



Impact of Behavioral Risk Factors on Mortality Risk in Older Korean Women

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Abstract

Background: To investigate the impact of lifestyle risk factors on all-cause and cardiovascular disease (CVD) mortality in Korean women aged 60 yr and older.

Methods: Data (n = 3,034) obtained from the Korean longitudinal study of aging were analyzed. Exposures included lifestyle risk factors, such as smoking, alcohol abuse, underweight/obesity, physical inactivity, and unintentional weight loss. Primary outcomes were premature deaths from specific and all-causes.

Results: During 9.6±2.0 yr of follow-up, there were 628 cases (20.7%) of death from all causes, of which 137 cases (4.5%) were from CVD. Compared to zero risk factor (hazard ratio, HR=1), crude HR of all-cause mortality was 2.277 (95% confidence interval, CI, 1.712 ~ 3.030, P < 0.001) for one risk factor, 2.977 (95% CI, 2.124 ~ 4.003, P < 0.001) for two risk factors, and 5.154 (95% CI, 3.515 ~ 7.557, P < 0.001) for three or more risk factors. Compared to zero risk factor (HR=1), crude HR of CVD mortality was 2.035 (95% CI, 1.422 ~ 2.913, P < 0.001) for one risk factor, 2.468 (95% CI, 1.708 ~ 3.567, P < 0.001) for two risk factor, and 4.484 (95% CI, 2.830 ~ 7.102, P < 0.001) for three or more risk factors. Adjusted HRs of all-cause (P = 0.016) and CVD (P = 0.050) for three or more risk factors only remained significant for three or more risk factors.

Conclusion: The current findings showed that individual and combined lifestyle risk factors were significantly associated with increased risks of all-cause and CVD mortality in older Korean women.

Keywords: Unhealthy behaviors; Relative risk; Premature death; Korean adults

Introduction

A large proportion of global illness and death has been attributed to a small number of behavioral risk factors such as smoking, heavy alcohol consumption, physical inactivity, sedentary behaviors, overweight/obesity, and unhealthy diet (https://www.who.int/gho/ncd/risk_factors/en/). In addition, recent studies showed that

unintentional weight loss (UWL) might be a novel risk factor of cardiovascular diseases (CVDs) (1, 2), especially in elderly women (3). Although the exact pathology of UWL is unclear, the most common etiologies are malignancy (4), nonmalignant gastrointestinal disease (5), mental health (6), and



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medication use and polypharmacy (7). Furthermore, social factors, such as poverty, alcoholism, isolation, financial constraints, and physical barriers to obtaining food, may also contribute to UWL (8). Consequently, UWL is an important health issue that should not be overlooked but carefully monitored in older populations.

Behavioral risk factors are also important determinants of morbidity (9) and mortality (10) in South Korea. For example, a population-based cohort study showed that combined lifestyle risk factors were significantly associated with increased risks of 10-yr all-cause, cancer, and non-cancer mortality in Korean men and women (11). Another cohort study showed that smoking, elevated blood pressure, and elevated fasting blood glucose level were significantly associated with an increased risk of all-cause and CVD mortality among middle-aged Korean men (12). However, no previous study examined the additive role of UWL in determining the impact of lifestyle risk factors on mortality.

Adding UWL to the traditional risk factors will provide better information for understanding the complex etiology of death from all causes and CVDs. Furthermore, the impact of lifestyle risk factors on mortality may be modulated by covariates, including ethnicity, culture, religion, employment status, region, and others (13). In this study, therefore, we investigated the prognostic role of individual and combined behavioral risk factors in determining the risk of premature deaths from specific and all causes in older Korean women.

Materials and Methods

Study design and participants

Women aged 60 yr and older ($n = 3,034$) who had all information available regarding demographics, socioeconomic status, health behaviors, health conditions, and causes of death were retrospectively enrolled from women participants ($n = 5,600$) of Korean longitudinal study of aging (KLoSA), a nationwide survey study conducted in the Republic of Korea that launched in 2006. In

brief, the KLoSA survey was conducted by using a multi-stage, stratified sampling based on the geographical areas and housing types across the nation. A detailed description of the KLoSA is provided elsewhere (14).

The KLoSA protocol was reviewed and approved by the Institutional Review Board of the statistic Korea (approval number: 336052). All of the participants provided written informed consent. Descriptive statistics of study participants are provided in Table 1. Data from the KLoSA is accessible via the National public database (<http://www.kli.re.kr/klosa/en/about/introduce.jsp>).

Lifestyle risk factors

Lifestyle risk factors included smoking (currently or past smoker), heavy alcohol use (≥ 5 drinks per week) (15), underweight (<18.5) or obesity (body mass index ≥ 25), physical inactivity (less than 2 times per week), or UWL (weight loss of 5 kg or more) (2). A binary score (yes = 1 or no = 0) was given for each risk factor. A possible risk score obtained by summing each of the five risk factors ranged from 0 (healthiest) to 5 (least healthy), and the 3, 4, and 5 risk scores were merged into ≥ 3 risk scores.

Covariates

Age, household income, educational level, employment status, religion, type of housing, falls, comorbidity, and medications were included as covariates. Cognitive function and depressive symptoms were assessed with the Mini-mental Status Examination (K-MMSE) and Center for Epidemiological Studies of Depression 10 (CES-D 10), respectively. Activities of Daily Living (ADL) were used to assess impaired ADL (14).

Outcomes

The primary outcomes were CVD- and non-CVD-mortality as well as all-cause mortality. Mortality outcomes were crosschecked by the acquired information to the death records from the national statistical office in Korea.

Table 1: Description of study participants

<i>Variable</i>	<i>Result</i>
Age (yr)	70.6 ± 7.4
BMI (kg/m ²)	23.2 ± 3.6
Household income (10,000 won)	99 ± 145
Education, n (%)	
Elementary or less	2,492 (82.1)
Middle and high school	495 (16.3)
College or higher	47 (1.5)
Employment status, n (%)	
Yes	380 (1.5)
No	2,654 (87.5)
Religion, n (%)	
No religion	1,080 (35.6)
Protestant	671 (22.1)
Catholic	340 (11.2)
Buddhist	904 (29.8)
Others	39 (1.3)
Type of housing, n (%)	
General house	2,006 (66.1)
Apartment	1,028 (33.9)
Impaired cognition, n (%)	1,652 (54.4)
Depressive symptoms, n (%)	1,435 (47.3)
Impaired ADL, n (%)	218 (7.2)
Falls, n (%)	241 (14.3)
Hospitalization, n (%)	433 (7.9)
Comorbidity, n (%)	
0	983 (32.4)
1	1,091 (36.0)
≥2	960 (31.6)
Medications, n (%)	
0	1,240 (40.9)
1	1,046 (34.5)
≥2	748 (24.7)
Lifestyle risk factors	
Past/current smoking, n (%)	141 (4.6)
At-risk alcohol consumption, n (%)	30 (1.0)
Physical inactivity, n (%)	2,348 (77.4)
Unintentional weight loss, n (%)	410 (13.5)
Underweight/obesity, n (%)	870 (28.7)

BMI: body mass index, ADL: activities of daily living

Statistical analyses

Physical characteristics of study participants at baseline were presented as mean ± standard deviation (SD) or percentage. Pearson's χ^2 test and analysis of variance were used to compare categor-

ical and continuous variables, respectively. Absence of multicollinearity among the 5 risk factors were assessed by calculated variance inflation factors (VIFs). Bivariate correlations were calculated between covariates and outcomes. The Cox proportional hazards models were used to estimate

hazard ratios (HRs) and 95% confidence intervals (CIs) for mortality. Finally, the Kaplan-Meier procedure was used to estimate mortality functions according to number of risk factors at baseline. Survival time was measured as the time from the baseline survey to death or the censor point (November 30, 2016). All analyses were carried out taking into account complex sampling weights, using SPSS-PC 23.0 (SPSS Inc., Chicago, IL, USA).

Results

Table 2 represents descriptive statistics of measured parameters. With respect to parameters of demographics and socio-economic status, significant linear trends in mean age ($P < 0.001$), body mass index ($P = 0.022$), education ($P < 0.001$), religion ($P = 0.005$), and type of house ($P < 0.001$) were found according to increasing number of lifestyle risk factors. Those linear trends were interested as follows; individuals with one or more risk factors were likely to be older, heavier, less educated, absence of religion, and resident at a general house compared with individuals with zero risk factor.

Table 2: Descriptive statistics of measured parameters according to number of lifestyle risk factors at baseline

<i>Variables</i>	<i>Number of lifestyle risk factors</i>				<i>P value</i>
	0 (n=411/13.5%)	1 (n=1,581/52.1%)	2 (n=916/30.2%)	≥3 (n=126/4.2%)	
Age (yr)	68.6±6.5	70.5±7.4	71.1±7.4	73.9±8.4	<0.001
BMI (kg/m ²)	22.7±1.5	22.7±2.6	24.2±4.7	23.0±7.1	0.022
Income (10,000 won/month)	116±138	94±147	96±136	115±204	0.977
Education, n (%)					<0.001
Elementary or less	260 (63.3)	1326 (83.9)	787 (85.9)	119 (94.4)	
Middle/high school	135 (32.8)	230 (14.5)	123 (13.4)	7 (5.6)	
College	16 (3.9)	25 (1.6)	6 (0.7)	-	
Occupation, n (%)					0.084
Yes	23 (5.6)	230 (14.5)	113 (12.3)	14 (11.1)	
No	388 (94.4)	1351 (85.5)	803 (87.7)	112 (88.9)	
Religion, n (%)					0.005
No religion	108 (25.8)	579 (36.6)	349 (38.1)	46 (36.5)	
Protestant	100 (24.3)	361 (22.8)	189 (20.6)	21 (18.7)	
Catholic	61 (14.8)	152 (9.6)	114 (12.4)	13 (10.3)	
Buddhist	135 (32.8)	466 (29.5)	257 (28.1)	46 (36.5)	
Other	9 (2.2)	23 (1.5)	7 (0.8)	-	
House type, n (%)					<0.001
General house	198 (38.2)	1076 (68.1)	644 (70.3)	88 (69.8)	
Apartment	213 (51.8)	505 (31.9)	272 (29.7)	38 (30.2)	
Impaired cognition, n (%)	132 (32.1)	900 (56.9)	535 (58.4)	85 (67.5)	<0.001
Depression, n (%)	135 (32.8)	742 (46.9)	479 (52.3)	79 (62.7)	<0.001
Impaired ADL, n (%)	9 (2.2)	102 (6.5)	86 (9.4)	21 (16.7)	<0.001
Falls, n (%)	24 (5.8)	129 (8.2)	73 (8.0)	15 (11.9)	0.085
Hospitalization, n	46 (11.2)	221 (14.0)	144 (15.7)	22 (17.5)	0.017

(%)					
Co-morbidity, n (%)					<0.001
0	152 (37.0)	534 (33.8)	258 (28.2)	39 (31.0)	
1	150 (36.5)	579 (36.6)	319 (34.8)	43 (34.1)	
≥2	109 (26.5)	468 (29.6)	339 (37.0)	44 (34.9)	
Medications, n (%)					<0.001
0	182 (44.3)	671 (42.4)	338 (36.9)	49 (38.9)	
1	144 (35.0)	564 (35.7)	294 (32.1)	44 (34.9)	
≥2	85 (20.7)	346 (21.9)	284 (31.0)	33 (26.2)	

Lifestyle risk factors include smoking, heavy alcohol consumption, physical inactivity, unintentional weight loss, and underweight and/or obesity. BMI: body mass index, ADL: activities of daily living

With respect to health conditions, significant linear trends in impaired cognition ($P < 0.001$), depressive symptoms ($P < 0.001$), impaired ADL ($P < 0.001$), hospitalization ($P = 0.017$), comorbidity ($P < 0.001$), and medications ($P < 0.001$) according to increasing number of lifestyle risk factors. Those linear trends were interpreted as follow; individuals with one or more risk factors were likely to have higher prevalence of cognitive impairments, depressive symptoms, impaired ADL, and hospitalization in conjunction with higher rates of

comorbidity and medications compared with individuals with zero risk factor.

Table 3 represents correlations between covariates and the primary outcomes. All-cause and CVD mortality were significantly associated with age, BMI, income, education, occupation, religion, cognition, depression, ADL, falls, hospitalization, comorbidity, and medication. Non-CVD mortality was significantly associated with comorbidity ($r=0.102$) and medication ($r=0.117$) only.

Table 3: Correlations between covariates and the primary outcomes

<i>Variable</i>	<i>All-cause mortality</i>	<i>CVD mortality</i>	<i>Non-CVD mortality</i>
Age	$r = 0.341^{**}$	$r = 0.338^{**}$	$r = 0.009$
BMI	$r = -0.164^{**}$	$r = -0.161^{**}$	$r = 0.006$
Income	$r = -0.136^{**}$	$r = -0.132^{**}$	$r = 0.032$
Education	$r = -0.149^{**}$	$r = -0.147^{**}$	$r = 0.006$
Occupation	$r = 0.197^{**}$	$r = 0.198^{**}$	$r = 0.057$
Religion	$r = -0.041^*$	$r = -0.042^*$	$r = -0.042$
House type	$r = -0.027$	$r = -0.026$	$r = -0.026$
Cognition	$r = -0.250^{**}$	$r = -0.250^{**}$	$r = -0.043$
Depression	$r = 0.181$	$r = 0.184$	$r = 0.064$
ADL score	$r = 0.199^{**}$	$r = 0.199^{**}$	$r = 0.034$
Falls	$r = -0.057^*$	$r = -0.055^*$	$r = 0.008$
Hospitalization	$r = 0.083^*$	$r = 0.083^*$	$r = -0.035$
Comorbidity	$r = 0.155^{**}$	$r = 0.162^{**}$	$r = 0.102^*$
Medication	$r = 0.144^{**}$	$r = 0.152^{**}$	$r = 0.117^*$

** $P < 0.001$ and * $P < 0.05$

Table 4 represents prevalence of lifestyle risk factors at baseline and mortality rate. With respect to mortality, smoking, physical inactivity, and UWL were significantly associated with increased risks

of premature death from all causes and CVD. Physical inactivity was also associated with an increased risk of non-CVD mortality.

Table 4: Prevalence of lifestyle risk factors at baseline and hazard ratio (HR) and 95% confidence interval (CI) of all-cause and cardiovascular disease (CVD) mortality during 10 years of follow-up

Lifestyle risk factors	Prevalence at baseline (n / %)	All-cause mortality, HR (95% CI)	P value	CVD mortality, HR (95% CI)	P value	non-CVD mortality, HR (95% CI)	P value
Current/past smoking	141 (4.6)	2.157 (1.632 ~ 2.852)	<0.00 1	2.203 (1.611 ~ 3.013)	<0.00 1	1.085 (0.793 ~ 1.484)	0.611
Heavy alcohol intake	30 (1.0)	1.135 (0.539 ~ 2.391)	0.739	1.457 (0.691 ~ 3.072)	0.323	1.227 (0.581 ~ 2.558)	0.592
Physical inactivity	2348 (77.4)	1.790 (1.437 ~ 2.229)	<0.00 1	1.804 (1.407 ~ 2.313)	0.002	1.518 (1.183 ~ 1.949)	0.001
Unintentional weight loss	410 (13.5)	1.676 (1.377 ~ 2.039)	<0.00 1	1.678 (1.343 ~ 2.095)	<0.00 1	1.021 (0.817 ~ 1.276)	0.856
Underweight/obesity	870 (28.7)	0.999 (0.841 ~ 1.188)	0.993	1.024 (0.843 ~ 1.244)	0.808	0.914 (0.752 ~ 1.110)	0.365

Table 5 represents hazard ratio (HR) of all-cause and CVD and non-CVD mortality according to number of behavioral risk factors. Crude HR for all-cause mortality was incremental in the order of one risk factor, two risk factors, and three or more risk factors, as compared to zero risk factor (HR=1). The HR for three or more risk factors remained significant ($P = 0.016$) even after adjustments for all the covariates. Crude HR for CVD mortality was incremental in the order of one risk factor, two risk factors, and three or more risk factors, as compared to zero risk factor (HR=1). None of the HRs were significant when adjusted

for all the covariates. Crude HR for non-CVD mortality was incremental in the order of one risk factor, two risk factors, and three or more risk factors, as compared to zero risk factor (HR=1). None of the HRs were significant when adjusted for all the covariates. Finally, the Kaplan-Meier mortality function showed that the survival rate of all-cause mortality decreased according to increasing number of risk factors (Fig. 1). Similarly, the survival rate of CVD- and non-CVD mortality decreased according to increasing number of risk factors (data not shown).

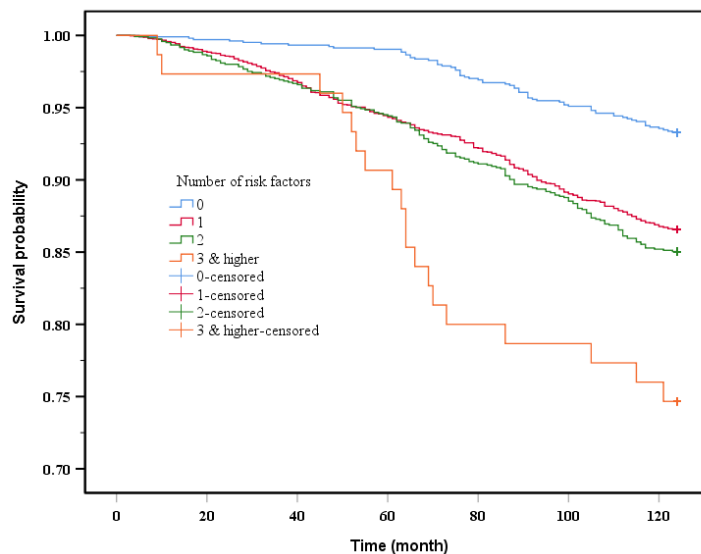


Fig. 1: Kaplan-Meier survival curve for all-cause mortality

Table 5: The risks of all cause- and cardiovascular disease-mortality according to number of lifestyle risk factors

	<i>Number of lifestyle risk factors</i>						
	0	1		2		≥ 3	
All-cause mortality		HR (95% CI)	P value	HR (95% CI)	P value	HR (95% CI)	P value
^a Death, n (%)	43 (10.5)	322 (20.4)		214 (23.4)		49 (38.9)	
Crude HR (95% CI)	1	2.277 (1.712 ~ 3.030)	<0.001	2.977 (2.214 ~ 4.003)	<0.001	5.154 (3.515 ~ 7.557)	<0.001
Adjusted HR (95% CI)	1	1.293 (0.925 ~ 1.807)	0.133	1.293 (0.912 ~ 1.832)	0.149	1.722 (1.105 ~ 2.681)	0.016
CVD mortality							
^a Death, n (%)	9 (2.2)	75 (4.7)		43 (4.7)		10 (7.9)	
Crude HR (95% CI)	1	2.035 (1.422 ~ 2.913)	<0.001	2.468 (1.708 ~ 3.567)	<0.001	4.484 (2.830 ~ 7.102)	<0.001
Adjusted HR (95% CI)	1	1.248 (0.853 ~ 1.826)	0.254	1.256 (0.846 ~ 1.867)	0.254	1.639 (0.988 ~ 2.704)	0.050
Non-CVD mortality							
^a Death, n (%)	34 (8.3)	247 (15.6)		171 (18.7)		39 (31.0)	
Crude HR (95% CI)	1	1.560 (1.088 ~ 2.235)	0.016	1.638 (1.131 ~ 2.373)	0.009	1.450 (0.919 ~ 2.308)	0.110
Adjusted HR (95% CI)	1	1.324 (0.901 ~ 1.945)	0.153	1.382 (0.927 ~ 2.058)	0.112	1.089 (0.659 ~ 1.798)	0.740

Adjusted for age, household income, education, occupation, religion, type of housing, cognition, depressive symptoms, comorbidity, medications, ADL condition, fall experience, and hospitalization. HR: hazard ratio, CI: confidence interval, CVD: cardiovascular disease, ADL: activities of daily living

Discussion

We examined the association between risk factors, all-cause, and CVD mortality during average 9.2 yr of follow-up in older Korean women and found that lifestyle risk factors, especially smoking, physical inactivity, and UWL, were significantly associated with an increased risk of all-cause and CVD-mortality.

The current findings support and extend those of previous studies reporting the association between

behavioral risk factors and mortality in Western populations. By using data from the Nord-Trøndelag Health Study (HUNT) involving 36,911 Norwegians aged 20~69 yr, all-cause and CVD mortality increased linearly according to increasing lifestyle risk score on the basis of smoking, excessive alcohol consumption, poor diet, physical inactivity, sedentary behaviors, too much/too little sleep, and poor social participation (16). On the other hand, a positive impact of healthy lifestyle factors on life expectancy has been

reported from a healthy ageing: a longitudinal study in Europe (HALE) study (17). By analyzing data obtained from a nurses' health study and a health professionals follow-up study, Li et al (13) also showed that adherence to non-smoking, healthy body weights, physical activity, moderate alcohol intake, and a healthy diet was associated with lower risks of all-cause mortality, cancer mortality, and CVD mortality.

The impact of lifestyle risk factors on mortality has been also observed in Korean populations. In the Severance Health Promotion Center visitors-based cohort study 59,941 Korean men and women aged 30-84 yr, Yun et al (11) found that in men, hazard ratio (HR) of 4 risk factors (i.e., smoking, heavy alcohol intake, overweight or obesity, physical inactivity, and unhealthy diet) was 2.00 (95% CI, 1.58-2.52) for all-cause mortality, 2.04 (95% CI, 1.57-2.87) for cancer mortality, and 1.92 (95% CI, 1.39-2.64) for non-cancer mortality compared to one or less risk factor (HR=1). In women, HR of 4 risk factors was 2.00 (95% CI, 0.93 - 4.29) for cancer mortality, 2.17 (95% CI, 1.01 - 4.67) for non-cancer mortality, and 2.09 (1.22 - 3.59) for all-cause mortality compared to one or less risk factor (HR=1). In the Seoul male cohort study involving 12,538 middle-aged and older men, Kim et al (12) showed that adjusted population attributable risk of the 3 combined risk factors (i.e., smoking, high blood pressure, and high fasting glucose) was 35.2% (95% CI, 21.7-47.4) for all-cause mortality and 52.8% (95% CI, 22.0-74.0) for CVD mortality. Together, those previous findings are in accordance with the findings of our study.

Yet, we are the first to report that adding UWL to traditional risk factors may strengthen their prognostic role for mortality risk in older Korean women. In accordance with the current findings, in a meta-analysis of 15 studies involving 178,644 participants, adjusted risk ratio of UWL was 1.38 (95% CI, 1.23-1.53) for all-cause mortality and 1.17 (95% CI, 0.98-1.37) for major cardiovascular events (1). In another meta-analysis involving men and women aged 60 yr and older, the impact of UWL on mortality was found in older women (HR, 1.68; 95% CI, 1.20-2.35; $P < 0.001$) but not

in older men (HR, 1.32; 95% CI, 0.97-1.77; $P > 0.05$) (2). Together, the findings of the previous studies are in accordance with the current findings of the study and support UWL as an additional risk factor.

Some explanations can be given for the impact of lifestyle risk factors on all-cause and CVD death risk observed in the current study. First, tobacco smoking is a well-established and leading cause of premature death worldwide (18). Second, heavy alcohol consumption is associated with a higher risk of all-cause and cancer mortality (19). Third, unhealthy body weight was independently associated with an increased risk of CVD- and cancer mortality (20). Fourth, UWL is a novel risk factor of health conditions, such as morbidity and mortality, in elderly persons (21). Lastly, physical activity is associated with a lower risk of all-cause and cause-specific mortality (22).

The present study had some limitations. First, the nature of this cross-sectional study was a limitation in drawing conclusions about causation. Therefore, the current findings should be confirmed via a longitudinal study to establish causal relationships between unhealthy behaviors and premature deaths from all causes and CVD and non-CVD in Korea adults. Second, the current study did not include other significant risk factors, such as poor nutrition, prolonged sitting and sleeping, which may affect health conditions and mortality. In particular, poor quality of diets (e.g., high-carbohydrate or high-fat) may contribute to an increased risk of mortality by triggering oxidative stress and thereby inflammatory responses (23). Considering the role(s) of those dietary factors will be necessary for better understanding the complexity of the relationships between lifestyle behaviors and mortality.

Despite the limitations, the current findings of the study confirm the independent role of lifestyle risk factors in predicting all-cause and CVD-mortality. To the best of our knowledge, this is the first to report the impact of adding UWL to the traditional risk factors on all-cause and CVD mortality in older Korean women. In this aspect, the current findings extend the current literature regarding the

prognostic role of unhealthy behaviors in determining the risks of all-cause and CVD-mortality in Asian countries.

Conclusion

Modifiable risk factors, individual or combined, were significantly associated with an increased risk of all-cause and CVD- and non-CVD mortality in older Korean women, implying the urgency of adopting/promoting healthy behaviors to ameliorate disease burden and mortality for women later in life.

Ethical considerations

Ethical issues (including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The Authors declare that there is no conflict of interest.

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