2.347) and 4.016 (3.360–4.801) ($P<0.001$ for all). For the CI, the ORs were 1.853 (1.562–2.197) and 4.273 (3.554–5.137); for the WWI, they were 1.979 (1.668–2.348) and 3.847 (3.193–

Table 2. Characteristics of study subjects

Characteristic	Males				Females			
	All males (n=3,536)	MONW (n=1,760)	MHNW (n=1,776)	*P*-value	All females (n=4,310)	MONW (n=2,476)	MHNW (n=1,834)	*P*-value
VAI	4.036±5.209	5.712±6.911	2.374±1.079	<0.001[a]	4.924±3.882	6.320±4.505	3.039±1.352	<0.001[a]
WC (cm)	84.244±6.145	86.151±5.777	82.355±5.913	<0.001	79.897±6.106	81.480±5.878	77.759±5.748	<0.001
BRI	3.511±0.691	3.711±0.654	3.313±0.669	<0.001	3.792±0.813	3.987±0.797	3.529±0.758	<0.001
WHtR	0.507±0.037	0.517±0.034	0.496±0.036	<0.001[a]	0.521±0.042	0.531±0.040	0.507±0.040	<0.001
CI	1.264±0.064	1.281±0.061	1.246±0.062	<0.001	1.248±0.072	1.265±0.070	1.226±0.067	<0.001
WWI	10.684±0.573	10.823±0.549	10.546±0.563	<0.001	10.989±0.683	11.134±0.669	10.793±0.653	<0.001
ABSI	0.0082±0.0004	0.0083±0.0004	0.0081±0.0004	<0.001	0.0081±0.0004	0.0082±0.0004	0.0080±0.0004	<0.001
BMI (kg/m^2)	22.502±1.650	22.858±1.515	22.149±1.701	<0.001[a]	22.470±1.620	22.737±1.545	22.108±1.649	<0.001[a]
SBP (mmHg)	125.8±17.0	127.6±16.9	124.0±16.9	<0.001	127.4±17.5	130.2±17.0	123.6±17.5	<0.001
DBP (mmHg)	73.4±9.7	73.8±9.8	73.1±9.5	<0.05	73.3±9.2	73.7±9.3	72.7±9.1	<0.001
Glucose (mg/dL)	107.4±25.1	116.1±30.0	98.8±14.8	<0.001[a]	103.5±23.6	109.8±28.0	95.0±11.2	<0.001[a]
HDL-C (mg/dL)	48.6±12.5	45.5±12.2	51.8±12.0	<0.001	53.0±12.9	49.7±11.9	57.6±12.8	<0.001[a]
Triglyceride (mg/dL)	130.4±99.8	172.4±125.2	88.8±28.3	<0.001[a]	122.0±67.6	147.4±76.7	87.7±27.2	<0.001[a]
TyG index	8.7±0.6	9.0±0.6	8.3±0.4	<0.001[a]	8.6±0.5	8.9±0.5	8.3±0.3	<0.001[a]
Age (yr)	70.0±6.4	69.8±6.3	70.3±6.4	<0.01	69.5±6.4	70.2±6.3	68.6±6.5	<0.001
Height (cm)	166.4±5.9	166.6±5.8	166.1±6.0	<0.01	153.5±5.8	153.6±5.7	153.4±6.0	0.213
Weight (kg)	62.4±6.5	63.6±6.3	61.2±6.5	<0.001	53.0±5.4	53.7±5.3	52.1±5.4	<0.001
Houshold income				0.220				<0.001
Low	1,181 (33.4)	592 (33.6)	589 (33.2)		1,738 (40.3)	1,052 (42.5)	686 (37.4)	
Lower-middle	1,064 (30.1)	552 (31.4)	512 (28.8)		1,180 (27.4)	688 (27.8)	492 (26.8)	
Upper-middle	709 (20.1)	343 (19.5)	366 (20.6)		785 (18.2)	425 (17.2)	360 (19.6)	
High	582 (16.5)	273 (15.5)	309 (17.4)		607 (14.1)	311 (12.6)	296 (16.1)	
Education level				0.468				<0.001
Primary school	1,198 (33.9)	602 (34.2)	596 (33.6)		2,417 (56.1)	1,467 (59.2)	950 (51.8)	
Middle school	646 (18.3)	309 (17.6)	337 (19.0)		684 (15.9)	389 (15.7)	295 (16.1)	
High school	1,003 (28.4)	515 (29.3)	488 (27.5)		812 (18.8)	430 (17.4)	382 (20.8)	
College	689 (19.5)	334 (19.0)	355 (20.0)		397 (9.2)	190 (7.7)	207 (11.3)	
Drinking				<0.001				<0.05
Never	1,042 (29.5)	461 (26.2)	581 (32.7)		2,550 (59.2)	1,508 (60.9)	1,042 (56.8)	
≤Once a week	1,336 (37.8)	661 (37.6)	675 (38.0)		1,549 (35.9)	854 (34.5)	695 (37.9)	
2–3 times/wk	614 (17.4)	339 (19.3)	275 (15.5)		143 (3.3)	74 (3.0)	69 (3.8)	
≥4 times/wk	544 (15.4)	299 (17.0)	245 (13.8)		68 (1.6)	40 (1.6)	28 (1.5)	
Smoking				<0.001				0.538
Never	709 (20.1)	291 (16.5)	418 (23.5)		4,059 (94.2)	2,325 (93.9)	1,734 (94.5)	
Former smoking	2,003 (56.6)	1,029 (58.5)	974 (54.8)		132 (3.1)	82 (3.3)	50 (2.7)	
Current smoking	824 (23.3)	440 (25.0)	384 (21.6)		119 (2.8)	69 (2.8)	50 (2.7)	
Medication								
Anti-hypertensive medication	1,402 (39.6)	919 (52.2)	483 (27.2)	<0.001	1,827 (42.4)	1,367 (55.2)	460 (25.1)	<0.001
Lipid-lowering medication	667 (18.9)	620 (35.2)	47 (2.6)	<0.001	1,342 (31.1)	1,186 (47.9)	156 (8.5)	<0.001
Anti-hyperglycemic medication	646 (18.3)	497 (28.2)	149 (8.4)	<0.001	723 (16.8)	636 (25.7)	87 (4.7)	<0.001
Physical activity								
LPA (min/wk)	62.0±158.9	58.8±156.6	65.2±161.1	0.237	31.3±98.5	23.4±80.6	42.0±117.7	<0.001[a]
OPA (min/wk)	22.8±154.7	23.1±165.8	22.6±142.9	0.927	15.1±125.1	11.1±98.0	20.5±154.2	0.184
Transfer time (min/wk)	112.8±198.5	110.1±190.1	115.6±206.5	0.412	98.2±160.6	95.7±155.0	101.7±167.8	0.223
Sedentary time (min/wk)	3,220.6±1,521.3	3,298.7±1,508.2	3,143.2±1,530.7	<0.01	3,223.0±1,645.8	3,276.1±1,674.5	3,151.2±1,603.9	<0.05

(Continued on the next page)

https://doi.org/10.15384/kjhp.2025.00108

Table 2. Continued

Characteristic	Males				Females			
	All males (n=3,536)	MONW (n=1,760)	MHNW (n=1,776)	*P*-value	All females (n=4,310)	MONW (n=2,476)	MHNW (n=1,834)	*P*-value
Nutrition								
Total energy intake (kcal/day)	1,978.2±742.8	1,934.8±710.3	2,021.1±771.5	<0.01	1,494.2±583.2	1,468.3±571.3	1,529.2±597.3	<0.01
Protein (g/day)	68.6±32.5	65.7±29.9	71.4±34.6	<0.001[a]	51.6±25.6	50.3±24.6	53.4±26.9	<0.001[a]
Fat (g/day)	36.4±26.8	35.0±24.9	37.8±28.5	<0.05[a]	27.9±20.9	26.9±20.3	29.3±21.5	<0.001[a]
Carbohydrate (g/day)	318.3±116.8	309.2±110.5	327.2±122.2	<0.001[a]	257.1±103.3	254.0±101.7	261.2±105.3	<0.05

Values are presented as mean±standard deviation or number (%).
ABSI, a body shape index; BMI, body mass index; BRI, body roundness index; CI, conicity index; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; LPA, leisure-time physical activity; MHNW, metabolically healthy and normal weight; MONW, metabolically obese but normal weight; OPA, occupational physical activity; SBP, systolic blood pressure; TyG index, triglyceride glucose index; VAI, visceral adiposity index; WC, waist circumference; WHtR, waist-to-height ratio; WWI, weight-adjusted-waist index.
[a]Mann-Whitney U-test was applied to assess the difference between groups.

Table 3. Sex-specific odds ratios for the association between body adiposity indices and MONW

Variable	Males (n=3,536)		Variable	Females (n=4,310)	
	Unadjusted model	Fully adjusted model[a]		Unadjusted model	Fully adjusted model[a]
VAI			VAI		
LT (n=1,179)	Reference	Reference	LT (n=1,436)	Reference	Reference
MT (n=1,178)	2.600 (2.167–3.119)***	2.607 (2.168–3.135)***	MT (n=1,437)	2.329 (1.999–2.712)***	2.261 (1.938–2.638)***
HT (n=1,179)	25.951 (20.792–32.390)***	26.542 (21.158–33.294)***	HT (n=1,437)	21.868 (17.723–26.982)***	21.495 (17.373–26.594)***
WC			WC		
LT (n=1,182)	Reference	Reference	LT (n=1,437)	Reference	Reference
MT (n=1,195)	1.906 (2.770–4.301)***	1.948 (1.645–2.307)***	MT (n=1,440)	1.710 (1.475–1.982)***	1.683 (1.450–1.953)***
HT (n=1,159)	4.214 (3.546–5.008)***	4.538 (3.798–5.423)***	HT (n=1,433)	4.317 (3.679–5.064)***	4.060 (3.452–4.775)***
BRI			BRI		
LT (n=1,179)	Reference	Reference	LT (n=1,436)	Reference	Reference
MT (n=1,177)	1.966 (1.665–2.321)***	1.981 (1.672–2.347)***	MT (n=1,437)	1.851 (1.596–2.147)***	1.785 (1.536–2.076)***
HT (n=1,180)	3.617 (3.052–4.286)***	4.013 (3.357–4.797)***	HT (n=1,437)	3.638 (3.112–4.254)***	3.292 (2.793–3.879)***
WHtR			WHtR		
LT (n=1,178)	Reference	Reference	LT (n=1,436)	Reference	Reference
MT (n=1,179)	1.968 (1.667–2.324)***	1.981 (1.672–2.347)***	MT (n=1,437)	1.852 (1.597–2.148)***	1.786 (1.537–2.077)***
HT (n=1,179)	3.621 (3.055–4.292)***	4.016 (3.360–4.801)***	HT (n=1,437)	3.637 (3.110–4.253)***	3.290 (2.791–3.878)***
CI			CI		
LT (n=1,179)	Reference	Reference	LT (n=1,436)	Reference	Reference
MT (n=1,178)	1.758 (1.490–2.075)***	1.853 (1.562–2.197)***	MT (n=1,437)	1.784 (1.539–2.069)***	1.688 (1.453–1.962)***
HT (n=1,179)	3.667 (3.093–4.346)***	4.273 (3.554–5.137)***	HT (n=1,437)	3.734 (3.192–4.369)***	3.348 (2.839–3.948)***
WWI			WWI		
LT (n=1,178)	Reference	Reference	LT (n=1,436)	Reference	Reference
MT (n=1,179)	1.854 (1.571–2.187)***	1.979 (1.668–2.348)***	MT (n=1,437)	1.826 (1.575–2.117)***	1.731 (1.488–2.013)***
HT (n=1,179)	3.214 (2.716–3.084)***	3.847 (3.193–4.636)***	HT (n=1,437)	3.199 (2.741–3.734)***	2.845 (2.401–3.369)***
ABSI			ABSI		
LT (n=1,178)	Reference	Reference	LT (n=1,436)	Reference	Reference
MT (n=1,179)	1.727 (1.464–2.036)***	1.817 (1.535–2.154)***	MT (n=1,437)	1.593 (1.375–1.846)***	1.499 (1.290–1.742)***
HT (n=1,179)	3.097 (2.619–3.664)***	3.519 (2.930–4.226)***	HT (n=1,437)	3.293 (2.819–3.847)***	2.917 (2.474–3.440)***
BMI			BMI		
LT (n=1,178)	Reference	Reference	LT (n=1,436)	Reference	Reference
MT (n=1,179)	1.890 (1.603–2.228)***	1.983 (1.675–2.347)***	MT (n=1,437)	1.586 (1.368–1.837)***	1.622 (1.396–1.884)***
HT (n=1,179)	2.661 (2.253–3.143)***	2.838 (2.392–3.367)***	HT (n=1,437)	2.426 (2.085–2.824)***	2.464 (2.111–2.877)***

Values are presented as odds ratio (95% confidence interval).
ABSI, a body shape index; BMI, body mass index; BRI, body roundness index; CI, conicity index; HT, highest tertile; LT, lowest tertile; MONW, metabolically obese but normal weight; MT, middle tertile; VAI, visceral adiposity index; WC, waist circumference; WHtR, waist-to-height ratio; WWI, weight-adjusted-waist index.
[a]Fully adjusted model was adjusted for age, education level, house income, smoking, drinking, leisure-time or occupational physical activity, transfer time, sedentary time and total, carbohydrate, protein and fat intake calories.
*P<0.05, **P<0.01, ***P<0.001.

Table 4. Sex-specific AUC comparisons for body adiposity indices in identifying MONW

Variable	AUC	Cutoff	Sensitivity	Specificity	*P*-value
Males (n=3,536)					
VAI	0.826	>3.181	72.8	79.1	<0.001
WC	0.679	>84.300	64.6	61.7	<0.001
BRI	0.665	>3.433	68.0	57.2	<0.001
WHtR	0.665	>0.504	68.1	57.2	<0.001
CI	0.659	>1.280	51.9	70.7	<0.001
WWI	0.640	>10.547	69.5	50.5	<0.001
ABSI	0.635	>0.0829	51.5	69.0	<0.001
BMI	0.622	>22.221	69.9	48.6	<0.001
Females (n=4,310)					
VAI	0.802	>4.339	64.4	84.3	<0.001
WC	0.676	>80.400	57.5	67.4	<0.001
BRI	0.662	>3.675	64.2	59.4	<0.001
WHtR	0.662	>0.517	64.3	59.3	<0.001
CI	0.662	>1.257	55.9	68.6	<0.001
WWI	0.646	>10.931	62.2	59.9	<0.001
ABSI	0.645	>0.0822	48.2	73.4	<0.001
BMI	0.612	>22.576	59.7	57.6	<0.001

ABSI, a body shape index; AUC, area under the curve; BMI, body mass index; BRI, body roundness index; CI, conicity index; MONW, metabolically obese but normal weight; VAI, visceral adiposity index; WC, waist circumference; WHtR, waist-to-height ratio; WWI, weight-adjusted-waist index.

4.636); for the ABSI, they were 1.817 (1.535–2.154) and 3.519 (2.930–4.226); and for the BMI, they were 1.983 (1.675–2.347) and 2.838 (2.392–3.367) (*P*<0.001 for all).

Among females, in the fully adjusted models, the VAI demonstrated ORs of 2.261 (1.938–2.638) for the middle tertile and 21.495 (17.373–26.594) for the highest tertile (*P*<0.001 for both). For WC, the ORs were 1.683 (1.450–1.953) and 4.060 (3.452–4.775), respectively (*P*<0.001 for both). The BRI had ORs of 1.785 (1.536–2.076) and 3.292 (2.793–3.879), whereas the WHtR yielded similar values: 1.786 (1.537–2.077) and 3.290 (2.791–3.878) (*P*<0.001 for all). For the CI, the ORs were 1.688 (1.453–1.962) and 3.348 (2.839–3.948); for the WWI, they were 1.731 (1.488–2.013) and 2.845 (2.401–3.369); for the ABSI, they were 1.499 (1.290–1.742) and 2.917 (2.474–3.440); and for the BMI, they were 1.622 (1.396–1.884) and 2.464 (2.111–2.877) (*P*<0.001 for all).

Table 4 presents the comparison of sex-specific ROC curves for body adiposity indices in identifying MONW. Among males, the VAI had the highest AUC of 0.826 (cutoff point: >3.181, sensitivity: 72.8, specificity: 79.1) (*P*<0.001). WC had an AUC of 0.679 (cutoff point: >84.300, sensitivity: 64.6, and specificity: 61.7) (*P*<0.001). Two indices, BRI and WHtR, demonstrated the same AUC of 0.665, with similar sensitivities (68.0 for BRI and 68.1 for WHtR) and the same specificity (57.2 for both) (*P*<0.001 for both). The CI, WWI, and ABSI exhibited progressively lower AUCs in descending order, with varying sensitivities (51.9 for CI, 69.5 for WWI, and 51.5 for ABSI) and specificities (70.7 for CI, 50.5 for WWI, and 69.0 for ABSI) (*P*<0.001 for all). BMI had the lowest AUC of 0.622 (cutoff point: >22.221, sensitivity: 69.9, specificity: 48.6) (*P*<0.001).

Similarly, among females, the VAI had the highest AUC at 0.802 (cutoff point: >4.339, sensitivity: 64.4, specificity: 84.3) (*P*<0.001). WC followed, with an AUC of 0.676 (cutoff point: >80.400, sensitivity: 57.5, specificity: 67.4) (*P*<0.001). Three indices, BRI, WHtR, and CI, had the same AUC of 0.662, with varying sensitivities (64.2 for BRI, 64.3 for WHtR, and 55.9 for CI) and specificities (59.4 for BRI, 59.3 for WHtR, and 68.6 for CI) (*P*<0.001 for all). The WWI and ABSI yielded similar AUCs of 0.646 and 0.645, respectively, with different sensitivities (62.2 for WWI and 48.2 for ABSI) and specificities (59.9 for WWI and 73.4 for ABSI) (*P*<0.001 for both). BMI had the lowest AUC at 0.612 (cutoff point: >22.576, sensitivity: 59.7, specificity: 57.6) (*P*<0.001).

DISCUSSION

This cross-sectional study examined the associations between various WC-based body adiposity indices and MONW in older Korean adults and compared their discriminative ability. The major findings can be summarized as follows: (1) All WC-based body adiposity indices were associated with MONW in both sexes; however, only the VAI demonstrated a stronger as-

 https://doi.org/10.15384/kjhp.2025.00108

sociation than WC did. (2) Although all indices could identify MONW in both sexes, only VAI outperformed WC in terms of discriminative ability, whereas the other indices showed inferior performance. These findings suggest that the VAI may serve as the most effective indicator for identifying MONW among older Korean adults that are not underweight or obese.

Ruderman and colleagues [21] first introduced the concept of MONW, which is a subset of individuals with a BMI <25 kg/m^2 who exhibit hyperinsulinemia, insulin resistance, and other metabolic abnormalities typically observed in obese individuals. Later, in 1998, they further confirmed that MONW individuals are relatively common and face an elevated risk for type 2 diabetes and cardiovascular disease [22]. Following their foundational work, a growing body of research has demonstrated various health concerns associated with MONW in Asian older adults [23-25]. Despite such health risks associated with MONW, the need for a universally applicable identification index has long been overlooked in public health.

In the present study, the VAI had the strongest association and the highest discriminative ability for identifying MONW in both sexes. Prior to the present study, several previous studies have shown that the VAI is effective at detecting metabolic abnormalities. For example, a cross-sectional study by Motamed et al. [26] indicated that the VAI was more closely related to MS than other indices, such as WC, BMI, WHR, and WHtR, in both sexes. Compared with other indices, the VAI has also demonstrated a superior ability to discriminate MS [26]. Additionally, a longitudinal study by Kang et al. [27] revealed that individuals in the highest tertiles of the VAI presented a 2.26-fold greater risk for males and a 1.75-fold greater risk for females in terms of progression from a metabolically healthy status to a metabolically unhealthy status. The VAI also exhibited greater discriminative ability than WC did, regardless of sex [27].

Although direct comparisons between these previous studies and the current study are limited by differences in participant characteristics, such as ethnicity, age, and BMI ranges, the previous findings collectively support the utility of the VAI as a sex-independent indicator for identifying and predicting metabolic abnormalities [13]. This usefulness may be derived from the incorporation of both anthropometric (WC and BMI) and metabolic (triglyceride and HDL cholesterol) parameters in the VAI. This combination allows for a more comprehensive reflection of visceral adiposity accumulation and dysfunction than does WC alone [13]. However, it is important to note that the VAI includes triglyceride and HDL cholesterol, which are also part of the operational definition of MONW. This overlap may lead to inflated observed associations and AUC values, limiting the interpretation of the VAI as a fully independent screening tool for metabolic risk.

In contrast, although the BRI, WHtR, CI, WWI, and ABSI were developed to improve assessments of abdominal obesity compared with WC or BMI, their associations with MONW and their discriminative abilities in older adults are relatively modest [12,14-16]. One possible explanation is that although these indices are helpful for general obesity screening, they may not adequately reflect the complex relationship between visceral fat and metabolic abnormalities in older adults. This is particularly relevant given that older individuals undergo physiological changes such as fat redistribution and loss of muscle mass, which complicate the obesity phenotype [28].

A key strength of this study is the extensive adjustment for demographic and lifestyle variables, enhancing the reliability of the associations observed. However, owing to the cross-sectional design, causality cannot be inferred. Longitudinal studies are needed to confirm these findings. Additionally, the inclusion criterion of BMI between 18.5 and 24.9 kg/m^2, while consistent with standard definitions of normal weight, may not accurately reflect true adiposity or metabolic risk in older adults. Age-related physiological changes, such as sarcopenia and fat redistribution, are not captured by BMI alone and may have influenced the classification of MONW individuals in this population. Furthermore, since all participants were older Korean adults, it remains uncertain whether the results can be extrapolated to individuals of other ethnicities or in different countries. Measurements such as WC and WC-based indices used in this study are known to vary by ethnicity, age, and sex, highlighting the need for ethnicity-specific cutoff points. Finally, although MONW was defined using both MS criteria and the TyG index to improve sensitivity, their partial overlap, particularly concerning glucose and triglyceride components, may introduce redundancy. The TyG-based cutoff values, which were derived from a Korean sample, also require external validation before being applied more broadly.

In conclusion, our findings suggest that, compared with WC and other indices, the VAI may be the most effective WC-based index for identifying MONW in older adults that are not underweight or obese. Considering the limitations of BMI, WC, and other indices in capturing metabolic abnormalities, the VAI may serve as a more practical and accurate indicator for clinical screening and public health surveillance.

ORCID

Bokun KIM, https://orcid.org/0000-0001-9553-3368

AUTHOR CONTRIBUTIONS

Dr. Bokun 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. The author reviewed this manuscript and agreed to individual contributions.

Conceptualization, data curation, formal analysis, methodology, validation, writing original draft, reviewing & editing: BK.

CONFLICTS OF INTEREST

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

FUNDING

This study was supported by the National Research Foundation of Korea grant funded by the Ministry of Education (No. NRF-2024S1A5B5A16020875).

DATA AVAILABILITY

Publicly available datasets were analyzed in this study. These data can be found here: The datasets generated during the current study are available in the 2014–2022 KHANES (https://knhanes.kdca.go.kr/knhanes/main.do) and analyzed during the current study are available from the corresponding author upon reasonable request.

REFERENCES

1. Ding C, Chan Z, Magkos F. Lean, but not healthy: the 'metabolically obese, normal-weight' phenotype. Curr Opin Clin Nutr Metab Care 2016;19(6):408-17.
2. Karelis AD, St-Pierre DH, Conus F, Rabasa-Lhoret R, Poehlman ET. Metabolic and body composition factors in subgroups of obesity: what do we know? J Clin Endocrinol Metab 2004;89(6):2569-75.
3. Lopez-Miranda J, Perez-Martinez P. It is time to define metabolically obese but normal-weight (MONW) individuals. Clin Endocrinol (Oxf) 2013;79(3):314-5.
4. Kim B, Taniguchi K, Isobe T, Oh S. Triglyceride-glucose index is capable of identifying metabolically obese, normal-weight older individuals. J Physiol Anthropol 2024;43(1):8.
5. Kim B, Kim GM, Huh U, Lee J, Kim E. Association of HOMA-IR versus TyG index with diabetes in individuals without underweight or obesity. Healthcare (Basel) 2024;12(23):2458.
6. Stefan N, Schick F, Häring HU. Causes, characteristics, and consequences of metabolically unhealthy normal weight in humans. Cell Metab 2017;26(2):292-300.
7. Kramer CK, Zinman B, Retnakaran R. Are metabolically healthy overweight and obesity benign conditions?: a systematic review and meta-analysis. Ann Intern Med 2013;159(11):758-69.
8. Ness-Abramof R, Apovian CM. Waist circumference measurement in clinical practice. Nutr Clin Pract 2008;23(4):397-404.
9. Zhu S, Wang Z, Heshka S, Heo M, Faith MS, Heymsfield SB. Waist circumference and obesity-associated risk factors among whites in the third National Health and Nutrition Examination Survey: clinical action thresholds. Am J Clin Nutr 2002;76(4):743-9.
10. Schneider HJ, Klotsche J, Silber S, Stalla GK, Wittchen HU. Measuring abdominal obesity: effects of height on distribution of cardiometabolic risk factors risk using waist circumference and waist-to-height ratio. Diabetes Care 2011;34(1):e7.
11. Nevill AM, Duncan MJ, Lahart IM, Davies P, Ramirez-Velez R, Sandercock G. Scaling children's waist circumference for differences in body size. Am J Hum Biol 2017;29(6):e23037.
12. Maessen MF, Eijsvogels TM, Verheggen RJ, Hopman MT, Verbeek AL, de Vegt F. Entering a new era of body indices: the feasibility of a body shape index and body roundness index to identify cardiovascular health status. PLoS One 2014;9(9):e107212.
13. Kim B, Kim GM, Oh S. Use of the visceral adiposity index as an indicator of chronic kidney disease in older adults: comparison with body mass index. J Clin Med 2022;11(21):6297.
14. Jayawardana R, Ranasinghe P, Sheriff MH, Matthews DR, Katulanda P. Waist to height ratio: a better anthropometric marker of diabetes and cardio-metabolic risks in South Asian adults. Diabetes Res Clin Pract 2013;99(3):292-9.
15. Park Y, Kim NH, Kwon TY, Kim SG. A novel adiposity index as an integrated predictor of cardiometabolic disease morbidity and mortality. Sci Rep 2018;8(1):16753.
16. Zhang A, Li Y, Ma S, Bao Q, Sun J, Cai S, et al. Conicity-index predicts all-cause mortality in Chinese older people: a 10-year community follow-up. BMC Geriatr 2022;22(1):971.
17. Ferreira FG, Juvanhol LL, da Silva DCG, Longo GZ. Visceral adiposity index is a better predictor of unhealthy metabolic

phenotype than traditional adiposity measures: results from a population-based study. Public Health Nutr 2019;22(9):1545-54.
18. Lee SH, Han K, Yang HK, Kim HS, Cho JH, Kwon HS, et al. A novel criterion for identifying metabolically obese but normal weight individuals using the product of triglycerides and glucose. Nutr Diabetes 2015;5(4):e149.
19. Kim KK, Haam JH, Kim BT, Kim EM, Park JH, Rhee SY, et al. Evaluation and treatment of obesity and its comorbidities: 2022 update of Clinical Practice Guidelines for Obesity by the Korean Society for the Study of Obesity. J Obes Metab Syndr 2023;32(1):1-24.
20. Kim B, Kim GM, Han K, Maki N, Taniguchi K, Oh S. The triglyceride-glucose index is independently associated with chronic kidney disease in the geriatric population, regardless of obesity and sex. Ann Geriatr Med Res 2023;27(3):258-65.
21. Ruderman NB, Schneider SH, Berchtold P. The "metabolically-obese," normal-weight individual. Am J Clin Nutr 1981;34(8):1617-21.
22. Ruderman N, Chisholm D, Pi-Sunyer X, Schneider S. The metabolically obese, normal-weight individual revisited. Diabetes 1998;47(5):699-713.
23. Choi HG, Kim HJ. Association between metabolically obese but normal weight and cardiovascular diseases in Korean menopausal women. Menopause 2023;30(5):506-11.
24. Chen Y, Wang C, Sun Q, Ye Q, Zhou H, Qin Z, et al. Comparison of novel and traditional anthropometric indices in Eastern-China adults: which is the best indicator of the metabolically obese normal weight phenotype? BMC Public Health 2024;24(1):2192.
25. Ye J, Guo K, Li X, Yang L, Zhou Z. The prevalence of metabolically unhealthy normal weight and its influence on the risk of diabetes. J Clin Endocrinol Metab 2023;108(9):2240-7.
26. Motamed N, Khonsari MR, Rabiee B, Ajdarkosh H, Hemasi GR, Sohrabi MR, et al. Discriminatory ability of visceral adiposity index (VAI) in diagnosis of metabolic syndrome: a population based study. Exp Clin Endocrinol Diabetes 2017;125(3):202-7.
27. Kang YM, Jung CH, Cho YK, Jang JE, Hwang JY, Kim EH, et al. Visceral adiposity index predicts the conversion of metabolically healthy obesity to an unhealthy phenotype. PLoS One 2017;12(6):e0179635.
28. JafariNasabian P, Inglis JE, Reilly W, Kelly OJ, Ilich JZ. Aging human body: changes in bone, muscle and body fat with consequent changes in nutrient intake. J Endocrinol 2017;234(1):R37-51.

Original Article

Korean J Health Promot 2025;25(3):84-90
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2025.00087

Korean Journal of Health Promotion
KJHP

The Effect of Resistance and Power Exercise Types on Maximum Strength and Muscular Endurance in University Students

Jun Woo KWON, BSME[1], Daihyuk CHOI, PhD[1], Hyungsik JO, PhD[1], and Kyung-A CHOI, PhD[2]

[1]Graduate School of Education, Sogang University, Seoul, Korea
[2]Department of Physical Education, College of Art & Physical Education, Kangnam University, Yongin, Korea

ABSTRACT

Background: This study aimed to compare and analyze the effects of two training modalities—resistance training and power training—on maximal strength (one-repetition maximum, 1RM) and repetition-based muscular endurance in university students.
Methods: Fifty-seven university students (34 males and 23 females) participated in a 12-week training intervention. The program was divided into two phases: phase 1 (first 6 weeks) involved resistance training with a controlled 3-second concentric-eccentric tempo, while phase 2 (last 6 weeks) incorporated power training with 20-second maximal repetition sets. A total of 12 exercises were included, comprising eight 1RM-based and four repetition-based exercises. Measurements were conducted at three time points—T1 (pre), T2 (mid), and T3 (post)—and included assessments of body composition and exercise performance. Data were analyzed using repeated measures ANOVA and paired t-tests.
Results: Significant improvements (P<0.001) were observed across most 1RM-based exercises, particularly during the power training phase. Repetition-based exercises also showed positive trends, although performance declines were noted in the kettlebell exercise for some participants. In terms of body composition, skeletal muscle mass significantly increased across all participants, while male participants exhibited a slight decrease in body fat percentage.
Conclusions: These findings suggest that power training is highly effective in improving maximal strength within a short period and that the effectiveness of exercise interventions may differ depending on contraction velocity and training modality. Based on a practical training design for general university students, this study offers foundational insights for developing efficient physical training programs.

Keywords: Resistance training, Power training, Maximal strength, Muscular endurance, 1 Repetition maximal

INTRODUCTION

In modern society, the issue of insufficient physical activity among university students is becoming increasingly serious [1]. This lack of activity has been associated with a heightened risk of decreased physical fitness, obesity, and musculoskeletal disorders [2]. Particularly, many students experience a significant decline in physical activity upon entering university, which can lead directly to deteriorating health and a reduced quality of life in the long term [3]. Against this backdrop, the importance of

Received: July 2, 2025; **Revised:** August 27, 2025; **Accepted:** September 10, 2025
Corresponding author: Daihyuk CHOI, PhD
Graduate School of Education, Sogang University, 35 Baekbeom-ro, Mapo-gu, Seoul 04107, Korea
Tel: +82-2-705-8553 Fax: +82-2-3274-4824 E-mail: choi6547@sogang.ac.kr

strength training has been emphasized [4]. Resistance training enhances muscle hypertrophy and maximal strength [5-7], while power training, performed at high velocity with low resistance, improves neuromuscular efficiency and fast-twitch fiber recruitment [8,9]. As these modalities differ in stimulus, their effects on maximal strength also differ. Maximal strength, commonly measured via one-repetition maximum (1RM) [10-12], is a key indicator of performance. Therefore, this study aims to compare the effects of resistance and power training on university students' maximal strength.

A unique aspect of this study is the use of identical exercises across two phases. Phase 1 applied the "3-second rule" for controlled repetitions, while phase 2 focused on high-speed repetitions within 20 seconds. Muscle strength and body composition were measured pre-, mid-, and post-intervention to assess training effects.

METHODS

This study involved 57 male and female students from Sogang University (mean age, 22.04 years). This study was approved by the Institutional Review Board at Sogang University (SGUIRB-A-1808-44) and all participants signed an informed consent form. Body composition (height, weight, muscle mass, %body fat) was measured using InBody (InBody Co.) at three time points (Table 1).

Experimental design and procedure

A 12-week repeated-measures design was used, with 24 sessions held twice weekly. The first 6 weeks focused on resistance training with controlled concentric and eccentric phases ("3-second rule"), and the last 6 weeks on power training with explosive movements.

Participants were assessed at:

- T1 (pre): 1RM/repetition test+InBody
- T2 (mid): post-resistance training
- T3 (post): post-power training

Exercise program structure

Twelve exercises were used:

- 1RM-based (8): leg press, leg curl, leg extension, shoulder press, chest press, fly, lat pull down, seated row
- Repetition-based (4): leg raise, sit-up, back extension, kettlebell

In phase 1, 1RM exercises followed the 3-second tempo, and repetitions were counted over 1 minute. Repetition-based exercises were done at a self-paced max effort for 1 minute. In phase 2, all exercises were performed as fast as possible for 20 seconds using the same load. Sessions included warm-up and cooldown, supervised by exercise specialists.

Statistical analysis

SPSS ver. 25.0 (IBM Corp.) was used. Means, standard deviations, repeated measures ANOVA, and paired t-tests were applied. For statistical analysis, Friedman repeated measures ANOVA (a non-parametric test) and paired t-tests were conducted for each exercise type. Missing data were handled by listwise deletion. Significance was set at $\alpha=0.05$.

RESULTS

Analysis of one-repetition maximum-based exercises

All eight 1RM-based exercises showed statistically significant improvements across time ($P<0.001$), with paired t-tests confirming gains from T1 to T3 (Fig. 1). This supports the effectiveness of power training on maximal strength. In contrast, some repetition-based exercises (leg raise, back extension, kettlebell) showed no significant improvement, possibly due to limited neuromuscular adaptation, core-focused nature, and inconsistent protocols between phases.

Analysis of repetition-based exercises

Sit-up and leg raise improved significantly ($P<0.05$) (Fig. 2). Back extension showed marginal significance, while kettlebell showed a Friedman effect but lacked paired t-test significance. Technical difficulty and execution variability likely influenced

Table 1. Categorization of statistical methods used in the analysis

Statistical procedure	Included columns	Description
Mean and standard deviation	T1 mean, T3 mean	Summary of pre- and post-test mean values
Repeated measures ANOVA	Friedman χ^2, *P*-value, N (repeated measures ANOVA)	Analysis of changes across three time points
Paired t-test	t-statistic, *P*-value, N (paired t-test)	Statistical comparison between T1 and T3
Missing value handling (listwise)	N (repeated measures ANOVA), N (paired t-test)	Valid sample sizes after listwise deletion of missing values

N, valid sample size; T1, pre-exercise; T3, post-exercise.

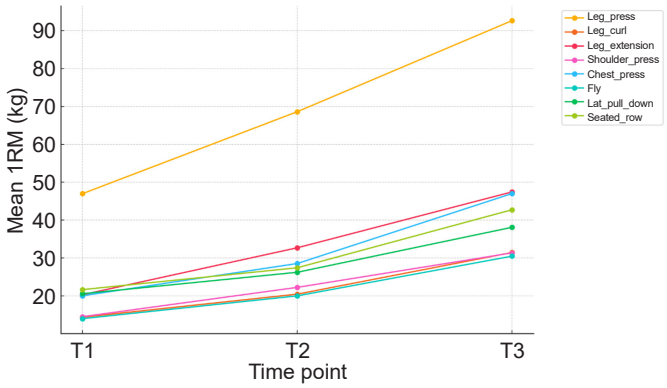


Fig. 1. Trends in mean one-repetition maximum (1RM) changes by exercise type. T1, pre-exercise; T2, mid-exercise; T3, post-exercise.

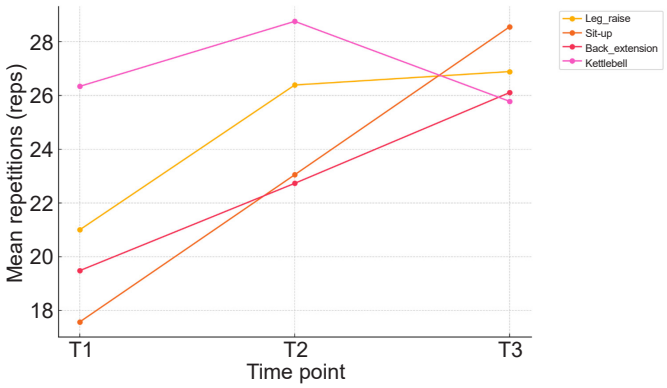


Fig. 2. Changes in performance by exercise for repetition-based movements. T1, pre-exercise; T2, mid-exercise; T3, post-exercise.

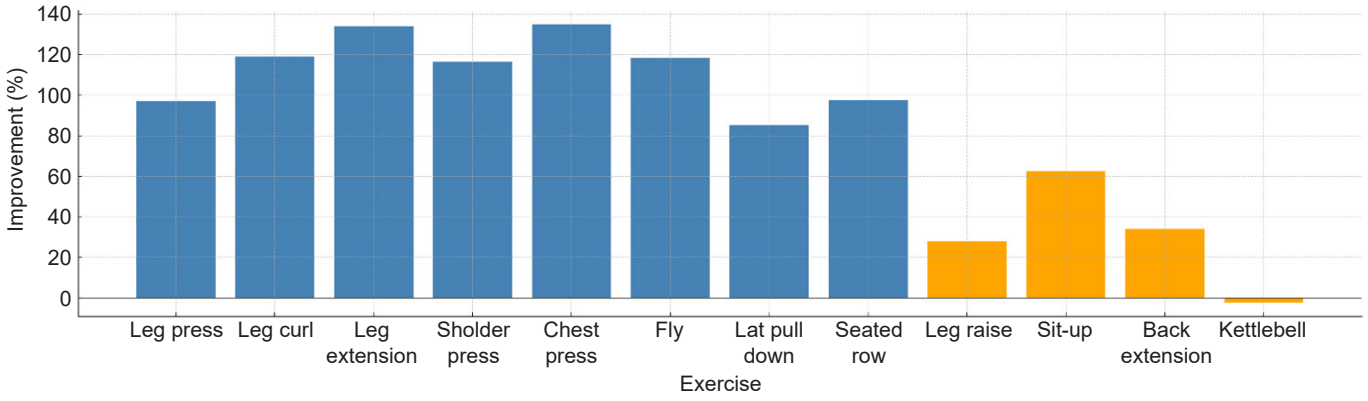


Fig. 3. Comparison of improvement rates by exercise from T1 (pre-exercise) to T3 (post-exercise).

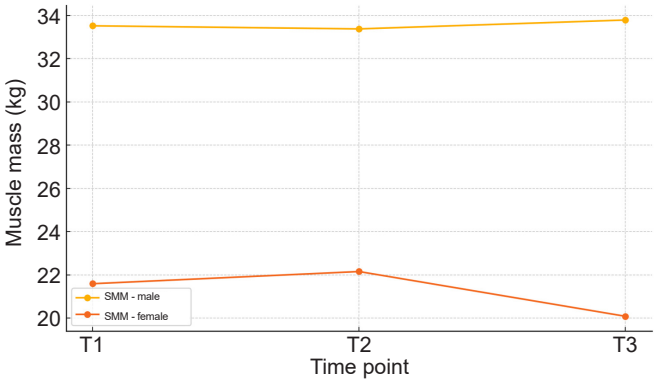


Fig. 4. Time-series changes in skeletal muscle mass (SMM) among male and female participants. T1, pre-exercise; T2, mid-exercise; T3, post-exercise.

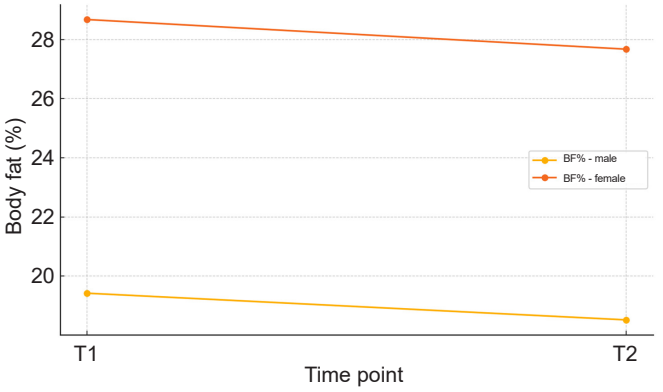


Fig. 5. Time-series changes in body fat percentage (BF%) among male and female participants. T1, pre-exercise; T2, mid-exercise.

https://doi.org/10.15384/kjhp.2025.00087

these outcomes.

Improvement summary

Most 1RM exercises improved by over 100%, while endurance exercises had lower gains. Fig. 3 visualizes all exercise-specific improvements.

Body composition

Muscle mass increased significantly overall, with male participants showing a slight decrease in body fat (Fig. 4, 5). These trends are attributed to hormonal/metabolic responses to training.

Statistical overview

Table 2 summarizes key results for all exercises. The leg extension showed high significance (χ^2=49.79, t(30)=–8.97, P<0.001). Non-parametric methods were used when normality was violated. Training phases were clearly differentiated: the first phase applied time-under-tension (3-second rule), and the second emphasized explosive 20-second bouts. Performance differences, especially in kettlebell work, suggest the importance of both neuromuscular stimulus and technical proficiency.

DISCUSSION

This study investigated the effects of resistance and power training on maximal strength (1RM), endurance performance (repetition-based), and body composition (skeletal muscle mass and body fat percentage) in a population of university students. Among the 12 exercises evaluated, 11 showed significant improvements, with particularly notable performance gains observed in exercises such as leg extension, chest press, and sit-up. The average improvement rate for the 1RM-based exercises exceeded 100%, indicating a pronounced effect of the training intervention over a relatively short period.

Resistance training has been shown to enhance muscle hypertrophy, neuromuscular efficiency, and muscle fiber cross-sectional area [13]. In contrast, power training emphasizes explosive speed and fast-twitch fiber recruitment, aiming to maximize repetitions within a short time window. In this study, both forms of training contributed to improved strength outcomes. Given that resistance and power training were applied sequentially rather than as isolated sessions, the observed effects may be interpreted as resulting from a combined or hybrid training model.

Skeletal muscle mass changes differed by sex; male participants generally showed consistent increases, whereas female participants displayed maintenance or slight decreases after the second measurement. This pattern is likely related to hormonal differences [14] and muscle fiber distribution characteristics, aligning with previous findings that men exhibit more rapid muscular adaptations to high-load training. Body fat percentage gradually decreased in both sexs, presumably due to increased energy expenditure and enhanced metabolic efficiency.

Not all exercises showed improvement, however. The kettlebell exercise was the only activity that exhibited a decline in average repetitions, a result that was not statistically significant. This outcome may be attributed to the technical difficulty of the movement, insufficient individual proficiency, or inconsistencies in exercise intensity prescription [15]. Accumulated fatigue

Table 2. Statistical analysis results by exercise type

Exercise	Friedman χ^2 (repeated measures ANOVA)	*P*-value (repeated measures ANOVA)	N (repeated measures ANOVA)	T1 mean	T3 mean	t-statistic (paired t-test)	*P*-value (paired t-test)	N (paired t-test)
Leg press	44.486	<0.001	30	43.55	88.84	–7.114	<0.001	31
Leg curl	38.71	<0.001	31	13.23	27.19	–6.673	<0.001	31
Leg extension	49.791	<0.001	31	19.35	46.94	–8.972	<0.001	31
Shoulder press	43.521	<0.001	30	14.03	29.32	–5.84	<0.001	31
Chest press	50.643	<0.001	30	18.55	44.35	–9.628	<0.001	31
Fly	43.146	<0.001	30	13.39	27.48	–6.093	<0.001	31
Lat pull down	38.242	<0.001	29	19.5	34.8	–6.706	<0.001	30
Seated row	35.958	<0.001	28	20.52	38.1	–7.433	<0.001	29
Leg raise	8.237	0.0163	15	19.5	25.75	–2.188	0.0449	16
Sit-up	17.238	<0.001	16	14.56	27.69	–4.132	<0.001	16
Back extension	8.842	0.012	15	18.88	26.0	–3.148	0.0066	16
Kettlebell	11.828	0.0027	15	28.93	26.33	1.033	0.319	15

N, valid sample size; T1, pre-exercise; T3, post-exercise.

and reduced movement accuracy may also have influenced the decrease in performance [16]. These findings highlight the need to reassess exercise-specific responsiveness and ensure clearly defined quantification criteria during program design.

Furthermore, among the repetition-based exercises, both leg raise and back extension did not exhibit statistically significant changes. This may be attributed to the inherent difficulty in providing a uniform training stimulus across participants. Specifically, the leg raise exercise involves lower abdominal activation without upper body stabilization, making performance highly dependent on individual core strength levels [17]. In the case of the back extension, variations in range of motion and the degree of bodyweight support across individuals hinder precise quantification of repetitions [18]. These factors likely contributed to the lack of statistical significance, suggesting the need for more refined intensity control methods for such exercises in future studies.

The results of this study show that resistance exercise effectively enhances muscular strength [19]. Furthermore, incorporating aerobic components into the training program appears to promote broader functional improvements [20]. This study provides empirical evidence that short-term, high-intensity interventions can significantly enhance maximal strength even in healthy college populations.

Nonetheless, several limitations should be acknowledged. First, the use of voluntary participants may limit the generalizability of the findings. Second, the independent effects of resistance and power training could not be fully isolated due to the sequential design of the intervention. Third, potential confounding variables such as prior training experience and physical activity levels outside the study were not controlled. Additionally, missing data were present for certain exercises and were addressed using listwise deletion.

Despite these limitations, the study presents a practical exercise program model aimed at improving maximal strength and endurance in a general college student population. The circuit-style intervention—incorporating a mix of strength- and repetition-based exercises—is suitable even for beginners and can be adapted for personalized programming based on sex and body composition.

A key strength of the study lies in its unique experimental design, which applied different training modalities to the same set of exercises. In the first phase, resistance training was conducted using the "3-second rule," with each repetition performed over 1 minute at a controlled tempo (1.5 seconds concentric+1.5 seconds eccentric). In the second phase, the same exercises were performed for 20 seconds using a power training format aimed at maximal repetition. By distinguishing between 1RM-measurable exercises (8 types) and repetition-based exercises (4 types), the study was able to comprehensively evaluate both strength and muscular endurance. This approach enabled a clear investigation into the combined effects of movement speed, duration, and repetition count on muscle development. It also provided a basis for examining the interaction between maximal strength and muscular endurance. Such a distinction is expected to serve as a meaningful framework not only for understanding improvements in muscular strength, but also for identifying neuromuscular and metabolic responses that differ according to training modality. Ultimately, the experimental framework suggests that a hybrid training program—combining resistance and power components—may yield superior outcomes compared to using either approach in isolation.

Practical implications and recommendations

Based on the findings of this study, the following practical recommendations are proposed:

1) A combined circuit training program incorporating both resistance and power exercises is effective for improving physical fitness in university students.
2) Individualization of training variables such as intensity and repetitions is essential, taking into account sex and baseline fitness levels.
3) Technically demanding exercises (e.g., kettlebell movements) should be accompanied by proper instruction and repeated practice to ensure safety and efficacy.
4) Future studies should control for external factors such as training cycle, intensity modulation, dietary habits, and psychological motivation.
5) Longitudinal research is needed to assess the sustainability and long-term maintenance of training effects.

ORCID

Jun Woo KWON, https://orcid.org/0009-0006-0635-9649
Daihyuk CHOI, https://orcid.org/0000-0002-5776-5376
Hyungsik JO, https://orcid.org/0009-0003-5422-1298
Kyung-A CHOI, https://orcid.org/0000-0002-6768-828X

 https://doi.org/10.15384/kjhp.2025.00087

AUTHOR CONTRIBUTIONS

Dr. Daihyuk CHOI 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: JWK and DC. Data curation: JWK, HJ, and KAC. Formal analysis: JWK. Investigation: JWK. Methodology: JWK. Project Administration: JWK and DC. Resources: DC, HJ, and KAC. Supervision: DC. Validation: JWK, HJ, and KAC. Visualization: JWK. Writing–original draft: JWK. Writing–review & editing: DC, HJ, and KAC.

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.

REFERENCES

1. Kljajević V, Stanković M, Đorđević D, Trkulja-Petković D, Jovanović R, Plazibat K, et al. Physical activity and physical fitness among university students: a systematic review. Int J Environ Res Public Health 2021;19(1):158.
2. Booth FW, Roberts CK, Laye MJ. Lack of exercise is a major cause of chronic diseases. Compr Physiol 2012;2(2):1143-211.
3. Simamkele Nyangiwe S, Tshegofatso Mgwambane T, Malema MJ. Perceptions of Physical activity among students living on and off campus in a university in the Western Cape. Open Public Health J 2020;13:705-11.
4. Suchomel TJ, Nimphius S, Bellon CR, Stone MH. The importance of muscular strength: training considerations. Sports Med 2018;48(4):765-85.
5. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc 2011;43(7):1334-59.
6. Hattabi S, Fadhlaoui H, Hammami N, Miguel Forte P, Sortwell A, Branquinho L. The impact of resistance training on mental health: neuropsychological and behavioral functioning. In: Branquinho L, Vagner Thomatieli dos Santos R, Teixeira JE, de França E, Miguel Forte P, Ferraz R, editors. Resistance training - bridging theory and practice. IntechOpen; 2025. p. 75-100.
7. Ratamess NA, Alvar BA, Evetoch TK, Housh TJ, Kibler WB, Kraemer WJ, et al. Progression models in resistance training for healthy adults. Med Sci Sports Exerc 2009;41(3):687-708.
8. Morrison RT, Taylor S, Buckley J, Twist C, Kite C. High-velocity power training has similar effects to traditional resistance training for functional performance in older adults: a systematic review. J Physiother 2023;69(3):148-59.
9. Sayers SP, Gibson K. A comparison of high-speed power training and traditional slow-speed resistance training in older men and women. J Strength Cond Res 2010;24(12):3369-80.
10. Peterson MD, Rhea MR, Alvar BA. Maximizing strength development in athletes: a meta-analysis to determine the dose-response relationship. J Strength Cond Res 2004;18(2):377-82.
11. Seo DI, Kim E, Fahs CA, Rossow L, Young K, Ferguson SL, et al. Reliability of the one-repetition maximum test based on muscle group and gender. J Sports Sci Med 2012;11(2):221-5.
12. Grgic J, Lazinica B, Schoenfeld BJ, Pedisic Z. Test-retest reliability of the one-repetition maximum (1RM) strength assessment: a systematic review. Sports Med Open 2020;6(1):31.
13. Coyle EF, Feiring DC, Rotkis TC, Cote RW 3rd, Roby FB, Lee W, et al. Specificity of power improvements through slow and fast isokinetic training. J Appl Physiol Respir Environ Exerc Physiol 1981;51(6):1437-42.
14. Roth SM, Ferrell RF, Hurley BF. Strength training for the prevention and treatment of sarcopenia. J Nutr Health Aging 2000;4(3):143-55.
15. Meigh NJ, Keogh JWL, Schram B, Hing WA. Kettlebell training in clinical practice: a scoping review. BMC Sports Sci Med Rehabil 2019;11:19.
16. Enoka RM, Duchateau J. Muscle fatigue: what, why and how it influences muscle function. J Physiol 2008;586(1):11-23.
17. Park DJ, Park SY. Which trunk exercise most effectively activates abdominal muscles? A comparative study of plank and isometric bilateral leg raise exercises. J Back Musculoskelet Rehabil 2019;32(5):797-802.
18. Schellenberg F, Schmid N, Häberle R, Hörterer N, Taylor WR,

Lorenzetti S. Loading conditions in the spine, hip and knee during different executions of back extension exercises. BMC Sports Sci Med Rehabil 2017;9:10.
19. Kraemer WJ, Ratamess NA, French DN. Resistance training for health and performance. Curr Sports Med Rep 2002;1(3):165-71.
20. Morales-Palomo F, Ramirez-Jimenez M, Ortega JF, Mora-Rodriguez R. Effectiveness of aerobic exercise programs for health promotion in metabolic syndrome. Med Sci Sports Exerc 2019;51(9):1876-83.

 https://doi.org/10.15384/kjhp.2025.00087

Original Article

Korean J Health Promot 2025;25(3):91-98
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2025.00129

Korean Journal of Health Promotion
KJHP

Examining the Mediating Effect of Resilience on Depression and Suicidal Ideation in Older Adults Living Alone

Ho Yeob KANG, PhD[1], Myeong Seop SONG, PhD[1], and Hee Jung KIM, PhD, RN[2]

[1]Department of Social Wlfare, Dong-A University of Health, Yeongam, Korea
[2]Department of Nursing, College of Nursing, Gachon University, Incheon, Korea

ABSTRACT

Background: This study explores whether resilience mediates the effect of depression on suicidal ideation among older adults living alone. It aims to clarify the role of resilience as a psychological protective factor and provide foundational data for developing suicide prevention strategies tailored to this vulnerable population.

Methods: Eighty-four older adults aged 70–80 years, living alone and receiving specialized senior care services in three Korean localities, participated in the study. Depression was assessed using the Geriatric Depression Scale, suicidal ideation with the Scale for Suicidal Ideation, and resilience using the resilience subscale of the Psychological Capital Questionnaire. SPSS 28.0 was used to conduct descriptive statistics, correlation analysis, multiple regression analyses following the Baron and Kenny causal-steps approach, and the Sobel test to assess mediation effects.

Results: Depression was positively correlated with suicidal ideation (r=0.287, P<0.01) and negatively correlated with resilience (r=−0.315, P<0.01). Suicidal ideation also showed a significant negative correlation with resilience (r=−0.359, P<0.01). Multiple regression analyses following the Baron and Kenny causal-steps approach confirmed that resilience partially mediated the relationship between depression and suicidal ideation. The Sobel test supported this result (Z=2.042, P<0.05), indicating that resilience functions as a psychological buffer.

Conclusions: This study confirms the importance of resilience in reducing suicidal ideation among older adults living alone. The findings highlight the need for effective, multidimensional intervention strategies that enhance resilience, not only through psychological approaches but also through broader policy and environmental support.

Keywords: Psychological resilience, Depression, Suicide prevention, Protective factors, Aged

INTRODUCTION

South Korea has rapidly advanced to become the world's 13th-largest economy; however, it faces a serious social issue as the country with the highest suicide rate among Organisation for Economic Co-operation and Development (OECD) nations. According to Statistics Korea [1], the suicide rate in 2023 was 27.3 per 100,000 population, an increase of 2.2 from the previous year. Suicide remains the leading cause of death by external factors across all age groups aged 10 and above, highlighting the

Received: August 5, 2025; **Revised:** September 5, 2025; **Accepted:** September 10, 2025
Corresponding author: Hee Jung Kim, PhD, RN
Department of Nursing, College of Nursing, Gachon University, 191 Hambangmoe-ro, Yeonsu-gu, Incheon 21936, Korea
Tel: +82-32-820-4224 E-mail: illine1214@gachon.ac.kr

severity of the problem. Notably, the suicide rates are highest among those aged 80 and older (59.4 per 100,000) and those in their 70s (39.0 per 100,000), underscoring the growing suicide issue in the elderly population.

Among them, older adults living alone are considered a particularly vulnerable group to depression and suicide risk due to complex factors such as social isolation, chronic illness, and loneliness. According to the 2023 national survey on older adults [2] conducted by the Ministry of Health and Welfare, 2% of older adults living alone reported having experienced suicidal thoughts, which is four times higher than that of older adults living with a spouse (0.5%) and approximately 3.3 times higher than those living with children (0.6%). Loneliness accounted for the highest proportion of reasons for suicidal ideation (28.3%), and the prevalence of depressive symptoms (16.1%) was more than twice as high as that of older adults living with a spouse (7.8%). These findings indicate that older adults living alone constitute a high-risk group for suicide, drawing attention to the relationship between depression and suicidal ideation in this population.

However, not all experiences of depression lead to suicidal ideation. In the same survey, while 16.1% of older adults living alone reported experiencing depression, only 2.0% reported having suicidal thoughts. This suggests the presence of psychological protective factors that prevent the progression from depression to suicidal ideation, even when individuals are exposed to various stressors. Identifying such protective factors provides a crucial theoretical foundation for developing practical intervention strategies for suicide prevention.

Recently, resilience has attracted attention as one of the key psychological protective factors. Resilience refers to an individual's ability to respond flexibly and recover psychologically when faced with stress or adversity, potentially buffering the relationship between depression and suicide. Depression has been identified as a major predictor of suicidal ideation [3], while resilience has been reported as a protective factor that reduces suicidal thoughts [4]. Kwon [5] found a moderating effect of resilience in the relationship between depression and suicidal intent, and Kim [6] also reported a moderating effect of resilience in the relationship between loneliness and suicidal ideation among older adults living alone. These findings suggest that resilience may alter the intensity of suicidal responses under stressful circumstances.

Additionally, according to Fredrickson's broaden-and-build theory of positive emotions, positive emotions such as joy, interest, contentment, and love promote cognitive flexibility and resilience. Increased resilience, in turn, activates positive emotions, facilitating psychological recovery and adaptation [7-9]. From this perspective, resilience may function as a protective factor in the relationship between depression and suicidal ideation.

These recent research trends indicate an expansion in the understanding of suicide from a risk-factor-centered approach to one that emphasizes protective factors. However, in South Korea, studies focusing on protective factors among high-risk groups such as older adults living alone remain limited.

Meanwhile, previous studies on resilience have primarily reported its buffering effect, whereby resilience moderates the intensity of the response between depression and suicidal ideation. However, there is a lack of domestic research examining the mediating role of resilience in the relationship between depression and suicidal ideation among older adults living alone. Therefore, this study focuses on the possibility that resilience functions not merely as a moderator of effect strength but as an internal psychological mechanism operating in the process through which depression leads to suicidal ideation.

Accordingly, this study aims to gain a deeper understanding of the internal psychological mechanism of resilience by exploring whether depression influences resilience, which in turn acts as a mediating factor affecting suicidal ideation. Through this, the study seeks to elucidate the psychological mechanism of resilience influencing suicidal ideation among older adults living alone and to provide foundational data for the development of effective suicide prevention interventions based on resilience.

METHODS

Study design

This study employed a cross-sectional survey design to examine the impact of depression on suicidal ideation among older adults living alone and to explore the mediating role of resilience in this relationship.

Participants

The participants in this study were adults in their 70s and 80s who were living alone and registered with Senior Customized Care Service institutions in three local municipalities in South Korea. Based on statistical evidence that suicide rates are highest among individuals in their 70s and 80s across all age groups [1], this study conducted a survey targeting older adults within

 https://doi.org/10.15384/kjhp.2025.00129

this age range. All participants were fully informed about the purpose of the study and voluntarily provided written consent to participate. The required sample size was calculated using G*Power 3.1 software to ensure the adequacy for hierarchical regression analysis. The parameters were set as an effect size of 0.15, a significance level (α) of 0.05, and statistical power (1–β) of 0.80, resulting in a minimum required sample size of 68. A total of 90 questionnaires were collected; after excluding six responses due to low response reliability, data from 84 participants were included in the final analysis.

Measures

Suicidal ideation

Suicidal ideation was assessed using the Scale for Suicidal Ideation developed by Beck et al. [10] and adapted into Korean by Shin et al. [11]. The scale comprises 19 items, each rated on a 3-point Likert scale. Total scores range from 0 to 38, with higher scores indicating greater suicidal ideation. Among adults, a score of 9 or above is generally interpreted as reflecting a heightened level of suicidal ideation compared to age-matched norms. The Scale for Suicidal Ideation was reported as Cronbach's α=0.87 in Shin et al.'s study [11] and 0.91 in the present study.

Depression

Depression was assessed using the Geriatric Depression Scale developed by Sheikh and Yesavage [12] and adapted into Korean by Park et al. [13]. The scale comprises of 15 items with dichotomous responses coded as "yes" (1 point) or "no" (0 points). Total scores range from 0 to 15, with higher scores reflecting greater depressive symptoms. A score of 6 or above is generally interpreted as indicative of clinically relevant depression. The Geriatric Depression Scale was reported as Cronbach's α=0.94 in Sheikh and Yesavage's study [12] and 0.61 in the present study.

Resilience

Resilience was assessed using the resilience subscale (5 items) of the Psychological Capital Questionnaire originally developed by Luthans et al. [14] and subsequently adapted and revised by Kwon [5]. The original scale questionnaire comprises four subscales: self-efficacy, hope, optimism, and resilience; however, this study employed only the resilience subscale in accordance with the research objectives. Items were rated on a 5-point Likert scale 1 (strongly disagree) to 5 (strongly agree), with total scores ranging from 5 to 25. Higher scores indicate a greater level of resilience. The reliability of the resilience subscale was reported as Cronbach's α=0.91 in Kwon's study [5] and 0.70 in the present study.

General characteristics

This study included five general characteristic variables—sex, age, educational level, health status, and income level—that have been reported in previous studies to influence suicidal behavior among older adults living alone [2].

Data collection

Data was collected between January 2 and January 31, 2025, from 84 older adults aged 70 to 80 years who live alone and voluntarily consented to participate in the study. Participants were recruited from specialized service providers affiliated with three local municipalities in South Korea.

Data analysis

Data was analyzed using IBM SPSS Statistics for Windows, Version 28.0. The following statistical procedures were employed:

1) Descriptive statistics (means and standard deviations) were calculated to assess levels of depression, suicidal ideation, and resilience among the participants.
2) Independent t-tests and one-way ANOVA were used to examine differences in key variables according to general characteristics.
3) Pearson correlation analysis was performed to explore the relationships among the main variables.
4) Multiple regression analyses following the Baron and Kenny causal-steps approach analysis and the Sobel test were performed to verify the mediating effect of resilience in the relationship between depression and suicidal ideation.

Ethical consideration

Prior to data collection, ethical approval for this study was obtained from the Institutional Review Board (IRB) of Gachon University, with which the researcher is affiliated (IRB Approval No.: 1044396-202410-HR-175-01). All research procedures were conducted in accordance with established ethical standards for human subjects research.

RESULTS

General characteristics of participants

The general characteristics of the 84 participants in this study are as follows. The majority were female, accounting for 82.1% (n=69), while males comprised 17.9% (n=15). In terms of age, 64.3% (n=54) were in their 70s, and 35.7% (n=30) were in their 80s, indicating a higher proportion of participants in their 70s. Regarding educational background, the largest groups were those with no formal education and those who had completed elementary school, each accounting for 32.1% (n=27), suggesting that the participants generally had low educational attainment. Regarding perceived health status, 69.0% (n=58) reported their health as "poor." For monthly income, the most frequently reported range was between 400,000 and 800,000 KRW, cited by 66.7% (n=56) of participants (Table 1).

Differences in depression and suicidal ideation according to general characteristics

An analysis of depression scores by participants' sociodemographic characteristics revealed no statistically significant differences by sex (t=0.349, *P*=0.728), age group (t=0.746, *P*=0.458), education level (F=1.305, *P*=0.275), perceived health status (F=2.205, *P*=0.117), or monthly income (F=1.928, *P*=0.152) (Table 1).

Similarly, suicidal ideation did not differ significantly by sex (t=1.759, *P*=0.082), age group (F=1.107, *P*=0.296), education level (F=1.018, *P*=0.403), perceived health status (F=0.201, *P*=0.818), or monthly income (F=1.747, *P*=0.181). These findings suggest that the sociodemographic variables examined in this study were not significantly associated with differences in depression or suicidal ideation among older adults living alone (Table 1).

Levels and correlations among depression, suicidal ideation, and resilience

The mean scores for the main variables were as follows: depression, 9.33±2.44; suicidal ideation, 13.06±7.73; and resilience, 15.52±3.88 (Table 2). Pearson correlation analysis revealed a significant positive correlation between depression and suicidal ideation (r=0.287, *P*<0.01), as well as significant negative correlations between depression and resilience (r=−0.315, *P*<0.01) and between suicidal ideation and resilience (r=−0.359, *P*<0.01) (Table 2). These results indicate that higher levels of depression are associated with increased suicidal ideation and lower resilience, while higher resilience is associated with lower suicidal ideation.

Table 2. Means, SDs, and correlations of key variables (n=84)

Variable	Mean±SD	Depression	Suicidal ideation	Resilience
Depression	9.33±2.44	1		
Suicidal ideation	13.06±7.73	0.287**	1	
Resilience	15.52±3.88	−0.315**	−0.359**	1

SD, standard deviation.
**P<0.01.

Table 1. General characteristics of participants (n=84)

Characteristic	Category	n (%)	Depression		Suicidal ideation	
			t	*P*	t	*P*
Sex	Male	15 (17.9)	0.349	0.728	1.759	0.082
	Female	69 (82.1)				
Age (yr)	70s group	54 (64.3)	0.746	0.458	1.107	0.296
	80s group	30 (35.7)				
Education level	No formal education (illiterate)	27 (32.1)	1.305	0.275	1.018	0.403
	Elementary school graduate	27 (32.1)				
	Middle school graduate	12 (14.3)				
	High school graduate	14 (16.7)				
	College graduate or higher	4 (4.8)				
Perceived health status	Poor health	58 (69.0)	2.205	0.117	0.201	0.818
	Fair health	17 (20.2)				
	Good health	9 (10.7)				
Income (won)	Under 400,000	11 (13.1)	1.928	0.152	1.747	0.181
	From 400,000 to 800,000	56 (66.7)				
	80,000 or more	17 (20.2)				
Total		84 (100)				

The sum of the percentages does not equal 100% because of rounding.

https://doi.org/10.15384/kjhp.2025.00129

Mediating effect of resilience on the relationship between depression and suicidal ideation

To examine the mediating effect of resilience on the relationship between depression and suicidal ideation among older adults, this study employed the hierarchical regression approach proposed by Baron and Kenny [15]. The statistical significance of the mediating effect was further verified using the Sobel test.

The mediation analysis followed Baron and Kenny's three-step procedure. In the first step, the effect of the independent variable (depression) on the mediating variable (resilience) was tested. In the second step, the effect of depression on the dependent variable (suicidal ideation) was examined. In the third step, both depression and resilience were simultaneously entered into the regression model to assess their respective effects on suicidal ideation, thereby determining whether resilience mediated the relationship between depression and suicidal ideation.

In the first step of the mediation analysis, depression had a significant negative effect on resilience (t=–3.005, P<0.01), accounting for 8.8% of the variance in resilience. The model was statistically significant (F (1, 82)=9.031, P<0.01). In the second step, depression exhibited a significant positive effect on suicidal ideation (t=2.713, P<0.01), explaining 7.1% of the variance. This model was also statistically significant (F (1, 82)=7.358, P<0.01). In the third step, when both depression and resilience were entered simultaneously into the regression model, resilience demonstrated a significant negative effect on suicidal ideation (t=–2.781, P<0.01), while the effect of depression on suicidal ideation was reduced to marginal significance (t=1.802, P<0.05). The Sobel test further confirmed the significance of the mediating effect, yielding a Z-value of 2.042 (P<0.05). These findings indicate that resilience partially mediates the relationship between depression and suicidal ideation (Table 3, Fig. 1).

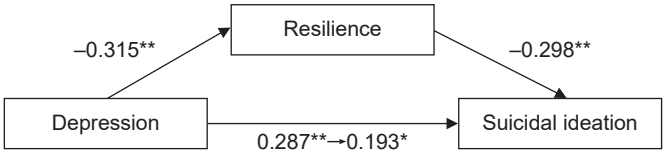
DISCUSSION

The main purpose of this study was to explore whether resilience mediates the relationship between depression and suicidal ideation among older adults living alone. The main findings are discussed as follows.

First, an analysis of participants' demographic characteristics revealed that the majority were female (82.1%, n=69), with the most represented age group being those in their 70s (64.3%). Regarding educational attainment, illiteracy and elementary school education were the most prevalent, each comprising 32.1% of the sample, followed by middle school, high school, and college graduates in descending order.

In terms of perceived health status, 69.0% of participants rated their health as "poor," and the most frequently reported monthly income was between 400,000 and 800,000 KRW (66.7%). These findings suggest that the older adults living alone in this study were characterized by low levels of education, poor perceived health, and financial hardship. Moreover, the average scores for depression and suicidal ideation were 9.33±2.44 and 13.06±7.73, respectively, both exceeding the clinical cutoff points for risk (≥6 for depression and ≥9 for suicidal ideation). These results indicate that this population is at elevated risk for both depression and suicidal ideation, potentially influenced by intersecting factors such as limited educational attainment, health vulnerability, and economic deprivation—findings that align with prior research [2].

Second, the analysis of differences in depression and suicidal ideation by demographic characteristics revealed no statistically significant differences across any of the examined variables,



*P<0.05, **P<0.01
Direct effect: effect=0.287**
Indirect effect (via resilience): effect=0.193*

Fig. 1. Mediating effect of resilience on depression and suicidal ideation in older adults living alone.

Table 3. Mediating effect of resilience on the influence of depression on suicidal ideation

	Independent variable	Dependent variable	B	SE	β	t	F (P)	R^2	Adj. R^2
Step 1	Depression	Resilience	–0.503	0.167	–0.315	–3.005	9.031**	0.099	0.088
Step 2	Depression	Suicidal ideation	0.910	0.335	0.287	2.713	7.358**	0.082	0.071
Step 3	Depression	Suicidal ideation	0.612	0.340	0.193	1.802	7.847**	0.016	0.014
	Resilience		–0.592	0.213	–0.298	–2.781			

Adj., adjusted; SE, standard error.
**P<0.01, Sobel test statistic: 2.042, P<0.05.

including sex, age group, educational level, perceived health status, and income. This finding suggests that, among older adults living alone aged 70 and above, the levels of depression and suicidal ideation may be more strongly influenced by psychological rather than demographic factors [16]. These findings imply that while demographic background should be considered in interventions addressing depression and suicidal ideation among elderly living alone, interventions focusing primarily on intrapersonal psychological resources—such as resilience—and psychosocial factors may be more effective.

Third, correlation analysis among the key variables demonstrated that depression was significantly positively correlated with suicidal ideation (r=0.287, $P<0.01$) and significantly negatively correlated with resilience (r=–0.315, $P<0.01$). These results indicate that higher levels of depression are associated with increased suicidal ideation and lower levels of resilience. Furthermore, suicidal ideation was significantly negatively correlated with resilience (r=–0.359, $P<0.01$), suggesting that individuals with greater resilience tend to report lower levels of suicidal ideation.

These findings support the conceptualization of resilience as a protective psychological resource that mitigates the adverse effects of depression and suicidal ideation among older adults living alone. They underscore the potential value of resilience-enhancing interventions in suicide prevention efforts within this population.

Lastly, the analysis of the mediating effect of resilience on the relationship between depression and suicidal ideation among older adults living alone confirmed that resilience partially mediates this relationship. This finding suggests that depression influences suicidal ideation indirectly through the psychological resource of resilience, rather than exerting a direct effect. These findings are consistent with previous studies [17] that reported a negative association between resilience and suicidal ideation, as well as evidence indicating that ego-resilience significantly impacts suicidal ideation [4,6,18].

On the other hand, Kwon [5] reported that resilience functions as a moderator in the relationship between depression and suicidal ideation among older adults, which differs functionally from the mediating effect identified in this study. This discrepancy can be understood by distinguishing between buffering effects and indirect effects, which represent distinct functional pathways. Nevertheless, both perspectives underscore resilience as a psychological protective factor. In this study, resilience was identified as a mediating mechanism that attenuates the pathway through which depression leads to suicidal ideation. This finding contrasts with the pathway in which hopelessness elevates suicide risk [16] and further underscores resilience as a critical psychological resource for suicide prevention. Relatedly, Cross [19] defined resilience as the emotional recovery capacity that protects against suicide risk by enabling individuals to withstand and recover from stressful situations. Furthermore, Cha and Lee [18] reported that problem-solving ability, a component of resilience, plays a role in reducing suicidal ideation. These findings reaffirm that resilience is a key psychological resource that alleviates suicide risk.

Meanwhile, recent studies have expanded the concept of resilience beyond individual internal traits to a more multidimensional, system-wide capacity for recovery. Peeters et al. [20] redefined resilience as the ability of a system to recover and adapt after exposure to stressors and proposed understanding it from a multilevel (systemic) perspective. Specifically, to support resilience in older adults with cognitive decline, they emphasized the need for integrated strategies at the macro level, including organizational, policy, and community resources, going beyond psychological and cognitive interventions. This perspective suggests that interventions aimed at enhancing resilience should extend beyond simple individual-centered approaches to more practical and feasible multidimensional strategies.

Therefore, given that resilience was identified as a significant mediating variable in the relationship between depression and suicidal ideation among older adults aged 70 and above living alone, the development of integrated intervention strategies at both micro and macro levels is warranted to enhance resilience in this population. For physically and economically vulnerable older adults living alone, individual psychological counseling or cognitive training alone may be insufficient to effectively strengthen resilience. Accordingly, a multidimensional, community-based approach should be implemented in parallel to address the complex and interrelated factors contributing to suicide risk.

Based on the above discussion, the following recommendations are proposed. First, resilience has been identified as a key psychological protective factor that buffers the effects of depression and suicidal ideation among older adults aged 70 and above who are at risk of dying alone. Future research should focus on developing and evaluating multidimensional intervention strategies aimed at enhancing resilience in this population. It is particularly essential to design integrated approaches that extend beyond individual-level interventions to encompass

https://doi.org/10.15384/kjhp.2025.00129

community-based and policy-level strategies, thereby addressing the broader structural and social determinants of mental health and suicide risk. At the micro level, employing positive psychology and cognitive-behavioral strategies may enhance cognitive, emotional, and behavioral coping abilities in response to stressful situations, thereby strengthening resilience. This suggests that individual-level interventions focusing on psychological resources can play a pivotal role in suicide prevention among older adults living alone. At the macro level, more realistic policies are needed at the national level to ensure that older adults living alone can lead safe lives within their communities. Housing, health, and welfare policies are crucial, as are economic policies that can guarantee basic living standards. Building on these, we must establish a social structure that ensures adequate care within the community.

Second, this study focused on older adults aged 70 and above living alone who were receiving the government's specialized tailored care services—an identified high-risk group characterized by elevated levels of depression and suicidal ideation.

Therefore, psychological protective factors such as resilience identified in this study can serve as foundational data for evaluating the effectiveness of future specialized services and for developing related programs aimed at high-risk older adults living alone.

Meanwhile, this study has several limitations. First, the sample was limited to recipients of the national specialized care services in three selected local government areas, which restricts the generalizability of the findings.

Additionally, due to practical challenges in recruiting older adults living alone, data collection was conducted over a relatively short period. These factors necessitate caution in interpreting the results. Future research should consider expanding the survey area nationwide and allocating sufficient time to include samples with more diverse characteristics and backgrounds, thereby enhancing the reliability and validity of the study. Lastly, this study tested the mediating effect of resilience on depression and suicidal ideation among older adults based on a limited sample size (n=87). However, it is necessary to further examine the moderated mediating effect of resilience on depression and suicidal ideation in later life, taking into account potential moderators not identified in this study, and to verify these effects through longitudinal research that captures changes over time.

ORCID

Ho Yeob KANG, https://orcid.org/0009-0008-1027-8141
Myeong Seop SONG, https://orcid.org/0009-0000-3220-6343
Hee Jung KIM, https://orcid.org/0000-0001-6555-1813

AUTHOR CONTRIBUTIONS

Dr. Hee Jung 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: all authors. Methodology: all authors. Investigation: all authors. Data curation: all authors. Formal analysis: all authors. Writing–original draft: HYK and HJK. Writing–review & editing: HJK.

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.

ACKNOWLEDGMENTS

We appreciate all the study participants for their contributions.

REFERENCES

1. Statistics Korea. 2023 Cause of death statistics [Internet]. Korea Statistical Information Service; 2024 [cited Aug 4, 2025]. Available from: https://kostat.go.kr/board.es?mid=a10301010000&bid=218&act=view&list_no=433106
2. Ministry of Health and Welfare. 2023 National survey on older adults [Internet]. Ministry of Health and Welfare; 2024 [cited Aug 4, 2025]. Available from: https://www.mohw.go.kr/board.es?mid=a10411010100&bid=0019&act=view&list_

no=1483359&tag=&nPage=1
3. Lee C, Yeum D. A study on the influence on the elderly's suicidal thoughts. J Humanit Soc Sci 21 2021;12(3):873-88.
4. Johnson J, Gooding PA, Wood AM, Tarrier N. Resilience as positive coping appraisals: testing the schematic appraisals model of suicide (SAMS). Behav Res Ther 2010;48(3):179-86.
5. Kwon SM. Impact of old people's depression on their suicidal intent: focused on moderating effects of positive psychological capital [dissertation]. Catholic Kwandong University; 2017. Korean.
6. Kim EJ. A study on the moderating effects of resilience on the relation between loneliness and suicidal ideation of elderly living alone. J Soc Sci 2018;44(1):171-97.
7. Fredrickson BL, Levenson RW. Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. Cogn Emot 1998;12(2):191-220.
8. Fredrickson BL. The role of positive emotions in positive psychology. The broaden-and-build theory of positive emotions. Am Psychol 2001;56(3):218-26.
9. Fredrickson BL, Joiner T. Positive emotions trigger upward spirals toward emotional well-being. Psychol Sci 2002;13(2):172-5.
10. Beck AT, Kovacs M, Weissman A. Assessment of suicidal intention: the Scale for Suicide Ideation. J Consult Clin Psychol 1979;47(2):343-52.
11. Shin MS, Park KB, Oh KJ, Kim ZS. A study of suicidal ideation among high school students: the structural relation among depression, hopelessness, and suicidal ideation. Korean J Clin Psychol 1990;9(1):1-19.
12. Sheikh JI, Yesavage JA. Geriatric Depression Scale (GDS) recent edvice and development of a shorter version. In: Brink TL, editor. Clinical gerontology: a guide to assessment and intervention. The Haworth Press; 1986. p. 165-74.
13. Park HS, Deung Jung YJ, Lee CI, Oh JE, Hong SH, Cho CY. Comparing various short-form Geriatric Depression Scales in elderly patients. Korean J Fam Med 2006;27(5):364-9.
14. Luthans F, Avolio BJ, Avey JB, Norman SM. Positive psychological capital: measurement and relationship with performance and satisfaction. Pers Psychol 2017;60(3):541-72.
15. Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. J Pers Soc Psychol 1986;51(6):1173-82.
16. Wenzel A, Beck AT. A cognitive model of suicidal behavior: theory and treatment. Appl Prev Psychol 2008;12(4):189-201.
17. Heisel MJ, Flett GL. Psychological resilience to suicide ideation among older adults. Clin Gerontol 2008;31(4):51-70.
18. Cha KS, Lee HS. The effects of ego-resilience, social support, and depression on suicidal ideation among the elderly in South Korea. J Women Aging 2018;30(5):444-59.
19. Cross TL. The psychological well-being of students with gifts and talents: from amelioration to education. Gifted Child Today 2024;47(2):146-50.
20. Peeters G, Kok A, de Bruin SR, van Campen C, Graff M, Nieuwboer M, et al. Supporting resilience of older adults with cognitive decline requires a multi-level system approach. Gerontology 2023;69(7):866-74.

 https://doi.org/10.15384/kjhp.2025.00129

Original Article

Korean J Health Promot 2025;25(3):99-109
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2025.00122

Korean Journal of Health Promotion
KJHP

Associations between Fear of Cancer Recurrence and Health-Related Quality of Life, Psychological Distress, and Health Behaviors in Cancer Survivors

Seo-Hee CHOI, RN[1,2], Yeol KIM, MD, PhD[3], and Yu-Ri CHOE, MD, PhD[1,4,5]

[1]Gwangju-Jeonnam Regional Cancer Center, Hwasun, Korea
[2]Department of Public Health, Graduate School, Chonnam National University, Gwangju, Korea
[3]National Cancer Control Institute, National Cancer Center, Goyang, Korea
[4]Department of Family Medicine, Chonnam National University Hwasun Hospital, Hwasun, Korea
[5]Department of Family Medicine, Chonnam National University Medical School, Gwangju, Korea

ABSTRACT

Background: Fear of cancer recurrence (FCR) is a prevalent psychological concern among cancer survivors, closely linked to diminished health-related quality of life (HRQoL) and increased psychological distress. However, its impact on health-related behaviors remains poorly understood. This study investigated associations between FCR, HRQoL, psychological distress, and health-related behaviors in a diverse cancer survivor population.

Methods: This cross-sectional study analyzed data from 326 adult cancer survivors across diverse cancer types. FCR was assessed using four items addressing concern about recurrence, metastasis, second cancer, and follow-up and participants were classified as high FCR. HRQoL was evaluated using the EuroQol 5-Dimension Questionnaire (EQ-5D), EuroQol Visual Analogue Scale (EQ-VAS), and European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 (EORTC QLQ-C30); psychological symptoms were measured by the 9-item Patient Health Questionnaire (PHQ-9) and 7-item Generalized Anxiety Disorder scale (GAD-7). Health-related behaviors included recent screening, vaccination, and physical activity. Linear regression was used for continuous outcomes and logistic regression for binary outcomes, controlling for demographic and clinical covariates.

Results: Participants with high FCR demonstrated significantly poorer HRQoL across multiple domains, including Global Health Status/Quality of Life (β=−10.56, 95% confidence interval [95% CI]: −14.82 to −6.29, P<0.001), physical functioning (β=−7.04, P<0.001), and emotional functioning (β=−12.86, P<0.001). They also reported greater fatigue (β=11.11, P<0.001), pain (β=9.85, P<0.001), and financial difficulty (β=17.32, P<0.001). High FCR was strongly associated with depressive (PHQ-9: β=3.10, P<0.001) and anxiety symptoms (GAD-7: β=2.70, P<0.001). In contrast, no significant associations were found between FCR and health-related behaviors.

Conclusions: High FCR is strongly associated with impaired HRQoL and increased psychological distress but does not translate into increased engagement in preventive health behaviors. These findings underscore the need for integrated interventions addressing both emotional and behavioral aspects of survivorship care.

Keywords: Fear of cancer recurrence, Quality of life, Cancer survivors, Health behavior

Received: August 1, 2025; **Revised:** September 8, 2025; **Accepted:** September 11, 2025

Corresponding author: Yu-Ri CHOE, MD, PhD
Department of Family Medicine, Chonnam National University Hwasun Hospital, 322 Seoyang-ro, Hwasun-eup, Hwasun 58128, Korea
Tel: +82-61-379-7290 Fax: +82-61-379-7289 E-mail: hiyuriya@cnuh.com

INTRODUCTION

Advancements in cancer diagnosis and treatment, the expansion of national screening programs, and growing public awareness have led to a steady increase in the number of cancer survivors in Korea. As of 2020, approximately 2.56 million individuals in Korea had survived cancer, comprising nearly 5% of the national population, with the proportion of five-year survivors rising from 38.7% in 2010 to 57.7% in 2020 [1]. These trends signal a paradigm shift in the conceptualization of cancer—from an acute illness to a chronic condition requiring long-term survivorship care.

Even after completing primary treatment, many cancer survivors continue to face a variety of physical, psychological, and social challenges. Among these, fear of cancer recurrence (FCR) has emerged as one of the most common and persistent concerns [2-4]. FCR ranges from mild anxiety to clinically significant distress, with its intensity varying by cancer type, time since diagnosis, sex, and psychosocial characteristics. Excessive FCR has been linked to depression, anxiety, insomnia, and overall declines in health-related quality of life (HRQoL) [4,5].

FCR may also influence survivors' health behaviors, although the direction and magnitude of its effects remain unclear. For instance, a study of young breast cancer survivors revealed that individuals with high FCR were more likely to undergo screening but also engaged in detrimental behaviors such as smoking and alcohol use [6]. Other findings suggest that FCR can heighten somatic symptom sensitivity and psychological stress, influencing health behaviors and lifestyle management [7]. In colorectal cancer survivors, FCR has been associated with engagement in preventive behaviors like physical activity and smoking cessation [8]. Nevertheless, many prior studies have focused on narrow populations, limiting their generalizability. Moreover, some evidence indicates that while FCR significantly affects psychological functioning and HRQoL, its influence on health-related behaviors may be modest [9].

Accordingly, this study utilized data from the pilot phase of the Korean Nationwide Survey for Cancer Survivorship, the first population-based investigation of FCR in Korean survivors. By including six major cancer types (stomach, colorectal, liver, breast, cervical, and lung), the findings are more generalizable than those of cancer-specific studies. FCR was measured using a multidimensional tool covering recurrence, metastasis, secondary cancer, and follow-up concerns. This study assessed the associations between HRQoL, psychological symptoms, and health behaviors, addressing the limitations of prior research focused on narrower populations or outcomes. These findings inform integrated survivorship care that considers both emotional and behavioral aspects.

METHODS

Study design and participants

This study used data derived from a pilot survey conducted prior to the Korean Nationwide Survey for Cancer Survivorship. The pilot survey aimed to evaluate the feasibility of the study protocol, refine the questionnaire, and validate the data collection procedures. The survey covered a wide range of topics, including treatment history, current health status, quality of life, unmet needs, health behaviors, health policy indicators, and sociodemographic characteristics.

The eligibility criteria for the study participants were as follows: adults aged ≥19 years who were diagnosed with one of the six major cancers in Korea (stomach, colorectal, liver, breast, cervical, or lung cancer) and had survived for at least 1 year post-diagnosis. Participants were required to have completed primary cancer treatment, such as surgery, chemotherapy, or radiotherapy. Exceptions were made for individuals who were currently receiving oral chemotherapy without evidence of disease progression, who received adjuvant hormonal therapy following breast cancer treatment, or who exhibited no disease progression after receiving local treatment for liver cancer. Individuals currently undergoing treatment for recurrent or metastatic cancer and those diagnosed with terminal stage cancer were excluded.

Recruitment was conducted in collaboration with the medical staff at four institutions in Korea—namely, a national cancer center, two major private hospitals, and a regional cancer center. A total of 377 participants were enrolled from 6 November 2023 to 29 March 2024. Data were collected by a professional survey agency via either in-person interviews or self-administered online questionnaires, based on participant preferences. Out of 377 recruited individuals, 339 completed the survey. After excluding nine participants with stage IV cancer and four individuals diagnosed with non-major cancers (e.g., thyroid cancer, carcinoid sarcoma), 326 participants were finally included in the analysis (Fig. 1).

The study protocol was approved by the Institutional Review Board of the Chonnam National University Hwasun Hospital (IRB no. CNUHH-2025-073). Informed consent was obtained

 https://doi.org/10.15384/kjhp.2025.00122

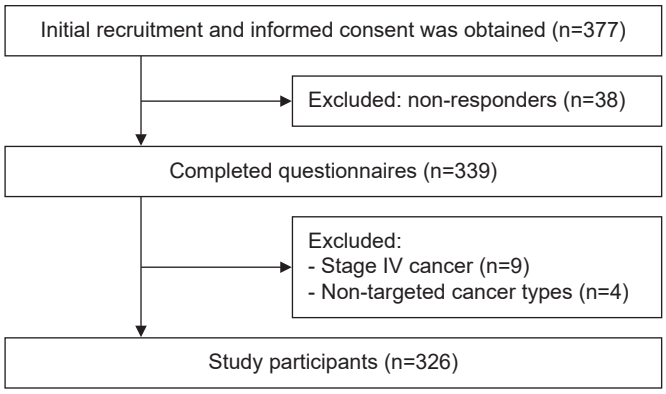


Fig. 1. Flow diagram of participant.

through face-to-face interviews with trained research nurses using a web-based form.

Covariates

Sociodemographic variables included age, sex, marital status, educational level, monthly household income, comorbidities, and employment status. Marital status was dichotomized into "single (including divorced or widowed)" and "married or cohabiting." Educational level was categorized into three groups: middle school graduate or lower, high school graduate, and college graduate or higher. Monthly household income was divided into quartiles. Comorbidity status was assessed based on the presence of major chronic conditions and categorized into "none" and "one or more." Employment status was classified according to current economic activity as either "employed" or "unemployed."

Cancer-related clinical variables included cancer type, stage, treatment history, and time since diagnosis. Cancer types were classified as breast, stomach, colorectal, lung, cervical or uterine, and liver. Cancer stage was categorized as stage 0, I, II, or III or unknown. Treatment history included surgery, chemotherapy, radiotherapy, hormone therapy, and other procedures, each treated as a separate binary variable. Time since diagnosis was categorized into "1.0 to <4.5 years" and "4.5 to ≤10 years."

FCR was assessed using four items that evaluated concerns regarding regular medical check-ups, the development of a second primary cancer, cancer recurrence, and metastasis. Each item was rated on a 4-point Likert scale ranging from 1 ("not at all") to 4 ("very much"). To classify the level of FCR, the number of items rated as 3 ("quite") or 4 ("very much") was counted. Participants who endorsed a score of 3 or higher on two or more items were categorized as having high FCR, whereas those with fewer than two such responses were classified as having low FCR. This classification reflects a multidimensional approach to capturing clinically meaningful levels of recurrence-related fear across multiple domains [10,11].

Health-related quality of life and psychological distress

HRQoL was assessed using the EuroQol 5-Dimension Questionnaire (EQ-5D), EuroQol Visual Analogue Scale (EQ-VAS), and European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 (EORTC QLQ-C30, version 3.0).

The EQ-5D [12] assesses five dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression), each rated on a 3-point scale. For analysis, responses were dichotomized: "no problems" (score=1) coded as 0, and "some" or "extreme problems" (scores=2 or 3) coded as 1. The EQ-VAS [12] is a 20-cm vertical scale ranging from 0 (worst health) to 100 (best health), reflecting self-rated current health. The EORTC QLQ-C30 [13] is a 30-item questionnaire developed to measure HRQoL in patients with cancer. It comprises the three components: the five functional scales, the nine symptom scales, and a Global Health Status/Quality of Life (GHS/QoL) scale. Each item is rated on a 4-point Likert scale ("not at all" to "very much") or a 7-point scale for GHS/QoL items. All scores were linearly transformed to a 0–100 scale, with higher scores indicating better functioning on the functional and GHS/QoL scales or worse symptoms on the symptom scales. The Korean version shows good reliability (Cronbach's α>0.70 for most subscales; α=0.60 for cognitive function) [14].

Depression was measured using the Korean version of the 9-item Patient Health Questionnaire (PHQ-9) [15], with scores ranging from 0 to 27 and higher scores indicating more severe symptoms. The Korean version has high internal consistency (α=0.88) [16]. Anxiety was assessed via the 7-item Generalized Anxiety Disorder scale (GAD-7) [17], with scores ranging from 0 to 21, also showing excellent reliability in Korean validation studies (α=0.91) [18].

Health-related behaviors

Health-related behaviors were assessed via self-administered questionnaires and categorized as change-or status-based.

Change-based behaviors included weight control, alcohol consumption, and smoking. Weight-control efforts were assessed using self-reported efforts to reduce, maintain, or gain weight over the past year. Alcohol consumption and smoking

behaviors were categorized as no change, reduction, cessation after diagnosis, or lifelong abstinence. Status-based behaviors included recent health check-ups (within 2 years), cancer screening (for cancers other than the index cancer), vaccinations (pneumococcal, herpes zoster, and seasonal influenza), physical activity, use of complementary and alternative medicine (CAM), and nutritional supplements.

Physical activity was assessed by the number of days per week participants walked ≥10 minutes and did strength training (e.g., push-ups, sit-ups, weightlifting) over the past week, categorized as <5 or ≥5 days for walking and <2 or ≥2 days for strength training [19] CAM use was assessed as ever or never used for cancer treatment after the diagnosis. The current use of nutritional supplements, including vitamins and traditional remedies, was also recorded.

Statistical analyses

Descriptive statistics are summarized as means with standard deviations for continuous variables and frequencies with percentages for categorical variables. Group comparisons based on FCR were performed using independent t-tests and chi-square tests.

To assess association between FCR and HRQoL or psychological symptoms, multivariate linear and logistic regression models were used for continuous and binary outcomes, respectively. All models were adjusted for age, sex, cancer type, cancer stage, comorbidities, time since cancer diagnosis, educational level, monthly household income, and employment status. Multicollinearity was assessed using variance inflation factors; all were <1.45. Bonferroni correction was applied for multiple comparisons with a significance threshold of $P<0.0024$.

Associations between FCR and health-related behaviors were examined using the chi-squared test. Multivariable logistic regression analyses assessed independent associations between each behavior and high FCR (coded 1), adjusting for demographic and clinical covariates. Each behavior was entered as the main independent variable in a separate model, and statistical significance was set at $P<0.05$.

All analyses were conducted using Python version 3.11.4 (Python Software Foundation) [20], with the statsmodels (v0.14.0) [21], pandas (v2.0.3) [22], and scikit-learn (v1.3.0) [23] libraries.

RESULTS

Characteristics of the participants

A total of 326 cancer survivors were included in the analysis (Table 1), of whom 149 (45.7%) were classified as having high FCR and 177 (54.3%) as having low FCR. The mean age of participants was 57.5±10.7 years, with the high FCR group being younger than the low FCR group (56.3±10.2 years vs. 58.5±11.0 years). Female accounted for 69.9% of the total sample and were slightly more represented in the high FCR group (71.1% vs. 68.9%). The majority of participants were married or cohabiting (73.6%) and had attained a college-level education or higher (55.2%). The distribution of monthly household income was relatively even across quartiles. Comorbid conditions were present in 30.1% of participants, and 56.1% were employed at the time of the survey. Breast cancer was the most common cancer type (32.2%), followed by stomach (23.0%) and colorectal cancer (15.0%). Most participants had been diagnosed with early-stage disease (stage 0–II, 71.8%). Nearly all participants had undergone surgery (94.5%), and over half had received chemotherapy (49.4%) or radiotherapy (39.6%). Time since diagnosis ranged from 1.0 to 10 years, with 53.4% having been diagnosed within the past 4.5 years. The mean total FCR score was 9.9±3.3.

There were no statistically significant differences in sociodemographic or clinical characteristics between the low and high FCR groups (all $P>0.05$), except for cancer type ($P=0.005$). Specifically, breast cancer was more prevalent among participants with high FCR (43.6% vs. 22.6%), while colorectal cancer was more common in the low FCR group (27.1% vs. 18.1%). The distributions of other cancer types showed no clear differences between groups.

Health-related quality of life and psychological symptoms according to fear of cancer recurrence

Table 2 presents the comparisons of HRQoL and psychological symptoms between participants with low and high FCR. After adjusting for age, sex, cancer type, cancer stage, comorbidity, time since diagnosis, education level, household income, employment status, and study group, several significant differences were observed across multiple domains.

On the EQ-5D, participants in the high FCR group were more likely to report problems in pain/discomfort (odds ratio [OR]=2.31, 95% confidence interval [95% CI]: 1.44–3.71; $P<0.001$), and anxiety/depression (OR=4.26, 95% CI: 2.58–7.02; $P<0.001$). The EQ-VAS score was also significantly lower in the

 https://doi.org/10.15384/kjhp.2025.00122

Table 1. Baseline characteristics of participants according to FCR status

Characteristic	Overall (n=326)	Low FCR (n=177)	High FCR (n=149)	*P*-value
Age (yr)	57.5±10.7	58.5±11.0	56.3±10.2	0.061
Sex				0.754
Male	98 (30.1)	55 (31.1)	43 (28.9)	
Female	228 (69.9)	122 (68.9)	106 (71.1)	
Marital status				0.225
Single	86 (26.4)	52 (29.4)	34 (22.8)	
Married and cohabiting	240 (73.6)	125 (70.6)	115 (77.2)	
Educational level				0.529
Middle school graduate or lower	34 (10.4)	19 (10.7)	15 (10.1)	
High school graduate	112 (34.4)	56 (31.6)	56 (37.6)	
College graduate or higher	180 (55.2)	102 (57.6)	78 (52.3)	
Monthly household income[a]				0.631
1Q	84 (25.8)	41 (23.2)	43 (28.9)	
2Q	80 (24.5)	44 (24.9)	36 (24.2)	
3Q	91 (27.9)	50 (28.2)	41 (27.5)	
4Q	71 (21.8)	42 (23.7)	29 (19.5)	
Comorbidity				0.754
0	228 (69.9)	122 (68.9)	106 (71.1)	
≥1	98 (30.1)	55 (31.1)	43 (28.9)	
Employment status				0.975
Unemployed	143 (43.9)	77 (43.5)	66 (44.3)	
Employed	183 (56.1)	100 (56.5)	83 (55.7)	
Cancer type				0.005
Breast	105 (32.2)	40 (22.6)	65 (43.6)	
Stomach	75 (23.0)	30 (16.9)	19 (12.8)	
Colorectal	49 (15.0)	48 (27.1)	27 (18.1)	
Lung	41 (12.6)	25 (14.1)	16 (10.7)	
Cervical or uterine	31 (9.5)	15 (8.5)	10 (6.7)	
Liver	25 (7.7)	19 (10.7)	12 (8.1)	
Cancer stage				0.140
0	24 (7.4)	17 (9.6)	7 (4.7)	
I	132 (40.5)	68 (38.4)	64 (43.0)	
II	78 (23.9)	38 (21.5)	40 (26.8)	
III	73 (22.4)	40 (22.6)	33 (22.1)	
Unknown	19 (5.8)	14 (7.9)	5 (3.4)	
Cancer treatment				
Surgery (yes)	308 (94.5)	168 (94.9)	140 (94.0)	0.894
Chemotherapy (yes)	161 (49.4)	83 (46.9)	78 (52.3)	0.384
Radiotherapy (yes)	129 (39.6)	58 (32.8)	71 (47.7)	0.009
Hormone therapy (yes)	60 (18.4)	22 (12.4)	38 (25.5)	0.004
Procedure (yes)	8 (2.5)	3 (1.7)	5 (3.4)	0.544
Time since diagnosis (yr)				0.651
1.0 to <4.5	174 (53.4)	97 (54.8)	77 (51.7)	
4.5 to ≤10	152 (46.6)	80 (45.2)	72 (48.3)	
FCR total score (range, 4–16)	9.9±3.3	7.4±1.4	12.9±2.1	<0.001

Values are presented as mean±standard deviation or number (%). FCR was assessed using four items addressing concerns about (1) routine check-ups, (2) the development of a second primary cancer, (3) recurrence of the original cancer, and (4) cancer metastasis. Each item was rated on a 4-point Likert scale (1="not at all" to 4="very much"). High FCR was defined as endorsement of a score ≥3 ("quite a bit" or "very much") on at least two of the four items, reflecting clinically meaningful levels of concern across multiple domains.

FCR, fear of cancer recurrence.

[a]Monthly household income was divided into quartiles.

Table 2. Comparison of health-related quality of life and psychological symptoms according to FCR status

	Range	Overall (n=326)	Low FCR (n=177)	High FCR (n=149)	Effect[e] (β or OR [95% CI])	*P*-value
EQ-5D						
Mobility	0–1	49 (15.0)	21 (11.9)	28 (18.8)	2.03 (1.03 to 3.99)	0.041
Selfcare	0–1	18 (5.5)	9 (5.1)	9 (6.0)	1.20 (0.45 to 3.25)	0.716
Usual activity	0–1	75 (23.0)	29 (16.4)	46 (30.9)	2.34 (1.33 to 4.11)	0.003
Pain/discomfort	0–1	166 (50.9)	72 (40.7)	94 (63.1)	2.31 (1.44 to 3.71)	<0.001[f]
Anxiety/depression	0–1	164 (50.3)	63 (35.6)	101 (67.8)	4.26 (2.58 to 7.02)	<0.001[f]
EQ-VAS[a]	0–100	70.3±17.6	74.3±16.2	65.6±18.0	−8.66 (−12.55 to −4.77)	<0.001[f]
EORTC QLQ-C30[b]						
GHS/QoL[a]	0–100	65.0±19.5	70.2±17.5	58.9±19.9	−10.56 (−14.82 to −6.29)	<0.001[f]
Functional scales[a]						
Physical functioning	0–100	77.7±17.2	81.4±15.5	73.3±18.0	−7.04 (−10.80 to −3.27)	<0.001[f]
Role functioning	0–100	77.6±24.1	82.1±23.7	72.1±23.6	−9.16 (−14.52 to −3.80)	<0.001[f]
Emotional functioning	0–100	72.4±21.7	79.3±18.0	64.2±22.9	−12.86 (−17.39 to −8.33)	<0.001[f]
Cognitive functioning	0–100	74.2±21.1	80.0±15.7	67.3±24.4	−9.82 (−14.24 to −5.40)	<0.001[f]
Social functioning	0–100	74.3±25.5	81.3±21.5	66.0±27.4	−13.41 (−18.89 to −7.93)	<0.001[f]
Symptom scales[c]						
Fatigue	0–100	38.3±23.0	32.5±20.8	45.3±23.6	11.11 (6.10 to 16.13)	<0.001[f]
Nausea and vomiting	0–100	11.5±17.3	9.4±16.9	13.9±17.6	4.22 (0.27 to 8.16)	0.036
Pain	0–100	21.8±23.7	15.9±21.3	28.7±24.6	9.85 (4.78 to 14.91)	<0.001[f]
Dyspnea	0–100	20.9±24.7	18.1±23.6	24.2±25.7	5.36 (−0.27 to 10.98)	0.062
Insomnia	0–100	33.7±31.5	25.4±27.8	43.6±32.9	14.51 (7.85 to 21.16)	<0.001[f]
Appetite loss	0–100	16.0±22.6	13.4±21.4	19.0±23.7	6.01 (0.84 to 11.17)	0.023
Constipation	0–100	25.1±27.2	22.6±25.2	28.0±29.3	5.44 (−0.84 to 11.72)	0.089
Diarrhea	0–100	20.9±24.8	20.7±24.8	21.0±24.9	3.23 (−2.14 to 8.59)	0.238
Financial difficulties	0–100	25.9±29.4	17.1±22.8	36.2±32.9	17.32 (11.19 to 23.44)	<0.001[f]
PHQ-9[d]	0–27	5.4±5.3	3.8±3.9	7.3±6.0	3.10 (1.99 to 4.22)	<0.001[f]
GAD-7[d]	0–21	3.9±3.9	2.5±3.0	5.6±4.2	2.70 (1.89 to 3.52)	<0.001[f]

Values are presented as number (%) or mean±standard deviation unless stated otherwise.
CI, confidence interval; EORTC QLQ-C30, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30; EQ-VAS, EuroQol Visual Analogue Scale; EQ-5D, EuroQol 5-Dimension Questionnaire; FCR, fear of cancer recurrence; GAD-7, 7-item Generalized Anxiety Disorder scale; GHS/QoL, Global Health Status/Quality of Life; OR, odds ratio; PHQ-9, 9-item Patient Health Questionnaire.
[a]Higher scores indicate better health status or quality of life. [b]All scores were linearly transformed to a 0–100 scale according to the EORTC QLQ-C30 scoring manual. [c]Higher scores indicate greater symptom burden. [d]Higher scores indicate greater psychological symptom severity (depression or anxiety). [e]Estimated using linear regression or logistic regression analysis after adjusting for age, sex, cancer type, cancer stage, comorbidity, time since cancer diagnosis, education level, monthly household income and job status. [f]Bonferroni correction was applied for multiple comparisons with a significance threshold of *P*<0.0024.

high FCR group (β=−8.66, 95% CI: −12.55 to −4.77; *P*<0.001).

In the EORTC QLQ-C30 domains, the high FCR group reported significantly lower scores in all functional scales, including physical (β=−7.04; *P*<0.001), role (β=−9.16; *P*<0.001), emotional (β=−12.86; *P*<0.001), cognitive (β=−9.82; *P*<0.001), and social functioning (β=−13.41; *P*<0.001), as well as in GHS/QoL (β=−10.56; *P*<0.001). Regarding symptom burden, participants with high FCR had significantly higher levels of fatigue (β=11.11; *P*<0.001), pain (β=9.85; *P*<0.001), insomnia (β=14.51; *P*<0.001), and financial difficulties (β=17.32; *P*<0.001). Although nausea/vomiting and appetite loss were more prevalent in the high FCR group (*P*=0.036 and *P*=0.023, respectively), they did not meet the Bonferroni-adjusted significance threshold (*P*<0.0024).

Psychological symptoms were also markedly elevated among participants with high FCR. Both PHQ-9 (β=3.10, 95% CI: 1.99–4.22; *P*<0.001) and GAD-7 scores (β=2.70, 95% CI: 1.89–3.52; *P*<0.001) were significantly higher compared to the low FCR group.

Health-related behaviors according to fear of cancer recurrence

Table 3 presents both the unadjusted prevalence of health-related behaviors in the low- and high-FCR groups and the adjusted associations derived from multivariable logistic regression. In chi-square analyses, no statistically significant differences were observed between groups for any change-based or status-based behavior. After adjusting for age, sex, cancer type, cancer stage,

 https://doi.org/10.15384/kjhp.2025.00122

Table 3. Comparison of health-related behaviors according to FCR status

	Low FCR (n=177)	High FCR (n=149)	*P*-value	OR (95% CI)[a]	*P*-value
Change-based behaviors					
Weight control effort	139 (78.5)	121 (81.2)	0.645	1.00 (0.65–1.53)	0.998
Change in alcohol consumption					
No change	43 (24.3)	27 (18.1)	0.400	Reference	0.265
Abstinence after cancer diagnosis	72 (40.7)	66 (44.3)	0.400	1.41 (0.75–2.63)	0.287
Lifetime non-drinker	62 (35.0)	56 (37.6)	0.400	1.45 (0.75–2.77)	0.266
Change in smoking status					
Continued or reduced smoking	12 (6.8)	9 (6.0)	0.702	Reference	0.427
Smoking cessation after cancer diagnosis	43 (24.3)	31 (20.8)	0.702	0.97 (0.36–2.62)	0.954
Lifetime non-smoker	122 (68.9)	109 (73.2)	0.702	1.18 (0.48–2.91)	0.719
Status-based behaviors					
General health check-up	153 (86.4)	130 (87.2)	0.960	0.97 (0.61–1.56)	0.902
Cancer screening	97 (54.8)	96 (64.4)	0.099	1.21 (0.76–1.91)	0.418
Pneumococcal vaccination	69 (39.0)	51 (34.2)	0.440	1.00 (0.64–1.56)	0.985
Herpes zoster vaccination	61 (34.5)	49 (32.9)	0.855	0.97 (0.62–1.52)	0.902
Seasonal influenza vaccination	70 (39.5)	65 (43.6)	0.528	1.02 (0.66–1.58)	0.933
Walking ≥5 day/wk	126 (71.2)	105 (70.5)	0.984	0.97 (0.64–1.47)	0.897
Strength training ≥2 day/wk	57 (32.2)	38 (25.5)	0.229	1.02 (0.67–1.56)	0.936
CAM use	35 (19.8)	21 (14.1)	0.521	0.97 (0.55–1.71)	0.907
Nutritional supplement use	57 (32.2)	105 (70.5)	0.856	0.99 (0.60–1.65)	0.975

Values are presented as number (%).
CAM, complementary and alternative medicine; CI, confidence interval; FCR, fear of cancer recurrence; OR, odds ratio.
[a]Estimated using logistic regression analysis after adjusting for age, sex, cancer type, cancer stage, comorbidity, time since cancer diagnosis, education level, monthly household income and job status.

comorbidity, time since diagnosis, educational level, household income, and employment status, none of the health-related behaviors remained significantly associated with high FCR. For example, the adjusted OR for general health check-up was 0.97 (95% CI: 0.61–1.56; *P*=0.902), for cancer screening 1.21 (95% CI: 0.76–1.91; *P*=0.418), and for CAM use 0.97 (95% CI: 0.55–1.71; *P*=0.907).

DISCUSSION

This study examined how FCR is associated with HRQoL, psychological symptoms, and health-related behaviors among cancer survivors. While high FCR was clearly associated with greater psychological distress and significantly poorer HRQoL across multiple domains, it did not correspond to increased engagement in health behaviors such as screening, physical activity, or vaccination. These findings suggest a divergence between emotional burden and behavioral response, underscoring the need for integrated survivorship strategies that address both psychosocial and behavioral dimensions.

Consistent with the present study, prior research has shown that high FCR are significantly associated with diminished HRQoL and heightened psychological distress. Previous study of colorectal cancer survivors reported that higher FCR levels were correlated with lower functional scores on the EORTC QLQ-C30 and increased symptoms of anxiety and depression [24]. Similarly, research involving Korean stomach cancer survivor populations has indicated that FCR in stomach cancer survivors was associated with social, psychological, and HRQoL factors [5]. Consistent findings have also been observed among patients with advanced cancer, wherein high FCR was associated with substantial psychosocial burden [25]. The present study aligns with this body of evidence, revealing that individuals with high FCR exhibited significantly poorer scores across all functional domains of HRQoL—including physical, role, emotional, cognitive, and social functioning—as well as higher levels of symptom burden, particularly in relation to fatigue, insomnia, pain, and financial difficulties.

In contrast to symptoms such as fatigue, pain, insomnia, and financial difficulties, gastrointestinal (GI) symptoms—including nausea/vomiting, appetite loss, dyspnea, constipation, and diarrhea—demonstrated no statistically significant association with FCR (*P*>0.0023). GI symptoms are often perceived as non-specific or treatment-related sequela rather than indicators of recurrence, particularly among non-GI cancers [5,24]. Moreover, FCR is fundamentally a cognitive-emotional construct centered

on the concern that cancer may return; it is more tightly tied to psychological distress and diminished functional domains than to isolated somatic complaints [3,4]. These findings are consistent with emerging evidence indicating that FCR correlates more strongly with fatigue, pain, and anxiety than with GI symptoms. Such a discrepancy emphasizes the need to consider both the interpretation and perceived salience of symptoms in understanding the psychological correlates of FCR.

Notably, multiple measures assessing psychological symptoms were included in this study, namely the EQ-5D anxiety/depression item, PHQ-9, and GAD-7. While each assesses facets of psychological well-being, they differ in both conceptual scope and psychometric design. The EQ-5D offers a singular, general indicator of emotional status within the broader context of HRQoL, whereas the PHQ-9 and GAD-7 are standardized multi-item instruments specifically developed to evaluate the severity of depressive and anxiety symptoms, respectively. The concurrent use of these measures permits a complementary assessment of emotional functioning, capturing both general distress and disorder-specific symptomatology.

Given that high FCR was not associated with increased engagement in screening, vaccination, weight control, alcohol use, smoking, physical activity, or supplement intake, several interpretative considerations warrant discussion. Contrary to the "teachable moment" hypothesis, which posits cancer experience and related fear motivate preventive action, findings suggest emotional distress alone may be insufficient to drive behavioral change [26,27]. This highlights the need for interventions combining psychosocial support with structured behavior-change strategies, rather than relying solely on psychological or educational approaches [28,29]. The conceptual distinction between psychological distress and behavioral adherence underscores the value of integrated multidisciplinary survivorship care that addresses both domains. CAM use and supplement intake were not evidence-based behaviors, but reflected broader coping responses to FCR. Although not medically validated, these behaviors may reflect emotionally driven adaptations offering insight into how cancer fear manifests behaviorally [30-32]. Moreover, recent evidence suggests FCR may indirectly affect behavior through unmet supportive care needs linked to lower screening participation, emphasizing the importance of addressing structural and psychosocial barriers alongside distress [9]. Finally, longitudinal research is needed to clarify how changes in FCR relate to health behaviors and whether individuals with persistently high FCR respond better to tailored interventions, providing more nuanced survivorship strategies [33,34].

In this study, FCR was not associated with cancer stage or time since diagnosis. While this may partly reflect limited variability, stage IV cases were excluded, and over half the participants were long-term survivors, possibly due to analytical constraints, as the time since diagnosis was dichotomized at 4.5 years. However, previous studies have reported high FCR in early stage [35,36] and long-term survivors [37,38], suggesting FCR is not solely determined by clinical status or time. It reflects the complex interplay of clinical and psychosocial factors, including cancer type, treatment history, and perceived support. Longitudinal studies are needed to clarify these associations with long-term survival, suggesting clinical indicators alone may be insufficient.

This study has several limitations. First, its cross-sectional design limits causal inferences. Although high FCR was associated with poor HRQoL and psychological distress, reverse causality is plausible; emotional distress may heighten FCR rather than result from it. Similarly, the null association with preventive behaviors should be interpreted cautiously, as distress may hinder engagement. These limitations highlight the need for longitudinal studies to clarify the directionality. Second, most variables were assessed via self-reports, potentially introducing recall and reporting biases. Social desirability may have influenced responses on psychological symptoms and health behaviors, possibly affecting the associations. Third, as a pilot study, the sample was relatively small, which may limit statistical power and generalizability. Fourth, FCR was assessed with four items on follow-up, secondary cancer, recurrence, and metastasis. High FCR was defined as a score ≥3 on at least two items, based on prior studies [39-41]. This approach balances clinical relevance and brevity, capturing key domains of recurrence-related fear while reducing respondent burden. Although not externally validated, it was deemed appropriate for a pilot study with a moderate sample size. Further refinement and psychometric validation are planned from an upcoming nationwide survivor survey. Fifth, inconsistent timeframes in assessing health-related behaviors may have affected the interpretation. Some behaviors (e.g., smoking, alcohol use, and weight control) were measured as post-diagnosis changes, whereas others (e.g., vaccination, physical activity, CAM use, and supplement intake) reflected current status. This heterogeneity complicates whether FCR affects initiation or maintenance of behaviors. Null findings should be interpreted cautiously; future studies should adopt standardized timeframes or longitudinal designs for clar-

ification.

Despite these limitations, this study had several strengths. It provides an integrated perspective on the relationships between FCR, HRQoL, psychological distress, and health-related behaviors in a diverse cohort of cancer survivors. Findings showed high FCR was strongly associated with poorer HRQoL and greater psychological burden, yet did not lead to increased participation in health-promoting behaviors, such as screening, vaccination, or physical activity. This discrepancy challenges the assumption that emotional distress—particularly fear—naturally motivates positive behavioral changes. Clinically, the results underscore the need for multidisciplinary survivorship programs addressing psychological and behavioral dimensions rather than relying on FCR alone as a driver of health behavior. Tailored interventions integrating emotional support with structured behavioral-change strategies may be essential for promoting long-term health among cancer survivors.

ORCID

Seo-Hee CHOI, https://orcid.org/0009-0001-5033-3669
Yeol KIM, https://orcid.org/0000-0003-1142-1559
Yu-Ri CHOE, https://orcid.org/0000-0002-4557-2323

AUTHOR CONTRIBUTIONS

Dr. Yu Ri CHOE 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 curation: YK and YRC. Formal analysis: SHC and YRC. Investigation: SHC. Methodology: YK and YRC. Project administration: YK and YRC. Software: SHC and YRC. Supervision: YRC. Validation: YK and YRC. Visualization: SHC and YRC. Writing–original draft: SHC. Writing–review & editing: SHC and YRC.

CONFLICTS OF INTEREST

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

FUNDING

This study was funded by a grant from the National Cancer Center of the Republic of Korea (NCC-2311470).

DATA AVAILABILITY

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

REFERENCES

1. Korea Central Cancer Registry. 2022 National Cancer Registration Statistics [Internet]. National Cancer Information Center; 2024 [cited Jul 31, 2025]. Available from: https://www.cancer.go.kr/lay1/bbs/S1T674C816/B/61/view.do?article_seq=85141&cpage=&rows=&condition=&keyword=&rn=1
2. Simard S, Thewes B, Humphris G, Dixon M, Hayden C, Mireskandari S, et al. Fear of cancer recurrence in adult cancer survivors: a systematic review of quantitative studies. J Cancer Surviv 2013;7(3):300-22.
3. Almeida SN, Elliott R, Silva ER, Sales CMD. Fear of cancer recurrence: a qualitative systematic review and meta-synthesis of patients' experiences. Clin Psychol Rev 2019;68:13-24.
4. Maheu C, Singh M, Tock WL, Eyrenci A, Galica J, Hébert M, et al. Fear of cancer recurrence, health anxiety, worry, and uncertainty: a scoping review about their conceptualization and measurement within breast cancer survivorship research. Front Psychol 2021;12:644932.
5. Shin J, Shin DW, Lee J, Hwang J, Lee JE, Cho B, et al. Exploring socio-demographic, physical, psychological, and quality of life-related factors related with fear of cancer recurrence in stomach cancer survivors: a cross-sectional study. BMC Cancer 2022;22(1):414.
6. Thewes B, Butow P, Bell ML, Beith J, Stuart-Harris R, Grossi M, et al. Fear of cancer recurrence in young women with a history of early-stage breast cancer: a cross-sectional study of prevalence and association with health behaviours. Support Care Cancer 2012;20(11):2651-9.
7. Hall DL, Jimenez RB, Perez GK, Rabin J, Quain K, Yeh GY, et al. Fear of cancer recurrence: a model examination of physical symptoms, emotional distress, and health behavior change. J Oncol Pract 2019;15(9):e787-97.
8. Fisher A, Beeken RJ, Heinrich M, Williams K, Wardle J. Health behaviours and fear of cancer recurrence in 10 969 colorectal cancer (CRC) patients. Psychooncology 2016;25(12):1434-40.
9. Kim ML, Kim Y, Choe YR. Unmet needs mediate the impact of fear of cancer recurrence on screening participation among can-

cer survivors: a cross-sectional study. Healthcare (Basel) 2025; 13(10):1184.
10. Mutsaers B, Jones G, Rutkowski N, Tomei C, Séguin Leclair C, Petricone-Westwood D, et al. When fear of cancer recurrence becomes a clinical issue: a qualitative analysis of features associated with clinical fear of cancer recurrence. Support Care Cancer 2016;24(10):4207-18.
11. Smith AB, Costa D, Galica J, Lebel S, Tauber N, van Helmondt SJ, et al. Spotlight on the fear of cancer recurrence inventory (FCRI). Psychol Res Behav Manag 2020;13:1257-68.
12. EuroQol Group. EuroQol: a new facility for the measurement of health-related quality of life. Health Policy 1990;16(3):199-208.
13. Aaronson NK, Ahmedzai S, Bergman B, Bullinger M, Cull A, Duez NJ, et al. The European Organization for Research and Treatment of Cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology. J Natl Cancer Inst 1993;85(5):365-76.
14. Yun YH, Park YS, Lee ES, Bang SM, Heo DS, Park SY, et al. Validation of the Korean version of the EORTC QLQ-C30. Qual Life Res 2004;13(4):863-8.
15. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med 2001; 16(9):606-13.
16. Park SJ, Choi HR, Choi JH, Kim KW, Hong JP. Reliability and validity of the Korean version of the Patient Health Questionnaire-9 (PHQ-9). Anxiety Mood 2010;6(2):119-24.
17. Spitzer RL, Kroenke K, Williams JB, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch Intern Med 2006;166(10):1092-7.
18. Seo JG, Park SP. Validation of the Generalized Anxiety Disorder-7 (GAD-7) and GAD-2 in patients with migraine. J Headache Pain 2015;16:97.
19. World Health Organization (WHO). WHO guidelines on physical activity and sedentary behaviour. WHO; 2020.
20. Python Software Foundation. Python language reference, version 3.11.4. Python Software Foundation; 2023.
21. Seabold S, Perktold J. Statsmodels: econometric and statistical modeling with python. SciPy Proceedings; 2010. p. 92-6.
22. McKinney W. Data structures for statistical computing in Python. SciPy Proceedings; 2010. p. 56-61.
23. Pedregosa F, Varoquaux G, Gramfort A, Michel V, Thirion B, Grisel O, et al. Scikit-learn: machine learning in Python. J Mach Learn Res 2011;12(85):2825-30.
24. Lyhne JD, Jensen LH, Fink P, Timm S, Frostholm L, Smith AB. Fear of cancer recurrence in long-term colorectal cancer survivors: a nationwide cross-sectional study J Cancer Surviv [Epub ahead of print] 2025. doi: 10.1007/s11764-025-01746-z
25. Calderon C, Gustems M, Galán-Moral R, Muñoz-Sánchez MM, Ostios-García L, Jiménez-Fonseca P. Fear of recurrence in advanced cancer patients: sociodemographic, clinical, and psychological correlates. Cancers (Basel) 2024;16(5):909.
26. Reed SC, Berrett-Abebe J, Whitney RL, Sarkar S, Bell JF. Relationships between fear of cancer recurrence, anxiety and worry, and health behaviors and health service use: a systematic review. J Psychosoc Oncol Res Pract 2021;3(4):e064.
27. Tollosa DN, Holliday E, Hure A, Tavener M, James EL. Multiple health behaviors before and after a cancer diagnosis among women: a repeated cross-sectional analysis over 15 years. Cancer Med 2020;9(9):3224-33.
28. Tauber NM, O'Toole MS, Dinkel A, Galica J, Humphris G, Lebel S, et al. Effect of psychological intervention on fear of cancer recurrence: a systematic review and meta-analysis. J Clin Oncol 2019;37(31):2899-915.
29. Butow PN, Turner J, Gilchrist J, Sharpe L, Smith AB, Fardell JE, et al. Randomized trial of ConquerFear: a novel, theoretically based psychosocial intervention for fear of cancer recurrence. J Clin Oncol 2017;35(36):4066-77.
30. Dawczak-Dębicka A, Kufel-Grabowska J, Bartoszkiewicz M, Perdyan A, Jassem J. Complementary and alternative therapies in oncology. Int J Environ Res Public Health 2022;19(9):5071.
31. Judson PL, Abdallah R, Xiong Y, Ebbert J, Lancaster JM. Complementary and alternative medicine use in individuals presenting for care at a comprehensive cancer center. Integr Cancer Ther 2017;16(1):96-103.
32. Kim EEH, Kang J. Association between complementary and alternative medicine use and fear of cancer recurrence among breast cancer survivors. Korean J Fam Med 2022;43(2):132-40.
33. Séguin Leclair C, Lebel S, Westmaas JL. The relationship between fear of cancer recurrence and health behaviors: a nationwide longitudinal study of cancer survivors. Health Psychol 2019;38(7):596-605.
34. van Helmondt SJ, Lodder P, van Woezik R, de Vries J, van der Lee ML. CBT-based online self-help training to reduce fear and distress after cancer (CAREST randomized trial): 24 months follow-up using latent growth models and latent class analysis. Ann Behav Med 2023;57(9):787-99.
35. Aguiar-Ibáñez R, Mbous YPV, Sharma S, Chawla E, Pawar D. Clinical, humanistic and economic burden associated with recurrence among patients with early-stage cancers: a systematic literature review. Front Oncol 2025;15:1575813.

36. Shachar EK, Connor S, Kwan L, Chen J, Rodriguez VE, Litwin MS. Fear of recurrence among uninsured and underrepresented prostate cancer survivors of the Men's Health Study. J Clin Oncol 2025;43(16S):e17157.
37. Tran TXM, Jung SY, Lee EG, Cho H, Kim NY, Shim S, et al. Fear of cancer recurrence and its negative impact on health-related quality of life in long-term breast cancer survivors. Cancer Res Treat 2022;54(4):1065-73.
38. Meissner VH, Olze L, Schiele S, Ankerst DP, Jahnen M, Gschwend JE, et al. Fear of cancer recurrence and disease progression in long-term prostate cancer survivors after radical prostatectomy: a longitudinal study. Cancer 2021;127(22):4287-95.
39. Hanprasertpong J, Geater A, Jiamset I, Padungkul L, Hirunkajonpan P, Songhong N. Fear of cancer recurrence and its predictors among cervical cancer survivors. J Gynecol Oncol 2017;28(6):e72.
40. Custers JA, Kwakkenbos L, van der Graaf WT, Prins JB, Gielissen MF, Thewes B. Not as stable as we think: a descriptive study of 12 monthly assessments of fear of cancer recurrence among curatively-treated breast cancer survivors 0-5 years after surgery. Front Psychol 2020;11:580979.
41. Torbit L. Fear of cancer recurrence: testing a cognitive formulation across time in women with ovarian cancer [dissertation]. Ryerson University; 2018. English.

Erratum

Korean J Health Promot 2025;25(3):110-110
pISSN: 2234-2141 • eISSN: 2093-5676
https://doi.org/10.15384/kjhp.2024.00101.e

Korean Journal of Health Promotion
KJHP

Correction to "Association between Caffeinated Beverages Consumption and Sleep Quality of Urban Workers"

Byung Il HWANG, MPH[1,2], Ji-Young LEE, PhD[1,3], Hyeon Jeong LIM, MPH[1,3], Ryun HUH[1,3], Mikyung RYU, PhD[4], Sun Ha JEE, PhD[1,3], and Heejin KIMM, MD, MPH, PhD[1,3]

[1]Department of Epidemiology and Health Promotion, Graduate School of Public Health, Yonsei University, Seoul, Korea
[2]Department of Medical Sciences, Graduate School of Ajou University, Suwon, Korea
[3]Institute for Health Promotion, Graduate School of Public Health, Yonsei University, Seoul, Korea
[4]Institute on Aging, Ajou University Medical Center, Suwon, Korea

The authors would like to correct the errors in the publication of the original article (Korean J Health Promot 2025;25(1):9-19; https://doi.org/10.15384/kjhp.2024.00101). The first author's affiliation was corrected to "Department of Epidemiology and Health Promotion, Graduate School of Public Health, Yonsei University" and "Department of Medical Sciences, Graduate School of Ajou University", which also resulted in a change to the overall affiliation numbering.

The corrected details are given below for your reading.

[1]Department of Epidemiology and Health Promotion, Graduate School of Public Health, Yonsei University, Seoul, Korea
[2]Department of Medical Sciences, Graduate School of Ajou University, Suwon, Korea
[3]Institute for Health Promotion, Graduate School of Public Health, Yonsei University, Seoul, Korea
[4]Institute on Aging, Ajou University Medical Center, Suwon, Korea

The authors apologize for any confusion or inconvenience this may have caused and appreciate your understanding.

Instructions for Authors

Korean Journal of Health Promotion
KJHP

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)
Enacted in March, 2001

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.

The manuscript should be prepared according to the "ICMJE Recommendations for the Conduct, Reporting, and Publication of Scholarly Work in Medical Journals" (2023) (https://www.icmje.org/recommendations/). Matters unspecified in this document will follow the general principles of writing and editing of biomedical publication.

1. MANUSCRIPT SUBMISSION

All manuscripts must be submitted online via the online manuscript submission and review system for *KJHP* (https://submit.e-kjhp.org/)

Editor-in-Chief
Prof. Seung-Kwon MYUNG, MD, PhD
Department of Family Medicine, National Cancer Center
Department of Public Health & AI, National Cancer Center Graduate School of Cancer Science and Policy

Editorial Office
Department of Family Medicine, Asan Medical Center, 88 Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea

Tel: +82-2-3010-3820
Tel: +82-2-3010-3815
E-mail: kshpdp@amc.seoul.kr
For manuscript submission, please visit https://submit.e-kjhp.org/

2. CATEGORIES OF ARTICLES

KJHP publishes original articles, review articles (narrative reviews and systematic reviews without meta-analyses), letters to the editor, letters in reply, editorials, and viewpoints.

*Summary of Article Types

Article Type	Description	Requirements
Original Article	Cross-sectional study Case-control study Cohort study Clinical trial Meta-analysis Qualitative research Survey research Other observational or original research	• ≤3,500 words • ≤10 tables and/or figures • Structured abstract, ≤300 words • Key Points: Question, Findings, and Meaning, ≤100 words • ≤50 references • Title Page including Key Points • Manuscript text: Title, Abstract, Keywords, Introduction, Methods, Results, Discussion, Acknowledgments, Author Contributions, References, Figure Legends, and Tables • Figures uploaded separately • Cover letter
Review Article	Narrative review (general review) Systematic review without meta-analysis	• ≤3,500 words • ≤10 tables and/or figures • Unstructured abstract for narrative review and structured abstract for systematic review, ≤300 word • Key Points: Question, Findings, and Meaning, ≤100 words • ≤50 references • Subtitle should be 'A Narrative Review or A Systematic Review' • Title Page including Key Points • Manuscript text: Title, Abstract, Keywords, Introduction, Methods, Results, Discussion, Acknowledgments, Author Contributions, References, Figure Legends, and Tables • Figures uploaded separately • Cover letter

Letter to the Editor	Letters discussing a recent article in this journal should be submitted within 4 weeks of the article's publication in print.	• ≤1,000 words • ≤5 references • ≤3 authors • No abstract required
Letter in Reply	Replies by authors of original articles to letters from readers.	• ≤1,000 words • ≤5 references • ≤3 authors • No abstract required
Editorial	An opinion or a view of a member of the editorial board or any senior or reputed faculty written in a journal	• ≤1,000 words • 1 author • No abstract required
Viewpoint	A short opinion which focuses on some of the key topics, issues, or developments in health promotion and disease prevention	• ≤1,500 words • ≤10 references • ≤3 authors • Unstructured abstract, ≤150 words

3. MANUSCRIPT PREPARATION AND SUBMISSION REQUIREMENTS

1) Original Article and Review Article

Manuscript Style

Manuscripts should be prepared in accordance with the ICMJE Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals (https://icmje.org/recommendations) and written in proper and clear English.

Manuscript Components

The authors should prepare at least 3 files such as a cover letter, title page (with author details), manuscript text (no author identifiers), and as appropriate, figures. Start each of these sections on a new page, numbered consecutively. Tables should be included in the manuscript text, and figures should be uploaded as separate files (individual or combined figure files) and not included in the manuscript text. Also, a copyright transfer form should be signed by a corresponding author on behalf of all authors and submitted (a link for downloading the form should be inserted here).

Manuscript File Formats

For submission and review, please submit the manuscript as a Word document (e.g., Microsoft Office Word). Do not submit your manuscript in PDF format. For submission of drawings, photos, graphs, or combined figures, PPT and PDF formats are acceptable.

Use 12-point font size, double-space text, and leave both margins justified.

Cover Letter (≤200 words)

Prepare a cover letter. This is a great opportunity to highlight to the journal editor what makes your research new and important. The cover letter should explain why your work is perfect for the *KJHP* and why it will be of interest to our readers. The cover letter should have a maximum of 200 words and include complete contact information for the corresponding author (affiliation, postal/mail address, email address, and telephone number) and whether the authors have published, posted, or submitted any related papers from the same study.

Title Page (≤300 words)

The title page should include an article title; running head; type of study design; the full names, academic degrees, and affiliations of all authors (if an author's affiliation has changed since the work was done, the new affiliation also should be listed); name and complete contact information for corresponding author; word count of the abstract and manuscript text (not including title, abstract, acknowledgment, references, tables, and figure legends); total number of tables; total number of figures; number of references; funding sources; declaration of conflict of interests; and key points.

Provide ORCID IDs for all authors. Titles should be concise, specific, and informative. Limit the length of titles to 30 words. A running head or running title is a short version of the article title, which should consist of no more than 10 words.

The key points is a short structured summary of the findings of your manuscript (required only for research and review manuscripts), following 3 key points: Question, Findings, and Meaning. Limit to 100 words or less.

<Example>

Key Points

Question: Is intermittent high-dose vitamin D supplementation effective in the prevention of falls and fractures?

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.

Meaning: Our findings support that intermittent high-dose vitamin D supplementation for the prevention of falls and fractures should be discouraged.

Manuscript Text

A manuscript text should be prepared in the following sequence: title, abstract, keywords, introduction, methods, results, discussion, acknowledgments, author contributions, references, figure legends, and tables. The full text containing introduction, methods, results, and discussion should not exceed 3500 words.

Title (≤30 words)

An article title should be inserted at the top of the first page of the manuscript text file.

Abstract (≤300 words) and Keywords

An abstract should briefly summarize the content of the manuscript in a structured format for a systematic review and a unstructured format for a narrative review and should not exceed 300 words. The structured abstract should be structured as follows: Background, Methods, Results, and Conclusions. Three to six keywords should be listed after the abstract.

Introduction (≤500 words)

Desribe a brief background and purpose of the study and elaborate on its significance. Summarize the rationale and include only strictly pertinent references.

Methods (≤1,000 words)

Identify the methods. Describe study participants, controls, or laboratory animals clearly and identify procedures in sufficient details to allow other researchers to reproduce the results. Identify the apparatus or reagents used by giving the product's name, followed by the name of the product company in parentheses. Give references to established methods, including statistical methods. Provide references and brief descriptions for methods that have been published but are not well known or substantially modified, and give reasons for using them and evaluate their limitations.

Describe statistical methods with enough details to verify the reported results. Whenever possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Avoid relying solely on statistical hypothesis testing, such as the use of *P*-values, which fails to convey important quantitative information. When the results of the data in the text are given, provide details specifically in terms of average, proportion, or correlation coefficient to describe the difference between study groups or the relevant size and direction of variables. Specify statistical software used for statistical analysis.

Results (≤1,000 words)

Present the findings and results in logical sequence in the text, tables, and figures. Do not repeat in the text all data in the tables or figures, but describe important points and trends.

Discussion (≤1,000 words)

Emphasize the new and important aspects of the study and the conclusions that follow from them. Do not repeat in detail data or other materials given in the Introduction or the Results section. Include the implications of the findings and their limitations, including implications for future research. Link the conclusions with the purpose of the study by discussing and comparing the relevant results of other research data. Avoid unqualified statements and conclusions not completely supported by the data. Propose new hypotheses when warranted and recommendations, when appropriate, may be included.

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).

The submitting author is responsible for completing this information at submission, and it is expected that all authors will have reviewed, discussed, and agreed to their individual contributions ahead of this time.

<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.
Writing - review & editing: SKM, SWO, and YJC.

References

Authors are responsible for the accuracy and completeness of their references and for correct text citation. In the text, references should be cited with Arabic numerals in brackets, numbered in the order cited. In the references section, the references should be numbered and listed in order of appearance in the text. If there is more than one reference cited coincidentally, then a comma separates the numbers and only the last number is closed with a right bracket. If a consecutive number of references is cited together, then a hyphen '-' should be used between the first and the last number.

List all authors and/or editors up to 6; if more than 6, list the first 6 followed by "et al." Journal references should include the issue number in parentheses after the volume number. Reference styles are as follows:

Journal articles

Name(s) of author(s). Title of article. Abbreviated journal name. Year of publication;Volume number (Issue number):Page numbers.

<Example> Myung SK, Oh SW, Choi YJ. How to use the KJHP's online manuscript submission system. Korean J Helath Promot 2024;24(1):123-7.

Books

Name(s) of author(s). Title of publication: subtitle. Edition. Publisher; Year of publication. p. Page numbers.
Name(s) of the chaptor's author(s). Title of chapter. In: Name(s) of the editor(s). Title of publication. Edition. Publisher; Year of publication. p. Page numbers.

Conference proceedings

Name(s) of author(s). Title of conference proceedings. Title of conference; Date of conference; Place of conference. Publisher; Year of publication.

Dissertations

Name of author. Title of thesis [dissertation]. Name of university; Year when degree was given. Language of dissertation.

Journal articles in electronic media

Name(s) of author(s). Title of article. Abbreviated title of journal [Internet]. Year of publication;Volume number (Issue number):Page numbers. Name of source URL:

Website or online sources

Name(s) of author(s). Title of web page [Internet]. Name of publisher; Year of publication [Date of citation]. Available from: available URL

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.

Names of Drugs, Devices, and Other Products

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.

Generic Names, Numbers, and Measurement Units

Personal, geographical and generic names must be written in original language, if possible, and numbers must be written in Arabic numerals. The measurement units such as length, height, mass and volume should be indicated in the metric system (meter, kilogram, liter etc). Temperature must be indicated in centigrade and blood pressure in mmHg. Units for blood and clinical laboratory test measurements should be expressed in the ordinary scale or by International Units (SI). A space is required between a measured value and its unit.

Supplementary Materials

Supplementary materials for online-only publication can be submitted, when there is insufficient space to include the materials in the manuscript text or figures. Because supplementary materials are not edited or formatted after publication, authors are responsible for the accuracy and presentation of these materials.

Reporting Sex/Gender

The term sex (male, female) should be used when reporting biological factors and gender (man, woman) should be used when reporting gender identity or psychosocial/cultural factors. The methods used to obtain information on sex, gender, or both (e.g., selfreported, investigator observed or classified, or laboratory test) should be explained in the Methods section. If only one sex is reported, or included in the study, the reason the other sex is not reported or included should be explained in the methods section, except for studies of diseases/disorders that only affect males (e.g., prostate disease) or females (e.g., ovarian disease). The sex distribution of study participants or samples should be reported in the results section, including for studies of humans, tissues, cells, or animals. Study results should disaggregate and report all outcome data by sex.

2) Letters to the Editor, Letters in Reply, Editorials, and Viewpoints

For preparation of Letters to the Editor, Letters in Reply, Editorials, and Viewpoints, refer to 'Summary of Article Types' in the categories of articles secction.

4. REPORTING GUIDELINES FOR SPECIFIC STUDY DESIGNS

Authors should be aware of the information that must be in-

cluded in the contents of the research according to the study design and must reflect them in their articles. Authors should refer to STROBE (http://www.strobe-statement.org) for observational studies, CONSORT (http://www.consort-statement.org) for randomized controlled trials, STARD (http://www.stard-statement.org) for studies of diagnostic accuracy, and PRISMA (https://www.equator-network.org/reporting-guidelines/prisma/) and MOOSE (https://www.equator-network.org/reporting-guidelines/meta-analysis-of-observational-studies-in-epidemiology-a-proposal-for-reporting-meta-analysis-of-observational-studies-in-epidemiology-moose-group/) for systematic reviews and meta-analyses.

5. MANUSCRIPT REVIEW AND PUBLICATION

Upon submission of a manuscript, the Editorial Committee will review the article whether its contents meet the objectives of the Journal, and the article can be rejected at this initial review process. The Editorial Committee will entrust two or more experts with review of articles and will decide their acceptance for publication with the help of experts' recommendations. Based on comments from reviewers and editors, authors may be asked to revise their manuscripts. Authors are required to submit a revised manuscript and a letter of explanation regarding how they have dealt with all comments and questions raised by reviewers and editors through the electronic submission system. The Editorial Committee or the editor-in-chief may entrust an statistical expert with statistical review of articles at the final stage of review, and ask authors to revise their manuscripts, if necessary.

The acceptance for publication is decided by the Editorial Committee after its thorough review process, and the editor-in-chief will deliver an official approval of acceptance for publication.

6. COPYRIGHT

Once publication of the manuscript has been decided, the copyright will be deferred to the Korean Society for Health Promotion and Disease Prevention, and the copyright of the manuscript published will belong to the Society. The Society is entitled to publish, distribute and print a manuscript in the journal or other media. As the time of submission, a corresponding author, on behalf of all authors, must sign and submit the 'copyright transfer agreement form', which must be downloaded from the homepage, to confirm that its copyright is assigned.

7. ETHICAL REGULATIONS

Review and handling procedures related to all research ethics including ethics regulations and plagiarism, duplicate publication, and research misconduct will be followed according to the 'Good Publication Practice Guidelines for Medical Journals (http://kamje.or.kr/)' stipulated by the Korean Association of Medical Journal Editors (KAMJE).

1) Ethical Review and Informed Consent

If the research involves human participants, it must comply with the ethical standards of the Declaration of Helsinki (adopted in 1964; amended in 2008; https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/) and in principle must undergo scrutiny of an independent Institutional Review Board (IRB) or Research Ethics Committee (REC) which reviews the ethical issues of the human experiment. However, in clinical studies, the approval of the IRB or ERC and participant's consent must be received and specified in the text.

2) Privacy and Confidentiality

Every author must protect privacy and confidentiality of study participants. The personal information regarding the identity of a study participant must not be disclosed in any form: article, photo or pedigree. However, if a study participant's personal information is indispensable as scientific information, it must be explained to the study participant or his/her legal guardian, written informed consent should be obtained from him/her before publication, and his/her approval must be specified in a published article. At the time of explanation, a manuscript to be published, including photos, must be offered to a study participant and be approved by him/her. Description materials including photographs should not disclose study participant's name, english initials, and hospital identification number.

3) Redundant Publication/Duplicate Submission

An article that has been already reported in another journal or is being reviewed by another journal, and an article that has a redundant material previously published in the journal will be rejected. If the article contains similar work that has already been reported in another publication or has been published in the journal, the author should include copies of such material along with the submitted article. The Editorial Committee will decide on the matter of secondary publication of the submitted

article and then consider for its acceptance. Also, the author can not submit a published article to another journal without authorization. Only under the conditions for secondary publication stipulated in the 'Uniform Requirements for Manuscripts Submitted to Biomedical Journals' this may be allowed.

4) Authorship and Contributorship

Every author must meet the authorship standards set forth in the 'Uniform Requirements for Manuscripts Submitted to Biomedical Journals'. He/she has a duty of verifying that his/her article has not yet been published and is not the same as any existing one. All persons designated as authors must fulfill all three conditions that they had contributed to 1) conception and design, acquisition of data, or analysis and interpretation of data, 2) drafting the article or revising it critically for important intellectual content, and 3) final approval of the version to be published. All contributors participating in the research not meeting the authorship standards must be listed in 'Acknowledgments' section after receiving their permission. After a manuscript has been submitted, no author could not be added.

5) Conflicts of Interest and Financial Disclosures

Each author has a duty to disclose direct or indirect conflicts of interest in the subject matter discussed in the submitted article. All authors must reveal all possible conflicts of interest that related to research such as consultation fees and stocks when submitting their article and should provide all of their personal signatures to verify that they have revealed so. A financial grant or support received for research purposes should be disclosed at the bottom of the title page, and all conflicts of interest such as consulting fees and stocks associated with study should also be disclosed at the bottom of the title page or in acknowledgment section. The corresponding author is required to confirm whether his/her or his/her co-authors have any conflict of interest to declare, and to provide appropriate details to the Editorial Committee.

8. RESUBMISSION

The resubmission period for a manuscript sent to its author for revision must be three months, and if three months are exceeded, the manuscript must be judged again as a new manuscript.

9. PAGE PROOFS

Page proofs will be sent to corresponding authors by the Editorial Committee. Authors must send them back within 48 hours after reading them carefully and revising them if necessary. The revision of page proofs must be limited to the errors of typesetting, and it is prohibited to change or to add new contents to the article. Authors are responsible for the contents of page proofs.

10. ARTICLE PROCESSING CHARGE

No review fees are charged for all the submitted articles. Article processing charges are required for publication in the *KJHP*. Publication fees for all the accepted original or review articles are 300,000 Korean Won (250 US dollars). Additionally, if the article exceeds 6 pages of the journal, additional fees (50,000 Korean Won or 40 US dollars per extra page) will be charged.

11. CORRECTIONS

If necessary, requests to publish corrections should be sent to the Editorial Committee within one month of journal publication. Corrections are reviewed by editors and authors and published in the next issue of the journal.

Copyright Transfer Agreement

Manuscript Title: _____

_____

_____

Authors: _____

_____

_____

On behalf of all authors of the manuscript entitled as above, I, as a corresponding author, certify that this article is an original work and that none of the material in the manuscript has been published previously or will be published. The authors warrant that they have obtained permission from the copyright holder to reproduce any materials and media including printed and electronic forms not owned by the authors, and that they have acknowledged the source.

Also, all the authors of this manuscript declare that there is no commercial association (e.g., financial interest, stock ownership, consultancy, patent and licensing agreement, etc.) that might pose a conflict of interest in relation to the submitted manuscript.

On behalf of all the authors, I hereby transfer, convey, and assign all copyrights in the Article to the *Korean Journal of Health Promotion* (*KJHP*). Also, the copyright to the Contribution identified above is transferred to the *KJHP*. The copyright transfer covers the right to print, publish, distribute, and sell throughout the world the said Contribution and parts thereof, including all revisions or versions and future editions, in all forms and media expression – such as in its electronic form (offline, online) – now known or developed in the future, as well as to translate, print, publish, distribute, and sell the Contribution in any foreign languages and throughout the world.

Name of Corresponding Author: _____

Signature of Corresponding Author on behalf of All Authors: _____

Date: _____/_____/_____