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Walking exercise has a stronger association with quality of life in obese older adults than in non-obese older adults: A nationwide population-based study

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Aim: This study aimed to investigate the relationships between exercise type, obesity, and quality of life (QoL) in older adults, and to assess how the combined effects of exercise and obesity differ between obese and non-obese older adults.

Methods: We conducted a nationwide population-based cross-sectional study using data from the 2016–2020 Korea National Health and Nutrition Examination Survey. Exercise types were categorized as aerobic, resistance, or walking exercise (WE). Exercise status was classified as adequate, inadequate, or none. Obesity was defined as a body mass index ≥ 25 kg/m². QoL was measured using the EuroQol Five-Dimension Questionnaire (EQ-5D), and a low EQ-5D score was defined as an average score below 1 across the five domains (indicating low QoL). Multivariate logistic regression analysis was performed to examine (1) the associations between exercise type, obesity, and QoL in older adults and (2) the combined effects of exercise type and obesity on QoL, using non-obese older adults with adequate exercise for each exercise type as the reference group.

Results: A total of 6060 older adults were included. Compared with older adults who performed adequate WE, the odds ratio (OR) for having a low EQ-5D score was 1.71 (95% confidence interval [CI], 1.43–2.04) in those who did not perform WE. Additionally, obese older adults without WE had 2.33 times higher odds (95% CI, 1.80–3.02) of having a low EQ-5D score compared with non-obese older adults who performed adequate WE.

Conclusions: WE shows a strong positive association with QoL among older adults, and this relationship is notably more pronounced in obese older adults than in their non-obese counterparts. *Geriatr Gerontol Int* 2025; 25: 1065–1073.

Keywords: aging, obesity, physical activity, quality of life, walking exercise.

Introduction

The global population is aging. Currently, approximately 566 million people worldwide are aged 65 or older, and this number is projected to reach nearly 1.5 billion by 2050.¹ With life expectancy steadily increasing, improving the quality of life (QoL) for older adults is paramount.² However, a study on QoL in Korea revealed a concerning trend: individuals aged 60 or older reported a life satisfaction score of 6.1 out of 10. This relatively low rating is notable, with Korea ranking 36th among 38 OECD countries.³

Previous research has identified significant associations between exercise, obesity, and QoL in older adults.^{3–7} Multiple studies have demonstrated that older adults who exercise frequently tend to have higher EuroQol Visual Analogue Scale (EQ-VAS) scores than those who do not.^{4,5} In particular, walking exercise (WE) has been positively linked to higher QoL; older adults who walked at least 10 min a day for 4–7 days a week exhibited higher EuroQol Five-Dimension Questionnaire (EQ-5D) scores compared with those who did not engage in regular walking.⁶ Additionally, QoL has been shown to be

inversely correlated with obesity,⁷ as reflected in studies reporting lower 36-Item Short Form Health Survey scores in individuals with a higher body mass index (BMI).⁸ Several studies have shown that obese people have a significantly reduced QoL owing to obesity, which is associated with obesity-related comorbid conditions.⁹ Moreover, obese people generally experience reduced mobility owing to excess weight, which can cause joint stress, pain, and a heightened risk of arthritis.^{10,11} Such complications often lead to lower self-rated health status and higher rates of depression, both of which further limit exercise participation, ultimately impairing QoL by reducing mobility and fitness levels. In particular, obese older adults struggle with shortness of breath, joint pain, fatigue, and limited mobility, which can hinder regular exercise.¹² These observations highlight the importance of investigating the interactive effect of exercise and obesity on QoL in older adults.

However, most previous studies have examined only the individual effects of WE and obesity on QoL.⁶ Research that addresses the more complex relationships between exercise, obesity, and QoL often focuses on how increased exercise can reduce the risk of obesity, thereby improving QoL.^{13,14} Therefore, the present study aimed to evaluate the associations among exercise type, obesity, and QoL in older adults, and to investigate the combined effects of

Hye Jun Lee and Ji Min Hong are co-first authors.

exercise and obesity on QoL in obese compared with non-obese older adults, using nationwide population-based data from Korea.

Methods

Study population

This cross-sectional study used data from the 2016–2020 Korea National Health and Nutrition Examination Survey (KNHANES), a continuous, nationwide survey assessing the general health and nutritional status of non-institutionalized civilian Koreans. The survey is conducted by the Korean Ministry of Health and Welfare and the Division of Health and Nutrition Research and Analysis of the Korean Disease Control and Prevention Agency (KDCA).

Of the 39 738 individuals included in the 2016–2020 KNHANES, 8403 were aged 65 years or older. After excluding those who reported limitations in performing usual activities, 7089 remained eligible. Those without EQ-5D or physical activity data were further excluded, leaving 6060 individuals for the analysis (Fig. 1).

All KNHANES participants provided written informed consent before participating. The KNHANES protocol was approved by the Institutional Review Board of the KDCA; it was exempted from ethics review based on the Bioethics and Safety Act of 2016–2017 (no. 2018-01-03-P-A in 2018, no. 2018-01-03-C-A in 2019, and no. 2018-01-03-2C-A in 2020). This study was also exempted from review by the Institutional Review Board of Chung-Ang University Hospital (2312-009-19500).

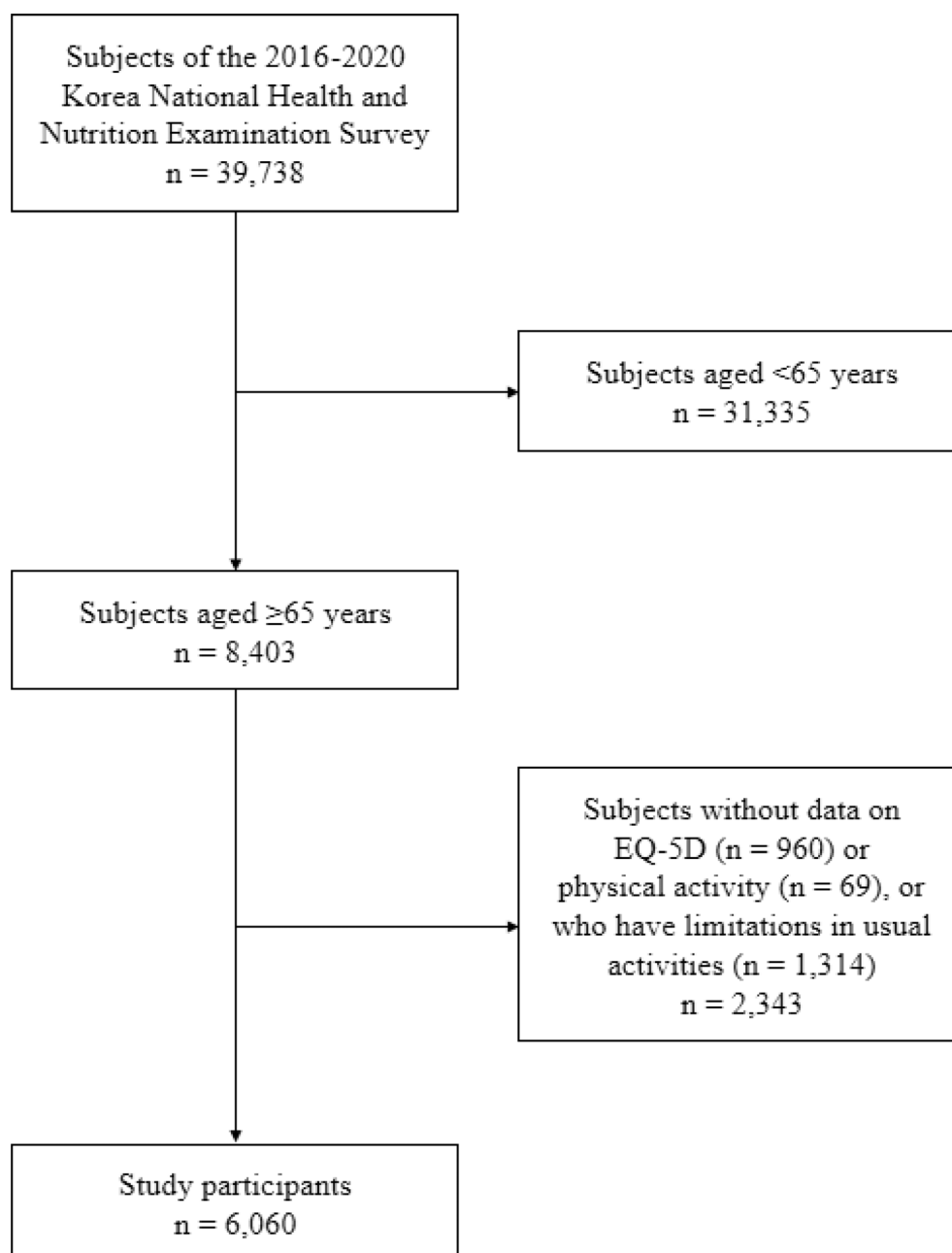


Figure 1 Flowchart of participant inclusion in the study.

Data collection

Trained staff interviewed KNHANES participants using standardized health questionnaires covering demographic and clinical information. Exercise type was classified as aerobic exercise (AE), resistance exercise (RE), and WE, following the Global Physical Activity Questionnaire (GPAQ)^{15,16} for AE, and an additional questionnaire for collecting walking-related and RE data not included in the GPAQ. The GPAQ was translated into Korean in 2013 by the KDCA, and its reliability and validity have been verified.¹⁷ The KNHANES also collected data on WE and RE. WE was assessed the number of days of walking for at least 10 min and walking time during the past week, and RE was assessed the number of days of doing RE, such as push-ups, sit-ups, dumbbells, weightlifting, or pull-ups during the past week.^{18,19}

AE was defined as at least 150 min of moderate-intensity or 75 min of high-intensity aerobic activity per week, or an equivalent combination of moderate- and high-intensity activity.²⁰ RE was defined as participation in RE on at least 2 days per week.²¹ WE was defined as at least 150 min of walking per week, which may include walking for work or leisure.

Based on the World Health Organization (WHO) guidelines on physical activity,²⁰ participants were operationally categorized into three groups for each exercise type (AE, RE, and WE): adequate, inadequate, and none. We defined the adequate group to be if AE, RE, and WE were as defined in the GPAQ and the additional questionnaire in the KNHANES, the none group to be if AE, RE, and WE were not performed, and the inadequate group to be if AE, RE, and WE did not meet the definition of adequacy.

QoL was measured using EQ-5D scores, with the questionnaire addressing five domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression.¹⁹ The respondents answered questions on their current health status in each domain using three levels: level 1, no problems; level 2, moderate problems; level 3, serious problems. A low EQ-5D score, calculated using a Korean-specific weighted formula, was defined as a score less than 1, indicating low QoL.¹⁴

Current smoking was defined as having smoked more than 100 cigarettes in a lifetime and currently smoking regularly. Hazardous alcohol intake was defined as consuming ≥ 7 drinks per session for men and ≥ 5 drinks per session for women at least twice a week. Self-rated subjective health was evaluated based on participants' own perception of their general health. Depression was assessed using the Patient Health Questionnaire-9, a depression screening tool, with a total score ≥ 10 considered indicative of depression. Medical history, including hypertension, diabetes mellitus, stroke, myocardial infarction or angina, osteoarthritis or rheumatoid arthritis, and cancer (stomach, liver, colon, breast, cervix, lung, thyroid, or other), was based on self-reported physician-diagnosed condition. Obesity was defined as a BMI ≥ 25 kg/m², according to the WHO Asia-Pacific criteria.²²

Statistical analysis

The KNHANES employs a stratified, multistage, clustered probability sampling method to produce a representative sample of the non-institutionalized civilian Korean population. Consequently, all statistical analyses in this study accounted for stratification, clustering, and sampling weights.

Participant characteristics were stratified by QoL level and are reported as mean and standard error (SE) for continuous variables and as weighted percentage and SE for categorical variables. Between-group comparisons for continuous variables were

performed using independent *t*-tests, and chi-square tests were used for categorical variables.

We conducted multivariate logistic regression analyses to evaluate the associations of exercise type and obesity with QoL, reporting odds ratios (ORs) and 95% confidence intervals (CIs). Interaction terms were incorporated to further verify significant relationships. We adjusted for multiple clinically relevant variables and variables that showed significant associations in the univariate analysis. The dependent variable was a low EQ-5D score (low QoL), while the primary independent variables were obesity and exercise type (AE, RE, and WE). When a particular exercise type (or obesity) was the primary independent variable, it was not included as a covariate in the same model. Other adjusted variables included age, sex, household income, education level, occupation, marital status, current smoking, hazardous alcohol intake, self-rated subjective health, depression, and diagnosis of hypertension, diabetes mellitus, dyslipidemia, stroke, myocardial infarction or angina, osteoarthritis or rheumatoid arthritis, and cancer.

Model 1 was adjusted for age and sex. Model 2 was further adjusted for household income, education level, occupation, marital status, AE, RE, WE, current smoking, hazardous alcohol intake, and obesity. Model 3 was additionally adjusted for self-rated subjective health, depression, and diagnosis of hypertension, diabetes mellitus, dyslipidemia, stroke, myocardial infarction or angina, osteoarthritis or rheumatoid arthritis, and cancer.

All statistical analyses were performed using SAS statistical software (version 9.4, SAS Institute Inc., Cary, NC, USA), with a *P*-value < 0.05 considered statistically significant.

Results

Demographic characteristics of the participants

A total of 39 738 participants were included in the 2016–2020 KNHANES. Of these, 33 678 were excluded: 31335 participants were younger than 65 years old, 960 lacked EQ-5D information, 69 had no exercise data, and 1314 had limitations in usual activities. Consequently, 6060 participants aged 65 years or older were included in this study (Fig. 1).

Table 1 summarizes the demographic characteristics of the participants according to EQ-5D score, as well as the odds (OR) and 95% CIs for having a low EQ-5D score. Overall, 2680 participants (44.2%) had low EQ-5D scores. Participants with low EQ-5D scores were more likely to be older, female, have a lower household income and education level, be unemployed, live alone, be physically inactive, have obesity, exhibit depression, and have chronic diseases (other than cancer) (all $P < 0.05$). Univariate regression analysis indicated that exercise was inversely associated with low EQ-5D, whereas obesity was positively associated with low EQ-5D (all $P < 0.01$).

Associations between exercise type, obesity, and quality of life

Table 2 shows the ORs and 95% CIs for low EQ-5D scores according to exercise type and obesity. The model was adjusted for age, sex, household income, education level, occupation, marital status, AE, RE, WE, current smoking, hazardous alcohol intake, obesity, self-rated subjective health status, depression, and history of hypertension, diabetes mellitus, dyslipidemia, stroke, myocardial infarction or angina, osteoarthritis or rheumatoid arthritis, and cancer.

Compared with the adequate WE group, the OR for having a low EQ-5D score was 1.30 (95% CI, 1.11–1.54) in the inadequate

Table 1 Demographic characteristics of Korean older adults categorized according to QoL and the ORs of low EQ-5D score from the 2016–2020 KNHANES

Variables	Number of participants (Total: <i>n</i> = 6060)	Low EQ-5D ^a (<i>n</i> = 2680)	OR (95% CI)	<i>P</i> -value
Age (years)	72.5 ± 0.1	73.5 ± 0.1		<0.01
<75	61.5 (0.8)	52.5 (1.2)	1.00	
≥75	38.5 (0.8)	47.5 (1.2)	1.97 (1.74–2.24)	
Sex				<0.01
Male	44.7 (0.6)	33.5 (0.9)	1.00	
Female	55.3 (0.6)	66.5 (0.9)	2.27 (2.01–2.57)	
Household income				<0.01
Q ₄ highest	11.8 (0.7)	9.1 (0.9)	1.00	
Q ₃ upper-middle	17.5 (0.7)	14.8 (0.9)	1.15 (0.90–1.46)	
Q ₂ lower-middle	28.2 (0.8)	25.8 (1.0)	1.32 (1.04–1.68)	
Q ₁ lowest	42.5 (1.0)	50.3 (1.3)	2.09 (1.67–2.61)	
Education level				<0.01
Above high school graduation	31.7 (0.9)	23.4 (1.1)	1.00	
Below middle school graduation	68.3 (0.9)	76.6 (1.1)	2.04 (1.78–2.33)	
Occupation				<0.01
Non-manual worker	4.2 (0.3)	2.4 (0.4)	1.00	
Service or sales worker	5.7 (0.4)	5.0 (0.5)	2.03 (1.31–3.15)	
Manual worker	25.9 (0.8)	23.1 (1.1)	2.11 (1.48–3.00)	
Unemployed ^b	64.1 (0.8)	69.5 (1.1)	2.96 (2.11–4.16)	
Married				<0.01
Living together	68.1 (0.8)	59.6 (1.2)	1.00	
Living alone	31.9 (0.8)	40.4 (1.2)	2.00 (1.76–2.28)	
Current smoking status				0.28
Non-smoker	90.6 (0.4)	91.2 (0.6)	1.00	
Current smoker ^c	9.4 (0.4)	8.8 (0.6)	0.89 (0.72–1.10)	
Alcohol consumption				0.02
Non-drinker	24.3 (0.7)	26.0 (1.0)	1.00	
Non-hazardous alcohol intake	70.8 (0.7)	70.1 (1.0)	0.86 (0.75–0.99)	
Hazardous alcohol intake ^d	4.9 (0.3)	3.9 (0.4)	0.61 (0.45–0.82)	
Aerobic exercise				<0.01
Adequate ^e	33.8 (0.8)	27.7 (1.1)	1.00	
Inadequate	25.6 (0.7)	27.0 (1.1)	1.52 (1.29–1.78)	
None	40.6 (0.9)	45.3 (1.3)	1.71 (1.47–1.99)	
Resistance exercise				<0.01
Adequate ^f	19.9 (0.6)	14.0 (0.8)	1.00	
Inadequate	1.2 (0.2)	1.0 (0.2)	1.33 (0.77–2.30)	
None	78.9 (0.7)	84.9 (0.8)	1.99 (1.70–2.34)	
Walking exercise				<0.01
Adequate ^g	51.7 (0.8)	43.1 (1.2)	1.00	
Inadequate	26.3 (0.7)	28.0 (1.0)	1.52 (1.32–1.74)	
None	22.0 (0.7)	28.9 (1.1)	2.40 (2.08–2.76)	
Body mass index (kg/m ²)	24.14 ± 3.12	24.40 ± 3.30		<0.01
Obesity ^h	29.2 (0.7)	31.5 (1.1)	1.22 (1.08–1.39)	<0.01
Self-rated subjective health status				<0.01
Excellent	5.2 (0.3)	9.9 (0.6)	1.00	
Good	5.2 (0.4)	2.6 (0.4)	1.12 (0.77–1.63)	
Fair	19.9 (0.6)	10.8 (0.7)	2.47 (1.74–3.50)	
Poor	52.7 (0.8)	49.4 (1.1)	8.00 (5.55–11.53)	
Very poor	17.1 (0.6)	27.3 (1.0)	18.11 (11.19–29.32)	
Depression ⁱ				<0.01
No	98.1 (0.2)	96.4 (0.4)	1.00	
Yes	1.9 (0.2)	3.6 (0.4)	6.52 (3.77–11.25)	
Chronic diseases ^j				<0.01
Hypertension				<0.01
No	45.9 (0.7)	42.1 (1.1)	1.00	
Yes	54.1 (0.7)	57.9 (1.1)	1.33 (1.17–1.50)	

(Continues)

Table 1 Continued

Variables	Number of participants (Total: <i>n</i> = 6060)	Low EQ-5D ^a (<i>n</i> = 2680)	OR (95% CI)	<i>P</i> -value
Diabetes				<0.01
No	78.5 (0.6)	75.3 (1.0)	1.00	
Yes	21.5 (0.6)	24.7 (1.0)	1.40 (1.22–1.62)	
Dyslipidemia				<0.01
No	64.2 (0.8)	61.3 (1.1)	1.00	
Yes	35.8 (0.8)	38.7 (1.1)	1.23 (1.09–1.39)	
Stroke				<0.01
No	94.7 (0.3)	93.1 (0.6)	1.00	
Yes	5.3 (0.3)	6.9 (0.6)	1.73 (1.34–2.24)	
Myocardial infarction or angina				0.02
No	92.0 (0.4)	91.0 (0.6)	1.00	
Yes	8.0 (0.4)	9.0 (0.6)	1.28 (1.04–1.57)	
Osteoarthritis or rheumatoid arthritis				<0.01
No	70.5 (0.6)	57.8 (1.1)	1.00	
Yes	29.5 (0.6)	42.2 (1.1)	2.98 (2.64–3.37)	
Cancer				0.65
No	89.8 (0.5)	90.1 (0.7)	1.00	
Yes	10.2 (0.5)	9.9 (0.7)	0.96 (0.79–1.16)	

Data were obtained from the 2016–2020 Korean National Health and Nutrition Examination Survey, and the statistical analyses performed in the present study were conducted by adopting stratification, clustering, and weight variables. Categorical variables are expressed as weighted percentages and standard errors (SE), whereas continuous variables are presented as means and SE. *P*-values were calculated using regression analysis. EQ-5D, EuroQol Five-Dimension Questionnaire; KNHANES, Korea National Health and Nutrition Examination Survey; OR, odds ratio; QoL, quality of life. ^aDefined as a composite index that integrates the scores of the EQ-5D on health-related quality of life (an average score of less than 1 is considered low). ^bIncluding homemakers and students. ^cDefined as smoking more than five packs of cigarettes (100 cigarettes) in a lifetime and currently smoking. ^dDefined as drinking an average number of ≥ 7 drinks for men and ≥ 5 drinks for women two or more times a week. ^eEngaged in aerobic exercise for 150 min or more during the past week. ^fEngaged in resistance exercise, such as push-ups, sit-ups, dumbbell exercises, weightlifting, and pull-ups, for two or more days during the past week. ^gEngaged in walking exercise for 150 min or more during the past week. ^hDefined as a body mass index ≥ 25 kg/m². ⁱDefined as a total Patient Health Questionnaire-9 (a depression screening tool) score of ≥ 10 . ^jSelf-reported physician-diagnosed condition.

Table 2 Adjusted ORs (95% CI) of low EQ-5D score categorized according to exercise type and obesity in Korean older adults from the 2016–2020 KNHANES

	Model 1	Model 2	Model 3
Aerobic exercise			
Adequate [†]	1.00	1.00	1.00
Inadequate	1.28 (1.08–1.51)*	1.11 (0.93–1.33)	1.08 (0.89–1.32)
None	1.49 (1.28–1.73)*	1.09 (0.92–1.29)	1.08 (0.9–1.29)
Resistance exercise			
Adequate [‡]	1.00	1.00	1.00
Inadequate	1.26 (0.72–2.22)	1.16 (0.65–2.07)	1.14 (0.6–2.18)
None	1.41 (1.19–1.68)*	1.20 (1.01–1.43)**	1.04 (0.86–1.26)
Walking exercise			
Adequate [§]	1.00	1.00	1.00
Inadequate	1.38 (1.2–1.59)*	1.32 (1.13–1.53)*	1.30 (1.11–1.54)*
None	2.06 (1.78–2.39)*	1.91 (1.62–2.24)*	1.71 (1.43–2.04)*
Obesity			
Non-obese	1.00	1.00	1.00
Obese [¶]	2.18 (1.92–2.47)*	1.23 (1.07–1.41)*	1.13 (0.98–1.30)

CI, confidence interval; EQ-5D, EuroQol Five-Dimension Questionnaire; KNHANES, Korean National Health and Nutrition Examination Survey; OR, odds ratio. QoL was assessed using the EQ-5D index, and low QoL was defined as a composite index that integrates the scores of the EQ-5D on health-related quality of life (an average score less than 1 is considered low). Model 1 was adjusted for age and sex. Model 2 was adjusted for household income, education level, occupation, marital status, aerobic exercise (when not treated as independent), resistance exercise (when not treated as independent), walking exercise (when not treated as independent), current smoking, hazardous alcohol intake, and obesity (when not treated as independent), in addition to the variables adjusted in Model 1. Model 3 was adjusted for self-rated subjective health status, depression, diagnosis of hypertension, diabetes mellitus, dyslipidemia, stroke, myocardial infarction or angina, osteoarthritis or rheumatoid arthritis, and cancer (stomach, liver, colon, breast, cervix, lung, thyroid, or other), in addition to the variables adjusted in Model 2. * indicates a *P*-value <0.05, and ** indicates a *P*-value <0.01. [†]Engaged in aerobic exercise for 150 min or more during the past week. [‡]Engaged in resistance exercise, such as push-ups, sit-ups, dumbbell exercises, weightlifting, and pull-ups, for two or more days during the past week. [§]Engaged in walking exercise for 150 min or more during the past week. [¶]Defined as a body mass index ≥ 25 kg/m².

WE group and 1.71 (95% CI, 1.43–2.04) in the no WE group (both $P < 0.05$). Among obese participants, the OR for low EQ-5D was 2.18 (95% CI, 1.92–2.47) in Model 1 and 1.23 (95% CI, 1.07–1.41) in Model 2, compared with their non-obese counterparts (both $P < 0.05$). However, in Model 3, the association between obesity and low EQ-5D was not statistically significant (OR, 1.13; 95% CI, 0.98–1.30; $P > 0.05$).

We additionally analyzed the association between EQ-5D components and exercise type and obesity (Table S1). Compared with the adequate WE group, the OR for having a problem in mobility, self-care, usual activities, and pain/discomfort was higher than in the inadequate or no WE group (OR = 2.30, 95% CI = 1.88–2.82 for mobility in the no WE group; OR = 1.45, 95% CI = 1.22–1.74 for mobility in the inadequate WE group; OR = 2.61, 95% CI = 1.84–3.69 for self-care in the no WE group; OR = 2.10, 95% CI = 1.59–2.77 for usual activities in the no WE group; OR = 1.50, 95% CI = 1.15–1.95 for usual activities in the inadequate WE group; OR = 1.32, 95% CI = 1.09–1.61 for pain/discomfort in the no WE group). In addition, compared with the non-obese participants, the OR for having a problem in mobility was higher in the obese participants (OR = 1.32, 95% CI = 1.13–1.55).

Combined effect of exercise type and obesity on quality of life

Figure 2 illustrates the combined effects of exercise type and obesity on QoL. Participants were classified into six groups based on obesity status (obese vs. non-obese) and exercise status (adequate, inadequate, or none) for each exercise type. The model was adjusted for the same variables as used in Model 3.

A significant inverse association was observed between WE and low EQ-5D scores for both non-obese and obese older adults. Among non-obese older adults, the ORs for a low EQ-5D score were 1.27 (95% CI, 1.06–1.52; $P < 0.01$) in the inadequate WE group and 1.73 (95% CI, 1.43–2.10; $P < 0.01$) in the no WE group, relative to those with adequate WE. Furthermore, obese older adults in the inadequate WE group had 1.48 (95% CI, 1.16–2.90; $P < 0.01$) times higher odds of a low EQ-5D than did non-obese older adults with adequate WE, whereas obese older adults in the no WE group had 2.33 (95% CI, 1.80–3.02; $P < 0.01$) times higher odds.

When interaction terms were added for obese older adults, those who did not perform WE had an OR of 2.18 (95% CI, 1.02–2.04; $P < 0.05$) for a low EQ-5D score compared with obese older adults with adequate WE. No significant interaction effect was found for AE or RE with obesity (Table S2).

Among obese older adults who did not engage in RE or AE, the OR for a low EQ-5D score was 1.36 (95% CI, 1.07–1.73; $P < 0.01$) and 1.27 (95% CI, 1.00–1.63; $P < 0.05$), respectively, compared with non-obese older adults with adequate RE or AE. However, after adding interaction terms, neither AE nor RE demonstrated a significant interaction with obesity for those who did not exercise compared with those who did (AE: 1.50, 95% CI, 1.01–2.22; $P = 0.59$; RE: 1.00, 95% CI, 0.67–1.48; $P = 0.79$).

Discussion

This cross-sectional study, using 2016–2020 KNHANES data, found an inverse association between WE and EQ-5D scores among older adults. Notably, WE demonstrated a stronger association with QoL in obese older adults compared with their non-obese counterparts. Additionally, obese older adults who engaged

in adequate WE had a lower risk of reporting low EQ-5D scores than did non-obese older adults who did not engage in WE, underscoring the importance of adequate WE in this population.

WE is a form of whole-body activity that supplies oxygen throughout the body, promotes respiratory and circulatory functioning,²³ and stimulates the secretion of mood-enhancing hormones such as serotonin and dopamine.²⁴ A study conducted in Melbourne, Australia, indicated that walking paths (19.6%; 95% CI = 17.1–22.1) are the most important park feature motivating older adults to visit and socialize,²⁵ while walking in natural settings has also been shown to effectively improve mental health.²⁶ Moreover, social bonds formed within walking groups can promote commitment to physical activity and foster a sense of companionship and shared wellness experiences,²⁷ partly influenced by serotonin.²⁸ Collectively, these findings suggest that low-intensity WE may help older adults improve their QoL by allowing them to engage with nature and socialize, rather than relying on moderate-intensity AE.

WE helps maintain and improve both physical and mental health, thereby preserving individuals' independence and minimizing activity limitations, which are the key factors that have the greatest impact on older adults' QoL.²⁹ In our study, adequate WE also showed an inverse association with EQ-5D components, such as a problem in mobility, self-care, usual activities, and pain/discomfort. A longitudinal study in Australia, targeting middle-aged women, reported that those who maintained physical activity (including WE) over 15 years had higher QoL outcomes in both physical and mental health domains than those who did not engage in any physical activity.³⁰ Conversely, obesity in older adults impairs physical function and accelerates cellular processes through chronic inflammation in adipose tissue, elevated reactive oxygen species production, oxidative stress, and mitochondrial dysfunction.³¹ Additionally, obesity disrupts key cellular energy regulators (e.g., insulin, insulin-like growth factor, adenosine monophosphate-activated protein kinase, leptin, and adiponectin), raising the risk of chronic diseases, cancer, and insulin resistance.³² These metabolic disturbances can limit older adults' ability to live independently and socially isolate them, subsequently reducing their QoL.^{33,34} This is consistent with our study, which showed that obesity was associated with a problem in mobility among the EQ-5D components. A longitudinal study from the UK similarly linked increased obesity to decreased health-related quality of life (HRQoL).³⁵ These pathways may explain the significant interaction between WE, obesity, and QoL observed in the present study.

Regarding the relationship between RE, obesity, and QoL, the OR for a low EQ-5D score was 1.36 among obese older adults who did not engage in RE, compared with non-obese older adults who performed adequate RE (95% CI, 1.07–1.73, $P < 0.01$). RE increases anabolic hormone levels, such as testosterone and growth hormones, while stabilizing cortisol, all of which are critical for maintaining physical health in obese older adults.³⁶ Additionally, RE can induce myokine production, which positively influences metabolic, cardiovascular, immunological, and even mental processes.³⁷ Further research is needed to clarify the mechanisms by which RE and obesity affect QoL.

This study has some limitations. First, because it employed a cross-sectional design, causal relationships could not be established. Prospective longitudinal studies are necessary to clarify how exercise, obesity, and QoL interact over time. Second, in our analysis, some elements of walking could potentially overlap with AE. The moderate-intensity physical activity measured via the Korean version of the GPAQ includes brisk walking, and KNHANES separately surveys weekly walking time. Despite the

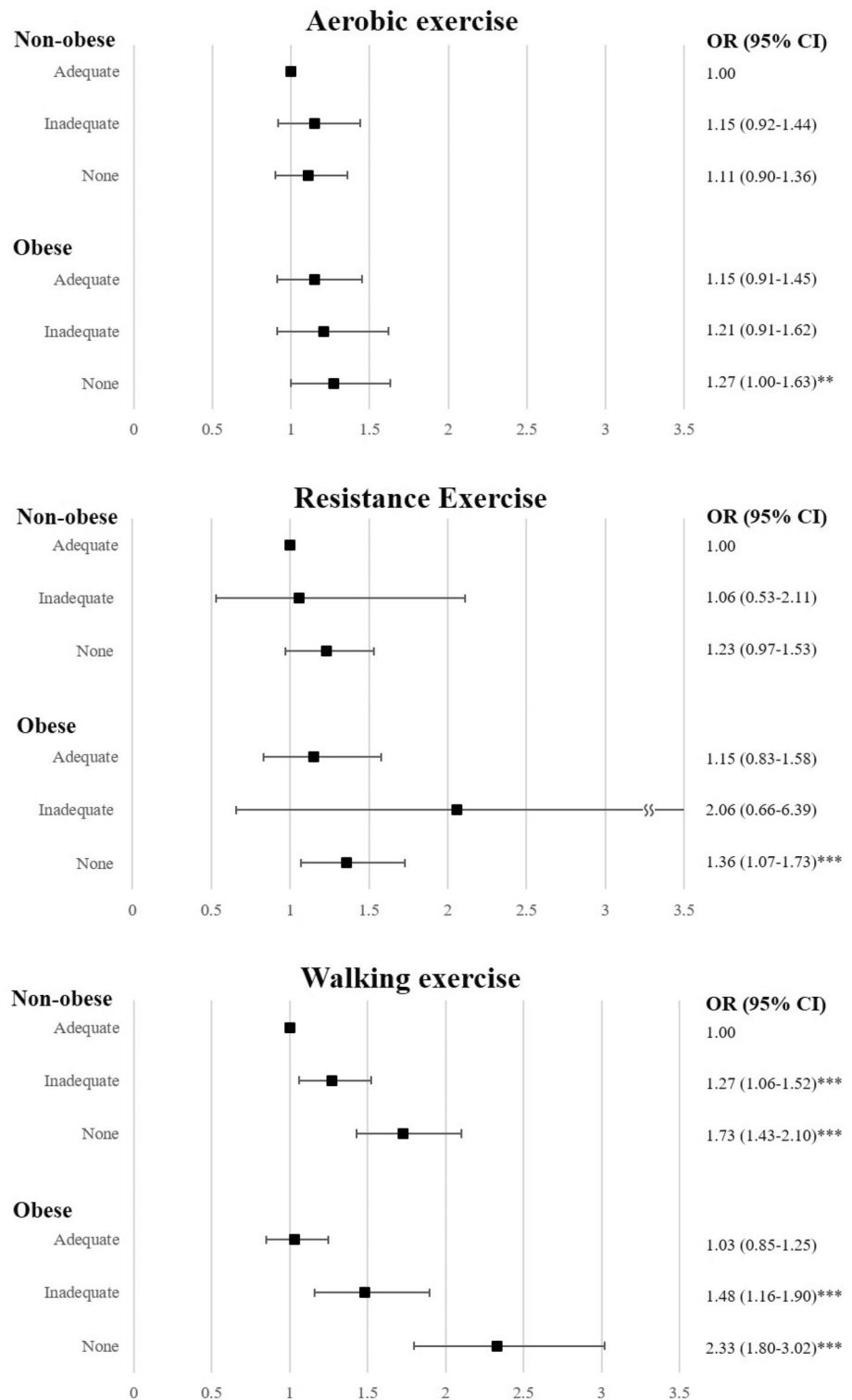


Figure 2 Combined effects of exercise type and obesity on quality of life. The figure shows ORs (95% CI) for a low EQ-5D score categorized according to obesity and status of exercise for each type of exercise (nine groups). CI, confidence interval; EQ-5D, EuroQol Five-Dimension Questionnaire; OR, odds ratio.

nonsignificant association between AE and QoL, we found a significant association between WE and QoL, suggesting that even mild-intensity (slow) walking, as opposed to brisk walking, may be an effective strategy to enhance QoL in older adults. This aligns with the WHO recommendation to reduce daily sedentary time,²⁰ and highlights walking as a feasible option. Third, because our dataset was cross-sectional, the analysis of interaction effects, such

as between exercise and obesity, is inherently limited. Further research incorporating interaction terms and longitudinal data would provide more definitive insights.

Despite these limitations, this study is noteworthy for being one of the first to quantitatively investigate the relationship between WE, obesity, and QoL in older adults. We used KNHANES data, which are collected from a large, ethnically

homogenous population using standardized methods and validated tools, thereby ensuring reliable population-level findings. Additionally, we compared the risk of having low EQ-5D scores among obese older adults who do not engage in WE with that among non-obese older adults who perform adequate WE, thus providing robust evidence of the role that WE plays in improving QoL, particularly for older adults with obesity.

In conclusion, our analysis of data from the 2016–2020 KNHANES indicates that WE is inversely associated with low EQ-5D scores among older adults. This inverse relationship was stronger in obese older adults compared to non-obese older adults, with obese older adults who do not engage in WE facing the highest risk of low QoL. Promoting adequate WE may therefore have the potential to be an effective, accessible, safe, and cost-efficient strategy for enhancing QoL in obese older adults. Because improved QoL in older adults is associated with reduced morbidity and mortality,³⁸ these findings carry significant clinical and public health implications. Future prospective and longitudinal studies are warranted to further elucidate these relationships and expand upon the findings reported here.

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Disclosure statement

The authors declare no conflict of interest.

Author contributions

Conceptualization: HJL, JMH, JHK; Data curation: HJL, JMH, JHK; Formal analysis: JHK, CWL; Investigation: HJL, JMH; Methodology: HJL, CWL, JHK; Project administration: JHK; Resources: HJL, JMH; Software: CWL, JHK; Supervision: JHK; Validation: JHK; Visualization: HJL, JMH; Writing – original draft: HJL, JMH; Writing – review & editing: HJL, JMH, CWL, JHK. All authors have read and approved the final version of the manuscript: HJL, JMH, CWL, JHK.

Data availability statement

Data were obtained from the 2016–2020 Korea National Health and Nutrition Examination Survey (KNHANES). The KNHANES is a nationwide population-based survey conducted by the Korean Ministry of Health and Welfare and the Division of Chronic Disease Surveillance of the Korean Centers for Disease Control and Prevention. All data used in the analyses are fully available without restriction. All data files are available from the KNHANES database (<https://knhanes.cdc.go.kr/knhanes/index.do>).

Ethics statement

The KNHANES was conducted following ethical approval by the Institutional Review Board of the Korea Centers for Disease Control and Prevention. However, the KNHANES was exempt from an ethics review based on the Bioethics and Safety Act of 2016–2017, no. 2018-01-03-P-A in 2018, no. 2018-01-03-C-A in 2019,

and no. 2018-01-03-2C-A in 2020. The present study was exempt from review by the Institutional Review Board of Chung-Ang University Hospital (2312-009-19500).

Patient consent statement

All participants provided written informed consent before participating in the study.

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Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's website:

Table S1. Association between EQ-5D components and exercise type and obesity in Korean older adults from the 2016–2020 Korea National Health and Nutrition Examination Survey.

Table S2. Adjusted ORs (95% CI) of low EQ-5D score categorized according to exercise type and obesity in Korean older adults from the 2016–2020 Korea National Health and Nutrition Examination Survey.

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