Associations between Korean coronary heart disease risk score and cognitive function in dementia-free Korean elderly

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ABSTRACT

Associations between Korean coronary heart disease risk score and cognitive function in dementia-free Korean elderly

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Background

Cardiovascular disease risk is modifiable factor to prevent dementia. Given the lack of optimal treatment options, it is crucial to manage its risk factors.

Objective

This study examined the association between cardiovascular risk as measured by the Korean coronary heart disease risk score (KRS) and cognitive decline in dementia-free Korean elderly people.

Methods

The study sample consisted of 8,600 dementia-free Korean elderly (3,394 men and 5,206 women) who received a medical evaluation from the National Health Insurance Service between 2015 and 2020. Cardiovascular risk was assessed by KRS, which accounts for age, sex, blood pressure, diabetes status, total cholesterol, high density lipoprotein and smoking status. Participants were categorized as having highest, middle, or lowest KRS group. Cognitive function was assessed by the Korean Dementia Screening Questionnaire-Cognition

(KDSQ-C). Scores of 6 or more indicate cognitive decline. Logistic regression analysis was used to estimate odds ratios and 95% CIs for the associations between cardiovascular risk and cognitive function. Weight, height, stroke history, coronary heart disease history, alcohol consumption, and physical activity engagement were adjusted.

Results

The average age of the study sample is 69.74 years old (SD = 3.10). Divided into three groups based on the KRS, 5,923 people (68.9%) in the lowest risk group, 2,343 (27.2%) in the middle risk group and 334 (3.9%) in the highest risk group. The highest KRS group in all participants exhibited a greater risk of cognitive decline than the lowest KRS group (odds ratio = 1.339, 95% CI: 1.034 to 1.734). The highest KRS female group aged 71–75 years old exhibited greater cognitive decline than the corresponding lowest KRS group (Odds ratio = 1.595, 95% CI 1.045 to 2.434).

Conclusion

Those with high cardiovascular risk exhibited significantly more cognitive decline than those with low cardiovascular risk, especially among older women. These results indicate that the Korean coronary heart disease risk prediction model can be used to identify older women at risk high risk of cognitive decline. This study's results show that cardiovascular risk factors should be managed to promote healthy mental aging in elderly people without dementia.

Keywords: korean coronary heart disease risk score, cardiovascular risk, Framingham score, cognitive function, korean dementia screening questionnaire-cognition

Associations between Korean coronary heart disease risk score and cognitive function in dementia-free Korean elderly

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I. INTRODUCTION

Dementia is one of the biggest public health disease in aged society. In Korea, the number of dementia patients is expected to pass 3 million in 2050.[1] The rate at which the number of dementia patients is increasing is also itself increasing faster than expected. The cost of dementia management worldwide is expected to reach about $1 trillion in 2018 and exceed $2 trillion by 2030, with costs in Korea showing a similar growth trend.[2]

Given the lack of effective treatments for dementia, identifying modifiable risk is very crucial. It is also necessary to prevent the increase in medical costs and reduce family and social burdens by managing modifiable factors not genetic factors such as apolipoprotein E. The Lancet Committee published 12 modifiable risk factors for dementia in 2020, including cardiovascular-related factors such as hypertension, diabetes, obesity and smoking.[3]

Traditional cardiovascular risk factors such as hypertension, diabetes, dyslipidemia, obesity and smoking have been associated with rapid cognitive decline respectively.[4,5]

But cardiovascular risk factors are interrelated.[6,7] It is difficult to isolate their individual effects on cognitive decline. A composite score is required to evaluate the cardiovascular risk comprehensively. It is important to understand individuals' cardiovascular risk from the perspective of precision medicine. The Framingham score is commonly used to evaluate cardiovascular risk burden and developing cardiovascular risk because it also integrates demographic risk factors and cardiovascular risk factors.[8]

Framingham scores and cognitive functioning are related.[9-17] Two studies of people with Alzheimer's dementia and mild cognitive impairment showed that Framingham score was positively correlated with the rate of cognitive decline.[15,16] A study conducted in Korea showed that Framingham scores and cognitive decline were positively correlated among elderly women.[17]

However, the Framingham scores consistently overestimates cardiovascular risk, especially among Asian populations.[18–20] The Korean coronary heart disease risk score (KRS) was developed to more accurately measure cardiovascular risk among Korean populations.[20] In this study, we examined the association between cardiovascular risk as measured by KRS and global cognitive function in dementia-free Korean elderly people.

II. MATERIALS AND METHODS

1. Study Sample

This cross-sectional study was conducted on data from 373,933 Koreans aged 30–95 years old who received at least one biennial National Health Insurance Service (NHIS) medical evaluation between 2015 and 2020 at a single hospital. Data was only used for people 65–75 years old (n = 60,347). Of this sample, data for those who had dementia, which was defined as having ICD-10 diagnostic codes of F00, F01, F02, F03, G309, G300, G301, or G308 (n = 922); for whom data about cognitive function was missing (n = 45,880); and whose KRS data was missing (n = 4,945) was excluded, resulting in data for 8,600 people included in the final analysis (Figure 1). The study was approved by the Institutional Review Board of the National Health Insurance Medical Center (approval no. 2021-05-004-001).

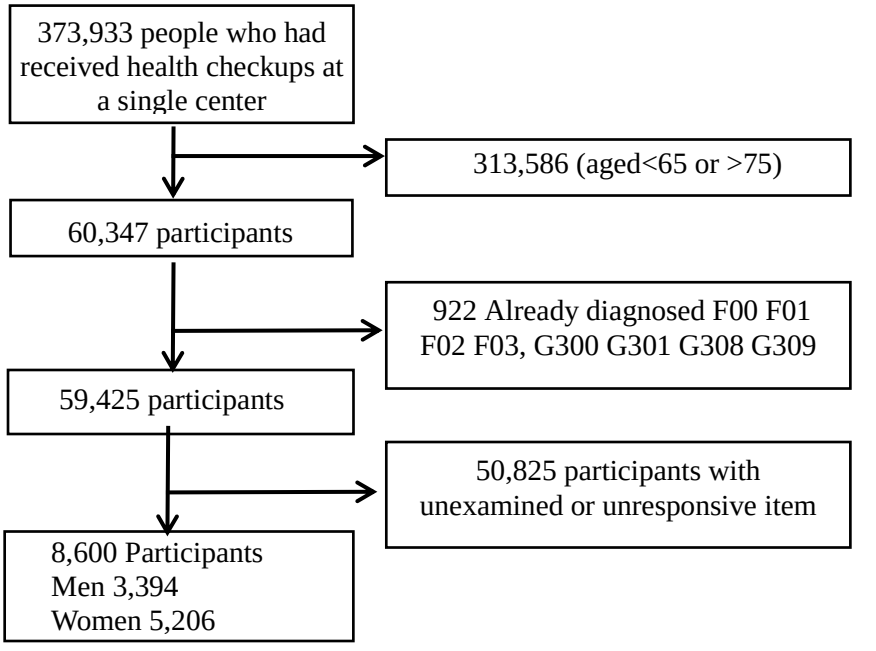

Figure 1. Study sample selection flowchart.

2. Data Collection

The biennial NHIS medical evaluation consisted of self-reporting, body measurement and laboratory test. Each person was asked to rest for five minutes, then their blood pressure was measured in the sitting position with an automatic blood pressure meter, then they rested again for five minutes and again their blood pressure was measured. Their height and weight were measured using an automatic scale while wearing a light gown after fasting since the midnight. Smoking habits were categorized as never smoked, formerly smoke, or currently smoke. Alcohol consumption was calculated in grams of alcohol per day.[21] Total weekly metabolic equivalents (MET) were calculated based on the number of days in which the person engages in moderate- or high-intensity exercise and the durations for such activities.[22] Hypertension was defined as a systolic blood pressure of 140 mmHg or higher, a diastolic blood pressure of 90 mmHg or higher, or if the person used antihypertensive medication. Diabetes was defined as a fasting blood sugar of 126 mg/dL or higher or if the person used diabetes medication. Dyslipidemia was classified as a total cholesterol level was 240 mg/dL or higher or if the person used dyslipidemia medication. Stroke, coronary heart disease, hypertension, diabetes, dyslipidemia, tuberculosis past and medication histories were assessed by questionnaires. Blood sample were taken, including lipid profiles. Cognitive function was ascertained by Korean dementia screening questionnaire – cognition (KDSQ-C). Missing total cholesterol and high density lipoprotein cholesterol (HDL) data were imputated by using data within the preceding 5 years.

3. Korean coronary heart disease risk score

The KRS was developed based on the data of 268,315 people who examined in the multicenter health checkup. The KRS is based on sex, age, systolic blood pressure, diastolic blood pressure, total cholesterol, HDL cholesterol, smoking status, and diabetes history.[20] The areas under the ROCs were 0.764 for men and 0.815 for women.[20]

When calculating KRS, blood pressure was classified according to the 7th Guidelines of the Joint National Committee on hypertension.[23] Total cholesterol was categorized as less than 160, 160-199, 200-239, 240-279, more than 280 mg/dL. HDL was categorized as less than 35, 35-44, 45-49, 50-59, more than 60 mg/dL.[20] KRS was categorized as 0–2%, 2–4%, or more than 4% likelihood of a coronary heart disease event occurring in the next 10 years, which corresponded to lowest, middle and highest.[24] A higher KRS indicates a higher current cardiovascular burden and greater risk of a coronary disease event occurring within the next 10 years (Appendices A).

4. The Korean Dementia Screening Questionnaire-Cognition

The KDSQ-C is a standard tool for the early diagnosis of dementia. It is a structured questionnaire that includes 15 questions that assess memory impairment, other cognitive impairments, and instrumental activity daily living activities. Each question can be responded to with either “No,” “Sometimes (a little bit) yes,” and “often (a lot) yes,” which receive 0, 1, and 2 points, respectively for a possible total score of 30 points.

The KDSQ-C is administered as part of biennial NHIS medical examinations starting at the age of 66.[25] It is not affected by patient or caregiver age, sex, or educational background. None of the items are concerned with reading or writing, so it is still effective for screening for dementia among those

with low education levels.[25] Higher scores reflect poorer cognitive function. Patients with scores ≥ 6 undergo additional tests for dementia diagnosis.[26] With respect to dementia diagnosis, the KDSQ-C's threshold of 6 points has a sensitivity of 79% and a specificity of 80%.[26]

5. Statistical Analysis

The study sample's baseline characteristics of by KRS were compared using a Fisher's exact test, chi-square test for categorical variables and a one-way ANOVA for continuous variables. Logistic regression analysis was used to estimate odds ratio and 95% confidence intervals for the associations between cardiovascular risk and cognitive function. Considering the repeated measurement of the same subject, the generalized estimation equation method was used.

Weight, height, stroke history, coronary heart disease history, alcohol consumption, physical activity engagement were adjusted. The statistical analyses were conducted using SPSS ver 26.0 (IBM Co. , Armonk, NY, USA). P-values of less than 0.05 were considered to be statistically significant.

III. RESULTS

Table 1. Demographic characteristics of the study sample by KRS group (n = 8,600)

	KRS				
	Lowest (n = 5,923, 68.9%)	Middle (n = 2,343, 27.2%)	Highest (n = 334, 3.9%)	Total (n= 8,600)	p-value
Age (mean±SD)	69.22±3.01	70.85±2.97	71.33±2.95	69.74±3.10	< 0.001
Women (%)	3881(65.5)	1188(50.7)	137(41.0)	5206(60.5)	< 0.001
Height (mean±SD)	158.54±7.94	160.14 ±8.19	161.80±7.94	159.10±8.06	< 0.001
Weight (mean±SD)	61.15±9.79	63.05±9.95	64.05±9.85	61.78±9.88	< 0.001
SBP (mean±SD)	130.04 ±12.07	134.20 ±11.98	137.23 ±13.00	131.45 ±12.28	< 0.001
DBP (mean±SD)	75.45±8.23	77.59±8.52	78.90±9.81	76.17±8.45	< 0.001
Total cholesterol (mean±SD)	180.20 ±36.80	201.11 ±42.42	218.41 ±45.36	187.38 ±40.33	< 0.001
HDL (mean±SD)	56.29±12.70	51.59 ±12.41	47.78±12.12	54.68 ±12.84	< 0.001
Smoking Status n(%)					< 0.001
Never	4449(75.1)	1338(57.1)	127(38.0)	5914(68.8)	
Ex- Smoker	1366(23.1)	715(30.5)	84(25.1)	2165(25.2)	
Smoker	108(1.8)	290(12.4)	123(36.8)	521(6.1)	
Alcohol amount (mean±SD)	45.17±69.89	46.47 ±66.27	47.37±61.98	45.61±68.62	0.660
Physical Activity (mean±SD)	1916.10 ±4768.49	1982.34 ±8363.38	1702.22 ±3106.19	1925.84±5923.39	0.703
Stroke, n(%)	195(3.3)	102(4.4)	17(5.1)	314(3.7)	0.024
Coronary heart disease, n(%)	449(7.6)	233(9.9)	39(11.7)	721(8.4)	< 0.001
KRS (mean±SD)	1.28±0.38	2.66±0.52	5.22±1.29	1.81±1.04	< 0.001
KDSQ-C Score(mean±SD)	2.98±3.11	2.90±3.07	3.17±3.18	2.96±3.10	0.284

KDSQ-C, n(%)				0.272
< 6	4946(83.5)	1961(83.7)	268(80.2)	7175(83.4)	
≥ 6	977(16.5)	382(16.3)	66(19.8)	1425(16.6)	

P values are from χ^2 test, Fisher's exact test or one-way ANOVA; categorical variable: number (percentage), continuous variable: Mean±Standard Deviation.

Epidemiological data are shown in Table 1. Of the 8,600 individuals included in the final analysis, 5,206 were men and 3,374 were women. They were 69.74 ± 3.1 years old. There were 5,923 (68.9%) people in the lowest KRS group, 2,343 (27.2%) in the middle group, and 334 (3.9%) in the highest group. The average KDSQ-C score was 2.96 ± 3.10 points. There were 1,425 (16.6%) people with a KDSQ-C score of 6 or higher while 7,175 (83.4%) did not. Smoking status, stroke history, and coronary heart disease history were statistically significantly correlated with KRS in all participants.

Table2. Characteristics of men with cardiovascular risk (n = 3,394)

	KRS				
	Lowest (n= 2,042, 60.2%)	Middle (n= 1,155, 34.0%)	Highest (n = 197, 5.8%)	Total (n= 3,394)	p-value
Age (mean±SD)	69.16±3.09	70.35±3.06	70.43±3.07	69.64±3.13	< 0.001
Height (mean±SD)	158.90±7.96	159.54 ±8.04	160.59±7.85	159.22±7.99	0.005
Weight (mean±SD)	61.32±9.75	62.08±9.51	62.94±9.82	61.67±9.68	0.017
SBP (mean±SD)	129.64 ±12.06	133.42 ±12.30	136.42 ±12.03	131.32 ±12.33	< 0.001
DBP (mean±SD)	75.34±8.17	77.27±8.62	78.49±8.50	76.18±8.41	< 0.001
Total cholesterol (mean±SD)	174.47 ±33.43	202.40 ±41.82	223.62± 43.94	186.83 ±40.39	< 0.001
HDL (mean±SD)	56.89±12.17	51.11±12.5	47.34±11.68	54.36±12.67	< 0.001
Smoking Status n(%)					< 0.001
Never	1469(71.9)	740(64.1)	90(45.7)	2299(67.7)	
Ex- Smoker	540(26.4)	300(26.0)	37(18.8)	877(25.8)	
Smoker	33(1.6)	115(10.0)	70(35.5)	218(6.4)	
Alcohol amount (mean±SD)	44.40±64.11	46.52 ±66.72	47.57±62.99	45.31±64.94	0.596
Physical activity (mean±SD)	1900.60 ±5848.51	1675.45 ±4773.29	1668.49 ±3027.13	1810.51 ±5372.74	0.486
Stroke, n(%)	64(3.1)	49(4.2)	15(7.6)	128(3.8)	0.004
Coronary heart disease, n(%)	153(7.5)	104(9.0)	22(11.2)	279(8.2)	0.098
KRS (mean±SD)	1.36±0.36	2.71±0.53	5.29±1.44	2.05±1.16	< 0.001
KDSQ-C Score (mean±SD)	2.43±3.02	2.51±2.97	2.68±2.69	2.47±2.98	0.475
KDSQ-C, n(%)					0.593
< 6	1770(86.7)	993(86.0)	166(84.3)	2929(86.3)	
≥ 6	272(13.3)	162(14.0)	31(15.7)	465(13.7)	

P values are from χ^2 test, Fisher's exact test or one-way ANOVA; categorical variable: number(percentage), continuous variable: Mean±Standard Deviation.

Table 3. Characteristics of women with cardiovascular risk (n=5,206)

	KRS				
	Lowest (n= 3,881, 74.6%)	Middle (n= 1,188, 22.8%)	Highest (n = 137, 2.6%)	Total (n = 5,206)	p-value
Age (mean±SD)	69.25±2.97	71.33±2.80	72.61±2.21	69.81±3.07	< 0.001
Height (mean±SD)	158.34±7.92	160.73±8.3	163.55±7.77	159.03±8.10	< 0.001
Weight (mean±SD)	61.05±9.81	64.00±10.2	65.65±9.70	61.85±10.01	< 0.001
SBP (mean±SD)	130.25 ±12.07	134.96 ±11.62	138.40 ±14.23	131.54 ±12.24	< 0.001
DBP (mean±SD)	75.51±8.27	77.91±8.41	79.49±11.44	76.16±8.47	< 0.001
Total cholesterol (mean±SD)	183.21 ±38.11	199.86 ±42.97	210.91 ±46.47	187.74 ±40.29	< 0.001
HDL (mean±SD)	55.97±12.96	52.07±12.2	48.43±12.74	54.88±12.95	< 0.001
Smoking Status n(%)					< 0.001
Never	2980(76.8)	598(50.3)	37(27.0)	3615(69.4)	
Ex- Smoker	826(21.3)	415(34.9)	47(34.3)	1288(24.7)	
Smoker	75(1.9)	175(14.7)	53(38.7)	303(5.8)	
Alcohol amount (mean±SD)	45.57±72.75	46.42 ±65.86	47.08±60.72	45.80±70.93	0.916
Physical activity (mean±SD)	1924.26 ±4088.09	2280.70 ±10755.24	1750.73 ±3227.09	2001.03 ±6255.70	0.430
Stroke, n(%)	131(3.4)	53(4.5)	2(1.5)	186(3.6)	0.085
Coronary heart disease, n(%)	296(7.6)	129(10.9)	17(12.4)	442(8.5)	< 0.001
KRS (mean±SD)	1.24±0.38	2.61±0.50	5.10±1.01	1.65±0.92	< 0.001
KDSQ-C Score(mean±SD)	3.26±3.13	3.28±3.11	3.88±3.66	3.29±3.14	0.150
KDSQ-C, n(%)					0.091
< 6	3176(81.8)	968(81.5)	102(74.5)	4246(81.6)	
≥ 6	705(18.2)	220(18.5)	35(25.5)	960(18.4)	

P values are from χ^2 test, Fisher's exact test or one-way ANOVA; categorical variable: number(percentage), continuous variable: Mean±Standard Deviation.

Table 2 and 3 display the demographic characteristics of men and women, respectively, by KRS group. More women (74.6%) were in the lowest KRS group than men (60.2%). Conversely, more men were in the highest KRS group (5.8%) than women (2.6%). There were fewer men (13.7%) with a KDSQ-C of 6 or higher than women (18.4%).

Smoking status was significantly associated with KRS for both men and women. Stroke history in men and coronary heart disease history in women were significantly associated with KRS. In men's age subgroup analysis, significant differences were observed in age, height, weight, systolic blood pressure, diastolic blood pressure, total cholesterol, HDL, and smoking status. No significant difference was observed in alcohol consumption, physical activity, or coronary heart disease history (Appendices Table 9,10).

Table 4. Odds ratio and 95% Confidence intervals for cognitive function by KRS group

Subject	KRS (n)	Odds ratio (95% confidence Intervals)		p value
All	Lowest (5923)	1	Reference	
(8600)	Middle (2343)	1.059	0.940-1.194	0.347
	Highest (334)	1.339	1.034-1.734	0.027
Male	Lowest (2042)	1	Reference	
(3394)	Middle (1155)	1.075	0.891-1.298	0.449
	Highest (197)	1.109	0.749-1.642	0.607
Female	Lowest (3881)	1	Reference	
(5206)	Middle (1188)	1.048	0.898-1.224	0.550
	Highest (137)	1.629	1.144-2.319	0.007

Adjusted for height, weight, alcohol amount, physical activity, sex(only in all subjects), stroke, coronary heart disease.

Relationship between KRS and cognitive function

The odds ratios of cognitive function by KRS group are shown in Table 4. The lowest group was used as the reference. Compared with the lowest group of KRS in all subjects, the highest risk in all participants was associated with cognitive decline in table 4 (Odds ratio = 1.339; 95% CI 1.034 to 1.734; p-value 0.005). Among women, the highest risk group was 1.629 times more likely to experience cognitive decline than the lowest risk group (Odds ratio = 1.629; 95% CI 1.144 to 2.319; p-value 0.004).

Table 5. Odds ratio and 95% Confidence intervals for cognitive function by KRS group among 65-70-year-olds

Subject	KRS (n)	Odds ratio (95% confidence Intervals)		p value
All	Lowest (3899)	1	Reference	
(5052)	Middle (1027)	1.111	0.932-1.325	0.241
	Highest (126)	1.377	0.897-2.114	0.144
Male	Lowest (1360)	1	Reference	
(2051)	Middle (593)	1.104	0.855-1.425	0.447
	Highest (98)	1.379	0.812-2.342	0.234
Female	Lowest (2539)	1	Reference	
(3001)	Middle (434)	1.133	0.890-1.444	0.311
	Highest (28)	1.361	0.611-3.032	0.451

Adjusted for height, weight, alcohol amount, physical activity, sex(only in all subjects), stroke, coronary heart disease.

Table 6. Odds ratios and 95% confidence intervals for cognitive function by KRS group among 71–75-year-olds

Subject	KRS (n)	Odds ratio (95% confidence Intervals)		p value
All	Lowest (2024)	1	Reference	
(3548)	Middle (1316)	1.021	0.850-1.228	0.821
	Highest (208)	1.370	0.949-1.979	0.093
Male	Lowest (682)	1	Reference	
(1343)	Middle (562)	1.009	0.749-1.358	0.954
	Highest (99)	0.809	0.428-3.032	0.515
Female	Lowest (1342)	1	Reference	
(2205)	Middle (754)	0.963	0.781-1.189	0.729
	Highest (109)	1.595	1.045-2.434	0.031

Adjusted for height, weight, alcohol amount, physical activity, sex(only in all subjects), stroke, coronary heart disease.

Tables 5 and 6 show the correlations between KRS group and KDSQ-C scores by age subgroup. There were no statistically significant correlations between KRS group and cognitive function among 65–70-year-olds. Among 71–75-year-olds, women in the highest KRS group were 1.595 times more likely to be experiencing cognitive decline than the lowest KRS group (odds ratio = 1.595, 95% CI = 1.045–2.434, p-value = 0.031). These results indicate that reducing cardiovascular risk among the elderly, especially older women, is important for healthy brain aging.

IV. DISCUSSION

As cardiovascular risk increased, Odds ratio increased across all participants, but this relationship was especially strong for older women. KRS was correlated with cognitive function among women, but not men.

In previous studies, Cardiovascular risk as assessed by Framingham score was positively correlated with cognitive decline.[9–16] One study showed that people with high Framingham score quickly progressed from mild cognitive impairment to dementia.[15] Also, higher vascular risk factor index was related with cognitive decline.[27]

One study found that Framingham score was positively correlated with the speed of the decline in global cognition, episodic memory, working memory, and perceptual speed.[9] In Korea, people with metabolic syndromes namely abdominal obesity, hypertryglycemia, low HDL, hypertension, and diabetes, have been found to have lower cognitive function scores than others.[28,29] This study was conducted on people who had undergone NHIS medical examinations and used a cardiovascular risk assessment model tailored for Koreans.

There are several neuroimaging studies explaining cerebrovascular changes in case of high cardiovascular risk.[9,30,31] Changes in the hippocampus, gray matter, and cerebral white matter of dementia-free elderly people with high cardiovascular risks have been observed in brain MRIs. Reduced hippocampus and gray matter volume indicate the presence of Alzheimer's dementia which is associated with neurodegeneration. White matter hyperintensity refers to microvascular lesions in cerebral white matter. Cardiovascular risk was positively correlated with neuronal degeneration and vascular changes.[9]

One study reported that Framingham score was positively correlated with β-amyloid burden of Pittsburgh compound PET. High cardiovascular risk and high β-amyloid burden cause synergistic effects and lead to decreased cognitive function scores.[30]

A study of elderly people with normal cognitive function showed that β –amyloid accumulation was negatively correlated with cerebrovascular responses.[31]

There are pathophysiological pathways that explain the correlations observed in this study. Cardiovascular risk factors can lead to systemic subclinical atherosclerosis or arteriosclerosis that affect the heart, brain, and peripheral blood vessels by inducing inflammation and oxidative stress. These effects can cause silent cerebral hypoperfusion, hypoxia, and inflammatory injury, which in turn can cause cognitive decline.[32]

The influence of cardiovascular risk factors on cognitive decline differs by sex. The correlation between Framingham scores and cognitive function, defined in terms of global cognition, verbal fluency, and long-term recall, was found to be stronger in women than in men.[33] One study reported that depression was significantly associated with cognitive impairment among both gender. Having limitation of instrumental activities of daily living, poor hearing was significant associated with cognitive decline only among Korean elderly women. In contrast limitation of activities of daily living was significant related with cognitive decline only among men.[34] In order to prevent cognitive decline, it is necessary to manage depression more thoroughly along with the control of cardiovascular risk factors in Korean elderly. The use of hearing aids is recommended to control hearing loss and prevent cognitive decline at the same time in korean elderly women.

The difference in the correlation between KRS and cognitive function by sex may be related to vascular physiology. Coronary microvascular and endothelial dysfunction is more common in women than men because of its smaller arterial size and more vascular remodeling in women. The same mechanism can cause more microvascular damage in women’s brains, resulting in quiet cerebral infarction and hypoperfusion.[33,35] A cohort study in China, Older subjects had more association between high cardiovascular risk and

worse calculation ability.[35]

The prevalence and cost of dementia management is increasing, but there are no effective treatments for it, so it is important to prevent it. Our study's results showed that optimal blood pressure and lipid levels, not smoking, and controlling diabetes promote healthy brain aging among dementia-free elderly people, especially women.

One of this study's strengths was that cardiovascular risk factors were reflected in the integrated KRS. It is important to understand individuals' cardiovascular risk from the perspective of precision medicine.

This study had three main limitations. The first was that it only used data from a single health center. Classified as normal if the patient is diagnosed with dementia at another hospital and only examined at the health checkup. The second limitation was that education also affects dementia, but due to the characteristics of the NHIS medical examination, education data was not available and so was not included in this study's analysis. The third limitation was that this study was cross-sectional, so subsequent cohort studies should examine the relationship between cardiovascular risk and cognitive decline. Also, the neurocognitive effect of statins is controversial, so we need to confirm it through follow-up studies.[36]

V. CONCLUSION

This study examined the relationship between cardiovascular risk and cognitive function among non-demented Korean elderly people between the ages of 65 and 75. This study's results showed that controlling hypertension, diabetes, dyslipidemia, and smoking may help maintain cognitive health in old age, especially among women.

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Appendices A. The Korean coronary heart disease Risk Score

For men, the risk score (KRS-M) is defined using the following steps:
x=0.13759*(AGE-45.7991)-0.0006964*(AGESQ-2186.58)+0.24130*(HTN2-0.40678)+0.54176*(HTN3-0.18005)+0.79091*(HTN4-0.06823)+0.30303*(TC2-0.43540)+0.72508*(TC3-0.31439)+1.02770*(TC4-0.08486)+1.51018*(TC5-0.01387)-0.41580*(HDL2-0.31063)-0.59809*(HDL3-0.22692)-0.80256*(HDL4-0.27050)-1.13973*(HDL5-0.11410)-0.00207*(EXSMOK-0.23029)+0.60138*(CUSMOK-0.53016) +0.49443*(DM-0.08389).
where AGESQ is the square of age, HTN is hypertension (HTN2: pre hypertension, HTN3: stage 1 hypertension, HTN4: stage 2 hypertension), TC is total cholesterol (TC2: 160-199 mg/dl, TC3: 200-239 mg/dl, TC4: 240-279 mg/dl, TC5: ≥280 mg/dl), HDL is HDL-cholesterol (HDL2: 35-44 mg/dl, HDL3: 45-49 mg/dl, HDL4: 50-59 mg/dl, HDL5: ≥60 mg/dl), EXSMOK is ex-smoker, CUSMOK is current smoker and DM is diabetes.
y=exp(x). Finally, the absolute 10-year risk of CHD is KRS-M =(1-0.99313**y), where 0.99313 is the baseline survival rate for men.

For women, the risk score (KRS-W) is defined similarly.
x=0.12962*(AGE-47.5808)-0.0003965*(AGESQ-2363.65)+0.41491*(HTN2-0.32308)+0.66187*(HTN3-0.14102)+1.10282*(HTN4-0.06657)+0.20005*(TC2-0.41642)+0.44176*(TC3-0.29841)+0.52267*(TC4-0.09640)+1.03573*(TC5-0.02196)-0.28121*(HDL2-0.18651)-0.18543*(HDL3-0.16015)-0.47018*(HDL4-0.30597)-0.72046*(HDL5-0.31451)+0.23099*(EXSMOK-0.03970)+0.67653*(CUSMOK-0.05079) +0.58729*(DM-0.06026).
y=exp(x). Finally, the absolute 10-year risk of CHD, KRS-W =(1-0.99815**y), where 0.99815 is the baseline survival rate for women.

Table 7. Characteristics of those 65-70 year olds by KRS (n = 5,206)

	KRS				
	Lowest (n = 3,899, 74.9%)	Middle (n = 1,027, 19.7%)	Highest (n = 126, 2.4%)	Total (n= 5206)	p-value
Age (mean±SD)	67.38±1.72	67.98±1.78	68.04±1.68	67.51±1.75	< 0.001
Women (%)	2539(65.1)	434(42.3)	28(22.2)	3001(59.4)	
Height (mean±SD)	158.73±8.02	160.44±8.0	162.22±8.11	159.16±8.07	< 0.001
Weight (mean±SD)	61.34±9.86	63.43±9.83	65.01±10.57	61.85±9.92	< 0.001
SBP (mean±SD)	130.24 ±12.15	134.49 ±11.87	138.10 ±14.61	131.30 ±12.32	< 0.001
DBP (mean±SD)	75.58±8.23	77.75±8.58	79.33±10.98	76.11±8.44	< 0.001
Total cholesterol (mean±SD)	181.79 ±37.29	205.79 ±42.61	222.52 ±44.21	187.68 ±40.18	< 0.001
HDL (mean±SD)	55.83±12.71	50.90±11.8	47.06±11.64	54.61±12.72	< 0.001
Smoking Status n(%)					< 0.001
Never	2873(73.7)	550(53.6)	46(36.5)	3469(68.7)	
Ex- Smoker	936(24.0)	306(29.8)	26(20.6)	1268(25.1)	
Smoker	90(2.3)	171(16.7)	54(42.9)	315(6.2)	
Alcohol amount (mean±SD)	45.64±65.22	45.95±65.5	42.48±49.50	45.63±64.94	0.851
Physical Activity (mean±SD)	1920.16±5088.00	2033.02±9080.86	1464.98±2755.28	1931.75±6076.52	0.594
Stroke, n(%)	124(3.2)	44(4.3)	6(4.8)	174(3.4)	0.161
Coronary heart disease, n(%)	302(7.7)	106(10.3)	14(11.1)	422(8.4)	0.016
KRS (mean±SD)	1.20±0.38	2.62±0.51	5.22±1.25	1.59±0.93	< 0.001
KDSQ-C Score (mean±SD)	2.91±3.10	2.80±3.05	2.96±3.02	2.89±3.09	0.604
KDSQ-C, n(%)					0.555
< 6	3284(84.2)	858(83.5)	102(81.0)	4244(84.0)	
≥ 6	615(15.8)	169(16.5)	24(19.0)	808(16.0)	

Table 8. Characteristics of those 71-75 year olds by KRS (n = 3,548)

	KRS				
	Lowest (n=2,024, 57%)	Middle (n=1,316, 37.1%)	Highest (n=208, 5.9%)	Total (n=3548)	p-value
Age (mean±SD)	72.76±1.31	73.09±1.33	73.32±1.31	72.92±1.33	< 0.001
Women (%)	1342(66.3)	754(57.3)	109(52.4)	2205(62.1)	< 0.001
Height (mean±SD)	60.78±9.65	62.75±10.0	63.47±9.36	61.67±9.83	< 0.001
Weight (mean±SD)	129.66 ±11.92	133.98 ±12.06	136.71 ±11.92	131.67 ±12.21	< 0.001
SBP (mean±SD)	75.20±8.23	77.47±8.47	78.63±9.05	76.24±8.46	< 0.001
DBP (mean±SD)	177.13 ±35.64	197.46 ±41.93	215.91 ±45.97	186.94 ±40.55	< 0.001
Total cholesterol (mean±SD)	57.16±12.66	52.14 ±12.82	48.23±12.41	54.78±13.03	< 0.001
HDL(mean±SD)	60.78±9.65	62.75±10.0	63.47±9.36	61.67±9.83	< 0.001
Smoking Status n(%)					< 0.001
Never	1576(77.9)	788(59.9)	81(38.9)	2445(68.9)	
Ex- Smoker	430(21.2)	409(31.1)	58(27.9)	897(25.3)	
Smoker	18(0.9)	119(9.0)	69(33.2)	206(5.8)	
Alcohol amount (mean±SD)	44.26±78.11	46.86±66.8	50.34±68.38	45.58±73.56	0.382
Physical Activity (mean±SD)	1908.29±4084.32	1942.78±7760.86	1845.94±3298.79	1917.43±5699.09	0.969
Stroke, n(%)	71(3.5)	58(4.4)	11(5.3)	140(3.9)	0.252
Coronary heart disease, n(%)	147(7.3)	127(9.7)	25(12.0)	299(8.4)	0.008
KRS(mean±SD)	1.44±0.32	2.69±0.53	5.21±1.31	2.12±1.10	< 0.001
KDSQ-C Score(mean±SD)	3.11±3.14	2.98±3.08	3.30±3.27	3.07±3.12	0.282
KDSQ-C, n(%)					0.245
< 6	1662(82.1)	1103(83.8)	166(79.8)	2931(82.6)	
≥ 6	362(17.9)	213(16.2)	42(20.2)	617(17.4)	

Table 9. Characteristics of men 65-70 year olds by KRS (n = 2,051)

	KRS			
	Lowest (n = 1,360, 66.3%)	Middle (n = 593, 28.9%)	Highest (n = 98, 4.8%)	p-value
Age (mean±SD)	67.28±1.69	67.83±1.84	67.77±1.67	< 0.001
Height (mean±SD)	159.12±8.07	159.82±7.99	161.16±7.79	0.018
Weight (mean±SD)	61.53±9.89	62.55±9.45	64.09±10.23	0.009
SBP (mean±SD)	129.79±12.10	133.95 ±12.49	137.38±11.67	< 0.001
DBP (mean±SD)	75.48±8.02	77.57±8.58	78.68±8.51	< 0.001
Total cholesterol (mean±SD)	175.94 ±34.53	207.28 ±41.44	225.59 ±42.96	< 0.001
HDL(mean±SD)	56.43±12.20	50.76±11.67	47.56±12.16	< 0.001
Smoking Status n(%)				< 0.001
Never	970(71.3)	364(61.4)	40(40.8)	
Ex- Smoker	362(26.6)	160(27.0)	19(19.4)	
Smoker	28(2.1)	69(11.6)	39(39.8)	
Alcohol amount (mean±SD)	44.69±65.95	48.02±68.33	42.94±50.45	0.546
Physical Activity (mean±SD)	1895.91 ±6286.08	1818.64 ±6062.64	1357.32 ±2590.33	0.693
Stroke, n(%)	43(3.2)	27(4.6)	5(5.1)	0.237
Coronary heart disease, n(%)	104(7.6)	49(8.3)	10(10.2)	0.628
KRS(mean±SD)	1.31±0.36	2.66±0.52	5.27±1.35	< 0.001
KDSQ Score(mean±SD)	2.36±2.99	2.46±2.97	2.67±2.81	0.520
KDSQ, n(%)				0.189
< 6	1190(87.5)	509(85.8)	80(81.6)	
≥ 6	170(12.5)	84(14.2)	18(18.4)	

Table 10. Characteristics of men 71-75 year olds by KRS (n = 1,343)

	KRS			
	Lowest (n = 682, 50.8%)	Middle (n = 562, 41.8%)	Highest (n = 99, 7.4%)	p-value
Age (mean±SD)	72.91±1.32	73.02±1.34	73.07±1.38	0.283
Height (mean±SD)	158.48±7.73	159.23±8.08	160.02±7.91	0.084
Weight (mean±SD)	60.90±9.45	61.58±9.57	61.81±9.32	0.380
SBP (mean±SD)	129.36±12.00	132.87 ±12.08	135.47 ±12.37	< 0.001
DBP (mean±SD)	75.05±8.46	76.95±8.66	78.29±8.52	< 0.001
Total cholesterol(mean±SD)	171.56±30.93	197.26 ±41.65	221.68 ±45.02	< 0.001
HDL (mean±SD)	57.80±12.08	51.47±13.35	47.11±11.24	< 0.001
Smoking Status n(%)				< 0.001
Never	499(73.2)	376(66.9)	50(50.5)	
Ex- Smoker	178(26.1)	140(24.9)	18(18.2)	
Smoker	5(0.7)	46(8.2)	31(31.3)	
Alcohol amount (mean±SD)	43.83±60.31	44.93±65.01	52.16±73.30	0.473
Physical Activity (mean±SD)	1909.95 ±4864.06	1524.36 ±2834.95	1976.52 ±3390.13	0.141
Stroke, n(%)	21(3.1)	22(3.9)	10(10.1)	0.004
Coronary heart disease, n(%)	49(7.2)	55(9.8)	12(12.1)	0.117
KRS(mean±SD)	1.46±0.32	2.76±0.54	5.31±1.53	< 0.001
KDSQ Score(mean±SD)	2.57±3.06	2.56±2.98	2.68±2.58	0.936
KDSQ, n(%)				0.809
< 6	580(85.0)	484(86.1)	86(86.9)	
≥ 6	102(15.0)	78(13.9)	13(13.1)	

Table 11. Characteristics of women 65-70 year olds by KRS (n = 3,001)

	KRS			
	Lowest (n = 2,539, 84.6	Middle (n = 434, 14.5%)	Highest (n = 28, 0.9%)	p-value
Age (mean±SD)	67.43±1.73	68.18±1.68	69.00±1.36	0.283
Height (mean±SD)	158.52±7.98	161.27±8.05	165.95±8.23	0.084
Weight (mean±SD)	61.23±9.84	64.63±10.22	68.22±11.30	0.380
SBP (mean±SD)	130.48±12.17	135.23 ±10.94	140.64 ±22.14	< 0.001
DBP (mean±SD)	75.63±8.35	78.00±8.58	81.61±17.06	< 0.001
Total cholesterol (mean±SD)	184.92±38.33	203.76 ±44.12	211.79±47.58	< 0.001
HDL (mean±SD)	55.51±12.96	51.08±12.04	45.29±9.59	< 0.001
Smoking Status n(%)				< 0.001
Never	1903(75.0)	186(42.9)	6(21.4)	
Ex- Smoker	574(22.6)	146(33.6)	7(25.0)	
Smoker	62(2.4)	102(23.5)	15(53.6)	
Alcohol amount (mean±SD)	46.15±64.84	43.13±61.54	40.86±46.86	0.615
Physical Activity (mean±SD)	1933.14 ±4312.85	2325.94 ±12041.28	1841.79 ±3294.13	0.456
Stroke, n(%)	81(3.2)	17(3.9)	1(3.6)	0.733
Coronary heart disease, n(%)	198(7.8)	57(13.1)	4(14.3)	< 0.001
KRS (mean±SD)	1.13±0.37	2.56±0.48	5.05±0.76	< 0.001
KDSQ Score (mean±SD)	3.20±3.12	3.27±3.09	3.96±3.51	0.407
KDSQ, n(%)				0.518
< 6	2094(82.5)	349(80.4)	22(78.6)	
≥ 6	445(17.5)	85(19.6)	6(21.4)	

Table 12. Characteristics of women 71-75 year olds by KRS (n = 2,205)

	KRS			
	Lowest (n = 1,342, 60.9%)	Middle (n = 754, 34.2%)	Highest (n = 109, 4.9%)	p-value
Age (mean±SD)	72.69±1.30	73.14±1.32	73.54±1.20	0.283
Height (mean±SD)	158.01±7.79	160.41±8.43	162.93±7.56	0.084
Weight (mean±SD)	60.72±9.76	63.63±10.30	64.99±9.19	0.380
SBP (mean±SD)	129.82±11.87	134.80 ±11.99	137.83±11.44	< 0.001
DBP (mean±SD)	75.27±8.11	77.85±8.31	78.94±9.52	< 0.001
Total cholesterol (mean±SD)	179.96±37.50	197.61 ±42.17	210.68 ±46.40	< 0.001
HDL (mean±SD)	56.84±12.93	52.64±12.40	49.24±13.34	< 0.001
Smoking Status n(%)				< 0.001
Never	1077(80.3)	412(54.6)	31(28.4)	
Ex- Smoker	252(18.8)	269(35.7)	40(36.7)	
Smoker	13(1.0)	73(9.7)	38(34.9)	
Alcohol amount (mean±SD)	44.47±85.77	48.31±68.18	48.68±63.88	0.532
Physical Activity (mean±SD)	1907.45 ±3626.39	2254.66 ±9948.29	1727.34 ±3224.68	0.449
Stroke, n(%)	50(3.7)	36(4.8)	1(0.9)	0.124
Coronary heart disease, n(%)	98(7.3)	72(9.5)	13(11.9)	0.075
KRS (mean±SD)	1.43±0.32	2.64±0.51	5.12±1.07	< 0.001
KDSQ Score (mean±SD)	3.38±3.14	3.29±3.12	3.86±3.71	0.301
KDSQ, n(%)				0.096
< 6	1082(80.6)	619(82.1)	80(73.4)	
≥ 6	260(19.4)	135(17.9)	29(26.6)	

ABSTRACT (IN KOREAN)

한국 노인에서 관상동맥질환 발생 위험도와 인지기능의 연관성

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배경: 심혈관질환 위험은 치매를 예방하기 위한 교정 가능한 요인이다. 치매에 대한 최적의 치료법이 부족함을 고려할 때, 교정 가능한 위험인자를 조절하는 것은 매우 중요하다.

목적: 이 연구는 치매가 없는 한국 노인들에서 한국형 관상동맥 질환 위험 점수로 평가된 높은 심혈관 위험도가 인지능력 저하와 관련이 있다는 것을 조사하였다.

방법: 2015-2020년 국민건강보험공단 건강검진에 참여한 치매가 없는 한국 노인 8,600명에 대해 분석하였다. 심혈관 위험도는 한국인 관상동맥 질환 위험 점수(KRS)에 의해 평가하여 세 등급으로 분류하였고 인지 기능은 KDSQ-C 평가도구를 사용하여 6점 이상인 경우 인지기능 저하로 정의하였다. 로지스틱 회귀 분석을 사용하여 심혈관 위험도와 인지 기능 사이의 연관성에 대한 odds ratios 및 95% 신뢰 구간을 추정했다. 키, 체중, 뇌졸중 과거력, 관상동맥질환 과거력, 알코올 섭취력, 신체활동을 보정하였다.

결과: 연구 대상자는 남성 3,394명 여성 5,206명이다. 전체 대상자

평균 나이는 69.74세(표준편차 3.10)이다. 전체 대상자의 한국형 관상동맥질환 위험점수의 저위험군은 5,923명(68.9%) 중위험군은 2,343명(27.2%) 고위험군은 334명(3.9%)이다. 모든 피험자에서 KRS의 저위험군과 비교하여, KRS 고위험군은 인지 저하와 관련이 있었다(Odds ratio = 1.339, 95% CI 1.034 - 1.734). 특히 71-75세 여성에서 KRS 저위험군과 비교했을 때, KRS 고위험군은 인지력 저하와 관련이 있었다(Odds ratio = 1.595, 95% CI 1.045- 2.434).

결론: 심혈관 위험도가 높은 경우 인지기능의 저하와 관련이 있으며 특히 고령 여성에서 이러한 관련성이 유의하였다. 관상동맥 위험도가 높은 고령여성에서는 인지기능 저하의 가능성을 고려하여야 하며, 향후 교정가능한 심혈관 위험요소 조절을 통한 치매예방의 효과평가를 위한 후속연구가 필요하다. 이 연구는 치매를 예방하기 위해 특히 고령 여성에서 교정가능한 심혈관 위험 요소들을 조절할 필요성을 강조한다.

핵심되는 말: 한국형 관상동맥위험도, 심혈관 위험도, 프래밍험 심혈관 위험도, 인지기능, 한국판 치매 선별도구