

State of the Art Review



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Modifiable Risk Factors for Cardiovascular Disease in Korea and Japan

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AUTHOR'S SUMMARY

Hypertension, diabetes, dyslipidemia, cigarette smoking, physical inactivity, obesity, and poor-quality diet are major modifiable risk factors for cardiovascular disease (CVD) in Korean and Japanese populations. In both Korea and Japan, physical inactivity exhibits the highest prevalence among the risk factors, followed by hypertension in Japan or obesity in Korea. Implementation of the primordial prevention strategies focused on the above-mentioned risk factors should be the priority of the health policymakers to tackle the growing burden of CVD in both countries.

ABSTRACT

Cardiovascular disease (CVD) is the leading cause of death and a major contributor to disability worldwide. Since the majority of cardiovascular events are preventable, identification of modifiable CVD risk factors and implementation of primordial prevention strategies should be a public health priority. In this aspect, the American Heart Association declared a strategic goal to reduce total CVD mortality in the US by 20% within 10 years via eliminating 7 major CVD risk factors (hypertension, diabetes, dyslipidemia, cigarette smoking, physical inactivity, obesity, and poor-quality diet) in 2010, and their strategy has been achieving. However, the applicability of similar metrics to prevent CVD among East Asians requires an in-depth investigation of the modifiable CVD risk factors based on national and regional evidence-based findings. Herein, this review article aims to discuss several modifiable risk factors for CVDs, using epidemiological evidence from cohort studies and nationally representative data of 2 East Asian countries: Korea and Japan.

Keywords: Risk factor; Modification; Prevention; Cardiovascular disease; Korea; Japan

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Conflict of Interest

The authors have no financial conflicts of interest.

Data Sharing Statement

The data generated in this study are available from the corresponding authors upon reasonable request.

Author Contributions

Conceptualization: Arafa A, Lee HH, Kim HC, Iso H; Data curation: Lee HH, Eshak ES, Liu K; Formal analysis: Lee HH, Liu K; Funding acquisition: Kim HC, Iso H; Investigation: Arafa A, Lee HH, Shirai K, Li J; Methodology: Arafa A, Lee HH, Eshak ES, Shirai K, Li J, Kim HC; Project administration: Shirai K, Kim HC, Iso H; Resources: Arafa A, Liu K, Li J, Shim SY; Supervision: Shirai K, Liu K, Kim HC, Iso H; Validation: Eshak ES, Liu K, Li J, Anni NS, Shim SY, Kim HC, Iso H; Visualization: Kim HC; Writing - original draft: Arafa A, Lee HH, Anni NS; Writing - review & editing: Eshak ES, Shirai K, Liu K, Li J, Shim SY, Kim HC, Iso H.

INTRODUCTION

Cardiovascular diseases (CVDs), principally coronary heart disease and stroke, are by far the leading cause of morbidity and mortality worldwide.¹⁾ Throughout the previous 3 decades, the prevalent cases of CVD almost doubled from 271 million in 1990 to 523 million in 2019 while related mortality increased during the same period from 12.1 to 18.6 million.²⁾ Although age-standardized CVD mortality rates declined globally during previous decades, the number of CVD deaths is expected to increase continually due to population aging.²⁾

The above-mentioned temporal trends in CVD morbidity and mortality have also been observed in South Korea (hereafter Korea)³⁾⁴⁾ and Japan.⁵⁾ Since Korea is the fastest aging country in the world⁶⁾ and Japan is the most aged one,⁷⁾ it is not unexpected that CVDs will remain the chief contributor to morbidity and mortality in both countries. However, the process of CVD development in later years is never inevitable, because over 75% of CVDs can be prevented by ameliorating their risk factors.⁸⁾ Hence, we believe that identifying modifiable risk factors for CVD and estimating their prevalences are important steps toward adopting risk prevention programs to reduce the burden of CVD in Korea and Japan.

Precedently, the American Heart Association announced in 2010 a strategic goal to reduce total CVD mortality by 20% within 10 years.⁹⁾ After a careful review of the available epidemiological evidence, 7 major CVD modifiable risk factors were selected and termed as the “Life’s Simple 7.”⁹⁾ Later, it seemed that the goal was, to a great extent, achieved.¹⁰⁾ Considering the difference in demographic characteristics, lifestyle, and cardiovascular risk between the East Asian and US population, building our cardiovascular health metrics based on the identified modifiable risk factors should be the key process to tackle the growing burden of CVDs in Korea and Japan.

As a primary step, this review article aims to discuss major modifiable risk factors for CVD, using epidemiological evidence from cohort studies and nationally representative data of both countries.

MODIFIABLE CARDIOVASCULAR RISK FACTORS IN KOREA AND JAPAN IN THE LITERATURE

Methods for current literature review

Articles were collected from PubMed scientific database using the search terms (“cardiovascular diseases” OR “coronary heart disease” OR “stroke”) AND (“risk factors” OR “hypertension” OR “obesity” OR “diabetes” OR “dyslipidemia” OR “Smoking” OR “physical activity” OR “diet” OR “food”) AND (“South Korea” OR “Japan”). Only cohort studies showing human evidence and published in English were considered. No limit regarding publication year was set.

Hypertension

The Korean Society of Hypertension and the Japanese Society of Hypertension define adult hypertension as systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg.¹¹⁾¹²⁾ In 2018, the Korean and Japanese total population was estimated to be 51.6 and 126.8 million people, respectively¹³⁾; of them, about 12 and 43 million people were estimated to have hypertension, respectively.¹²⁾¹⁴⁾

Hypertension is associated with the most solid evidence for CVD causation worldwide¹⁵⁾ and also in East Asian populations.¹⁶⁾¹⁷⁾ In a study conducted on 30,258 prehypertensive Korean adults, every increase in systolic blood pressure by 10 mmHg was associated with a 12% elevation in CVD mortality.¹⁸⁾ A prospective study conducted on 10,558 individuals aged ≥ 30 years from the NIPPON DATA 80 showed that Japanese people with blood pressure $\geq 180/105$ mmHg had a higher risk of CVD mortality by 37% in men and 18% in women than those with blood pressure $< 120/80$ mmHg.¹⁹⁾

Of note, the control of hypertension is thought to be the most effective way to prevent the development of CVDs.¹⁵⁾¹⁷⁾ In a cohort study using data of 1,402,975 adults aged 40–79 years from the National Health Information Database in Korea, the intensive control of blood pressure in hypertensive patients with several CVD risk factors led to a significant reduction in CVD events.²⁰⁾ Another study using the same database found that blood pressure lowering was beneficial for CVD prevention even in patients with uncomplicated, low-risk, stage-I hypertension.²¹⁾ A cohort study investigating 33,372 Japanese men and women aged 40–69 years from the Japan Public Health Center-based Prospective Study (JPHC study) showed that adequate control of hypertension was estimated to prevent 64% and 50% of stroke incidence, 67% and 29% of stroke mortality, and 38% and 36% of total CVD mortality in men and women, respectively.²²⁾

Diabetes mellitus

The diagnostic criteria for diabetes in Korea and Japan are fasting plasma glucose ≥ 126 mg/dL, 2-hour oral glucose tolerance test ≥ 200 mg/dL, hemoglobin A1c (HbA1c) $\geq 6.5\%$, or random plasma glucose ≥ 200 mg/dL with symptoms of diabetes (increased thirst, increased urination, and unexplained weight loss).²³⁾²⁴⁾ According to the International Diabetes Federation Atlas 2019, the prevalence of diabetes among adults aged 20–79 is 9.2% in Korea and 7.9% in Japan, with the number of people with diabetes reaching 3.6 million in Korea and 7.4 million in Japan.²⁵⁾

Diabetes is among the most significant risk factors for CVDs,²⁶⁾ even among Asian populations.¹⁶⁾²⁷⁾ In one study conducted on data of 76,434 Korean adults from the Health Screening and Promotion Center, diabetes was associated with increased risks of total CVD by 70%, coronary heart disease by 67%, and stroke by 58%.²⁸⁾ In the Korean Genome and Epidemiology Study (KoGES) Ansung-Ansan cohort, diabetes almost doubled the risk of CVD mortality among 10,038 Korean adults aged 40–69 years.²⁹⁾ The Circulatory Risk in Communities Study investigated 3 cohorts of Japanese adults aged 40–69 years for the burden of diabetes on CVD. The results revealed that diabetes was associated with increased risk of total CVDs by 40%, 93%, and 159% in the 3 cohorts and the population attributable fraction of total CVDs due to diabetes was 2.8%, 5.6%, and 12.4%, respectively; suggesting that diabetes control can have a significant role in preventing CVDs.³⁰⁾ In the JPHC study, diabetes was shown to be associated with elevations in the risk of CVD events: 205% in coronary heart disease among Japanese men and women ($n=31,192$)³¹⁾ and 64% in stroke among men ($n=13,129$) and 119% among women ($n=22,528$).³²⁾

Dyslipidemia

According to the Korean Society of Lipid and Atherosclerosis, dyslipidemia is defined as having one or more of the following: 1) total cholesterol ≥ 240 mg/dL, 2) low-density lipoprotein (LDL)-cholesterol ≥ 160 mg/dL, 3) high-density lipoprotein (HDL)-cholesterol < 40 mg/dL, or 4) triglyceride ≥ 200 mg/dL.³³⁾ The diagnosis of dyslipidemia, according to the

Japanese Atherosclerosis Society, is slightly different with one of the following conditions that should be met: 1) LDL-cholesterol ≥ 140 mg/dL, 2) HDL-cholesterol < 40 mg/dL, 3) triglyceride ≥ 150 mg/dL, or 4) non-HDL-cholesterol ≥ 170 mg/dL.³⁴⁾ More than 40% of Korean adults aged ≥ 30 years were shown to have dyslipidemia; 47.9% among men and 34.3% among women; significantly higher than that of Japanese adults aged ≥ 20 years.³⁵⁾ The prevalences of different biological abnormalities characterizing dyslipidemia in both countries were as follows: 1) total cholesterol ≥ 240 mg/dL: 19.3% of Korean men, 20.2% of Korean women, 11.0% of Japanese men, 19.9% of Japanese women, 2) LDL-cholesterol ≥ 160 mg/dL: 15.3% of Korean men, 19.7% of Korean women, 9.0% of Japanese men, 12.5% of Japanese women, 3) HDL-cholesterol < 40 mg/dL: 27.2% of Korean men, 11.8% of Korean women, 12.0% of Japanese men, 13.2% of Japanese women, and 4) triglyceride ≥ 200 mg/dL: 24.8% of Korean men, 11.0% of Korean women, 11.0% of Japanese men, 19.9% of Japanese women.³⁵⁾³⁶⁾

Dyslipidemia is one of the major risk factors for CVDs in Asia and worldwide.¹⁶⁾³⁷⁾ In a nationwide cohort study conducted on 5,688,055 statin-naïve Koreans aged 20–39 years, comparing the highest versus the lowest quartiles of dyslipidemia elements according to their CVD events showed the following: 1) total cholesterol: increased CVD mortality by 17%, myocardial infarction by 101%, and stroke by 63%, 2) LDL-cholesterol: increased myocardial infarction by 47% and stroke by 27%, and 3) HDL-cholesterol: decreased CVD mortality by 22%, myocardial infarction by 51%, and stroke by 41%.³⁸⁾ In a cohort study using the NIPPON DATA 80 ($n=10,546$), Japanese adults aged ≥ 30 years with total cholesterol ≥ 260 mg/dL showed a 281% increase in coronary heart disease risk compared with those with total cholesterol between 160 and 180 mg/dL.³⁹⁾

Smoking

Cigarette smoking is a global public health concern. In 2016, the smoking rate among people aged ≥ 15 years was comparable in Korea and Japan (22.8% and 20.0%, respectively). Although the smoking rate among men was higher in Korea (40.1% compared to 31.7% in Japan), that among women was higher in Japan (9.1% compared to 5.9% in Korea).⁴⁰⁾

Smoking represents the second major modifiable risk factor for CVDs occurring globally and in Asia.¹⁶⁾⁴¹⁾ In an analysis of the KoGES Ansong-Ansan cohort comprised of middle-aged (40–69 years) Korean adults, current smoking increased CVD events by 32% and CVD mortality by 109%.²⁹⁾ A prospective study conducted on 19,782 men and 21,500 women aged 40–59 years from the JPHC study showed that current smokers, compared to never smokers, had significantly higher risk of coronary heart disease incidence: 185% in men and 207% in women. The same study showed that the population-attributable risk of coronary heart disease was 46% in men and 9% in women and smoking cessation led to a rapid risk reduction of coronary heart disease within 2 years.⁴²⁾ In a pooled analysis of 3 Japanese cohort studies ($n=296,836$), current smoking compared with never smoking resulted in higher risks of total CVDs by 51% in men and 85% in women, coronary heart disease by 119% in men and 184% in women, and stroke by 24% in men and 70% in women. Smoking cessation among men and women led to comparable decreases in the risks of total CVDs, coronary heart disease, and stroke after 10 years.⁴³⁾

Physical inactivity

Per the World Health Organization guidelines on physical activity (≥ 150 minutes/week of moderate activity or ≥ 75 minutes/week of vigorous activity),⁴⁴⁾ approximately two-thirds of the Korean and Japanese adults did not comply with physical activity guidelines.⁴⁵⁾⁴⁶⁾

Substantial evidence, however, has shown that physical activity can result in significant risk reductions of CVD morbidity and mortality.¹⁶⁾⁴⁷⁾ A retrospective study of a total of 131,558 Korean adults from the National Health Insurance Services assessed the impact of physical activity on CVD mortality. The results showed that a 500 metabolic equivalent task-minutes/week increase in physical activity was associated with a 14% risk reduction in CVD mortality.⁴⁸⁾ A study of 74,913 Japanese adults from the JPHC study showed a 30% decline in both CVD and stroke risks from the lowest to 5–10 metabolic equivalent task-hours/day.⁴⁹⁾ In another study using data from the Japan Collaborative Cohort Study (JACC study) (n=77,676), walking ≥ 1 hour/day compared with 0.5 hours/day was associated with a decreased risk of total CVD by 16% while walking < 0.5 hours/day compared with 0.5 hours/day was associated with an increased risk of total CVD by 35%.⁵⁰⁾

Obesity

Obesity is a global public health problem. Worldwide, a body mass index > 25 kg/m² is considered overweight, and ≥ 30 kg/m² is obese⁵¹⁾; however, obesity for the Korean and Japanese population is defined as a body mass index ≥ 25 kg/m².⁵²⁾⁵³⁾ The prevalence of obesity in Korea and Japan has been increasing during the last decades.⁵⁴⁾⁵⁵⁾

Obesity is an established modifiable risk factor for CVD morbidity and mortality among Asian and non-Asian populations.¹⁶⁾⁵⁶⁾ In one Korean cohort study using the National Health Insurance Service data (n=209,598), obesity was associated with an increased risk of coronary heart disease among adults aged ≥ 20 years by 31%, and the population-attributable risk was 8.1%.⁵⁷⁾ In another study using the same data (n=2,611,450), weight gain from < 23.0 to ≥ 25 kg/m² was associated with increased risk of myocardial infarction by 67% in men and 50% in women and coronary heart disease by 35% in men and 31% in women.⁵⁸⁾ Further, in Japanese data of 42,343 men and 46,413 women aged 40–69 years from the JPHC, obesity resulted in an increased risk of cardioembolic strokes in men and women and lacunar and large-artery occlusive strokes in women only. Cumulative average body mass index was positively associated with lacunar, large-artery occlusive, and cardioembolic strokes in men and with lacunar and large-artery occlusive strokes in women.⁵⁹⁾

However, weight reduction to the normal range can lower the risk of CVD. In a Korean study of young adults,⁵⁸⁾ weight reduction from ≥ 25 kg/m² to < 23.0 kg/m² was associated with decreased risk of myocardial infarction by 33% in men and coronary heart disease by 23% in men and 33% in women. It should be noted that being underweight and excessive weight loss were shown in East Asian and Japanese literature to be associated with an increased risk of CVD mortality^{60–62)}; suggesting the importance of health expert consultation before planning to lose weight.

Diet

Solid evidence relating poor-quality diet to the risk of CVD has been emerging. Despite being debated, poor-quality diets have, in general, high salt, added sugars, and animal-source fats but low fish, fruits and vegetables, and whole grains.⁶³⁾ Herein, we will focus on 2 staple foods, fish and salt, that characterize the East Asian diet⁶⁴⁾ and were previously suggested as risk factors for CVDs.⁶⁵⁾⁶⁶⁾ On the other hand, consuming red meat,⁶⁷⁾⁶⁸⁾ rice,⁶⁹⁾⁷⁰⁾ and alcohol⁷¹⁾⁷²⁾ showed no or faint associations with the risk of CVDs among Korean and Japanese populations, and thus were not discussed in depth.

Fish is a recommended source of omega-3 fatty acids that confer benefits for reducing CVD risk.⁶⁵⁾ In a study conducted on 41,578 Japanese people aged 40–59 years from the JPHC study,

the intake of 180 g/day vs. 23 g/day of fish was associated with a 37% decrease in coronary heart disease risk, and the intake of omega-3 fatty acids was inversely associated with the risk of myocardial infarction.⁷³⁾ Another study using data from the JACC study (n=57,972) showed inverse associations between fish and omega-3 fatty acids intake and the risk of CVD mortality.⁷⁴⁾ A case-control study carried out in Korea (n=120) also revealed that every 1% increase in the omega-3 index was associated with 60.3% and 26.6% lower odds of hemorrhagic stroke and ischemic stroke, respectively.⁷⁵⁾

Dietary sodium intake is a potential risk factor for CVD.⁶⁶⁾ In a case-control study of 304 cases with stroke and 249 age-matched controls conducted in Korea, high sodium intake was associated with 40% and 50% higher odds of stroke in men and women, respectively.⁷⁶⁾ Another case-control study from Korea (n=146) revealed that a substantially higher proportion of stroke cases (60.3%) preferred salty foods than their counterparts (20.5%).⁷⁷⁾ In the Japanese cohort Study (JPHC; n=77,500), the highest compared with the lowest quintile of sodium and salted food intake was associated with a 19% increase in the total CVD risk.⁷⁸⁾ In the NIPPON DATA 80 (n=8,879), adherence to a reduced-salt Japanese diet led to a decrease in the risk of CVD mortality by 20%.⁷⁹⁾ Another study using the same data (n=8,702) showed that an increment of 2 g/1,000 kcal in household salt intake was associated with the increased risk of total CVD, coronary heart disease, and stroke mortality by 11%, 25%, and 12%, respectively.⁸⁰⁾ Alike, the JACC study (n=58,730) showed that the highest versus the lowest quintile of sodium intake was associated with increased risk of total CVD and stroke mortality by 42% and 55%, respectively.⁸¹⁾ In another study using the JACC study data (n=84,720), salt preference was associated with a 23% increase in stroke mortality.⁸²⁾

NATIONAL PREVALENCE OF MODIFIABLE CARDIOVASCULAR RISK FACTORS IN KOREA AND JAPAN

Data sources

We compared the prevalence of major modifiable CVD risk factors in Korea and Japan using the Korea National Health and Nutrition Examination Survey (KNHANES; 2016–2018)⁸³⁾ and Japan National Health and Nutrition Survey (JNHNS; 2017–2019).⁸⁴⁾ Detailed definitions of the assessed risk factors are described in **Table 1**. All analyses of the KNHANES data accounted for its complex multi-stage sampling design and were weighted to generate nationally representative estimates of the Korean population. Sex- and age-specific

Table 1. Definition of cardiovascular risk factors for Korean and Japanese data analyses

Risk factor	Definition
Hypertension	(1) Systolic blood pressure ≥ 140 mmHg or (2) Diastolic blood pressure ≥ 90 mmHg or (3) Taking antihypertensive agent
Diabetes*	(1) HbA1c ≥ 6.5 % or (2) Taking oral hypoglycemic agent or under insulin therapy
Current smoking	Currently smoking
Physical inactivity	
Korea	(1) Engaging in moderate-intensity physical activity ≤ 1 time/week and (2) Engaging in vigorous-intensity physical activity ≤ 1 time/week
Japan	Engaging in physical activity ≤ 1 time/week
Obesity	Body mass index ≥ 25 kg/m ²

HbA1c = hemoglobin A1c.

*Fasting glucose level was not included in the definition since it had not been measured in the Japan National Health and Nutrition Survey.

prevalence of risk factors in each country were calculated and compared. To adjust for the difference in population structures between Korea and Japan, age-standardization was performed by direct method with the population structure of Korea in 2017 as a reference, separately by sex. The prevalence of dyslipidemia was not calculated because fasting lipid levels had not been measured in the JNHNS.

The estimated prevalence of risk factors

Figure 1 depicts sex- and age-specific prevalence of risk factors in Korea and Japan. In both countries, the prevalence of hypertension was proportionately higher with age regardless of sex, reaching 63.7% and 74.2% at age ≥ 70 among Korean and Japanese men, respectively; 71.0% at age ≥ 70 among both Korean and Japanese women. Among men, the prevalence of hypertension was marginally higher in Korea under age 39, whereafter the prevalence was higher in Japan. Among women, the prevalence of hypertension was generally comparable across all ages, except for the 60s at which the prevalence was higher in Japan (45.7% and 52.1% in Korea and Japan, respectively) (**Figure 1A**). In both countries, the prevalence of diabetes was higher with older age regardless of sex. Among men, the prevalence of diabetes was higher in Japan across all ages, except for the age ≥ 70 group. Among women, the prevalence of diabetes was higher in Japan under age 39, whereafter the prevalence was higher in Korea (**Figure 1B**). In both countries, men smoked more in their 30s and 40s (44.7% and 44.8% in Korea and 37.2% and 37.8% in Japan, respectively); however, the proportion of smoking fell sharply after that, reaching $< 20\%$ at age ≥ 70 years. Japanese women smoked more in their 40s and 50s (12.1% and 10.9%, respectively), whereas Korean women smoked more in their 20s and 30s (10.0% and 7.7%, respectively) (**Figure 1C**). In Korea, the proportions of physically inactive men and women were generally higher with older age, whereas those in Japan were lower with age after the 30s (**Figure 1D**). However, since the definitions of physical inactivity in KNHANES and JNHNS are different, a direct comparison between Korea and Japan with regard to the proportion of physical inactivity should be made with caution. Obesity was more prevalent in Korea across all ages regardless of sex. Men were found to be more obese in their middle years (47.1% and 36.9% at age 40–49 in Korea and Japan, respectively), whereas women tended to be more obese with increasing age (42.1% and 26.9% at age ≥ 70 in Korea and Japan, respectively) (**Figure 1E**).

The age-standardized prevalence of risk factors in Korea and Japan are presented in **Table 2**. Japanese men had a higher prevalence of hypertension and diabetes than Korean men. However, the proportion of current smokers and obese adults were higher among Korean men than among Japanese men. Contrariwise, Japanese women were more likely to have hypertension or be current smoker than Korean women, while the greater prevalence of diabetes and obesity were observed among Korean women.

CONCLUSION

This review article introduced solid epidemiological evidence of the associations between major modifiable cardiovascular risk factors, including hypertension, diabetes, dyslipidemia, cigarette smoking, physical inactivity, obesity, and poor-quality diet, and CVD in the Korean and Japanese population. We also estimated the prevalence of risk factors in Korea and Japan, and compared them to provide an overview of the burden of CVD risk factors in both countries. Since a substantial proportion of CVD events are preventable, the implementation of primordial prevention strategies focused on the above-mentioned risk factors should

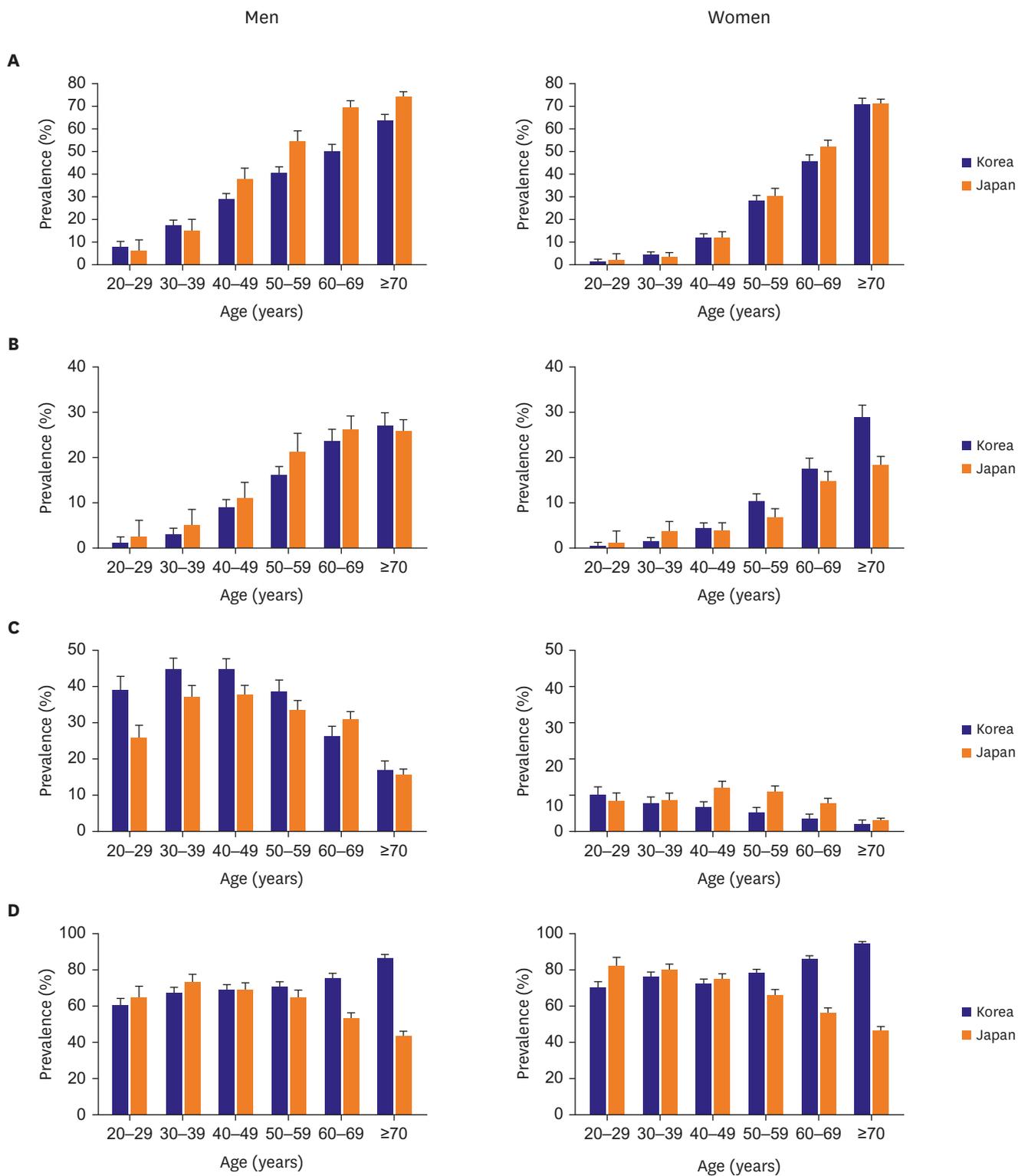


Figure 1. Prevalence of cardiovascular risk factors in Korea and Japan. (A) Hypertension, (B) diabetes, (C) current smoking, (D) physical inactivity, (E) obesity. Error bars indicate 95% confidence intervals.

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be the priority of the health policymakers and public health leaders to curb the increasing burden of CVD in Korea and Japan.

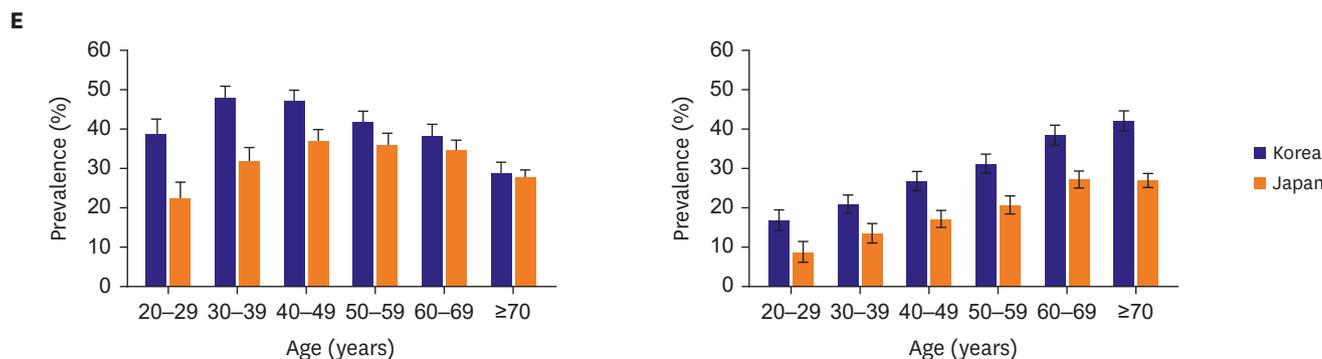


Figure 1. (Continued) Prevalence of cardiovascular risk factors in Korea and Japan. (A) Hypertension, (B) diabetes, (C) current smoking, (D) physical inactivity, (E) obesity. Error bars indicate 95% confidence intervals.

Table 2. Age-standardized prevalence of risk factors in Korea and Japan

Sex	Risk factor	Prevalence, % (95% confidence interval)	
		In Korea	In Japan
Male	Hypertension	31.3 (30.1–32.5)	38.7 (36.4–41.2)
	Diabetes	11.4 (10.7–12.1)	13.7 (12.4–15.3)
	Current smoking	37.6 (36.2–39.1)	31.8 (30.4–33.2)
	Physical inactivity	70.0 (68.1–71.9)	63.8 (60.6–67.2)
	Obesity	41.8 (40.3–43.3)	32.0 (30.4–33.7)
Female	Hypertension	24.9 (24.0–25.8)	26.1 (24.8–27.5)
	Diabetes	9.6 (9.0–10.1)	7.4 (6.7–8.2)
	Current smoking	6.0 (5.5–6.6)	8.9 (8.2–9.6)
	Physical inactivity	78.8 (77.1–80.6)	68.7 (66.0–71.6)
	Obesity	28.7 (27.7–29.8)	18.5 (17.5–19.6)

Age-standardization was performed by direct method using the population of Korea in 2017 as a reference population, separately by sex.

REFERENCES

- GBD 2017 Causes of Death Collaborators. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2018;392:1736–88.
[PUBMED](#) | [CROSSREF](#)
- Roth GA, Mensah GA, Johnson CO, et al. Global burden of cardiovascular diseases and risk factors, 1990–2019: update from the GBD 2019 study. *J Am Coll Cardiol* 2020;76:2982–3021.
[PUBMED](#) | [CROSSREF](#)
- Lee HH, Cho SMJ, Lee H, et al. Korea heart disease fact sheet 2020: analysis of nationwide data. *Korean Circ J* 2021;51:495–503.
[PUBMED](#) | [CROSSREF](#)
- Baek J, Lee H, Lee HH, Heo JE, Cho SMJ, Kim HC. Thirty-six year trends in mortality from diseases of circulatory system in Korea. *Korean Circ J* 2021;51:320–32.
[PUBMED](#) | [CROSSREF](#)
- Hata J, Ninomiya T, Hirakawa Y, et al. Secular trends in cardiovascular disease and its risk factors in Japanese: half-century data from the Hisayama study (1961–2009). *Circulation* 2013;128:1198–205.
[PUBMED](#) | [CROSSREF](#)
- Jang IY, Lee HY, Lee E50th Anniversary Committee of Korean Geriatrics Society. Geriatrics fact sheet in Korea 2018 from national statistics. *Ann Geriatr Med Res* 2019;23:50–3.
[PUBMED](#) | [CROSSREF](#)
- Nakatani H. Population aging in Japan: policy transformation, sustainable development goals, universal health coverage, and social determinates of health. *Glob Health Med* 2019;1:3–10.
[PUBMED](#) | [CROSSREF](#)
- Stewart J, Manmathan G, Wilkinson P. Primary prevention of cardiovascular disease: A review of contemporary guidance and literature. *JRSM Cardiovasc Dis* 2017;6:2048004016687211.
[PUBMED](#) | [CROSSREF](#)

9. Lloyd-Jones DM, Hong Y, Labarthe D, et al. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic Impact Goal through 2020 and beyond. *Circulation* 2010;121:586-613.
[PUBMED](#) | [CROSSREF](#)
10. Mensah GA, Wei GS, Sorlie PD, et al. Decline in cardiovascular mortality: possible causes and implications. *Circ Res* 2017;120:366-80.
[PUBMED](#) | [CROSSREF](#)
11. Lee HY, Shin J, Kim GH, et al. 2018 Korean Society of Hypertension guidelines for the management of hypertension: part II-diagnosis and treatment of hypertension. *Clin Hypertens* 2019;25:20.
[PUBMED](#) | [CROSSREF](#)
12. Umemura S, Arima H, Arima S, et al. The Japanese Society of Hypertension guidelines for the management of hypertension (JSH 2019). *Hypertens Res* 2019;42:1235-481.
[PUBMED](#) | [CROSSREF](#)
13. The World Bank. Data, population, total [Internet]. Washington, D.C.: The World Bank; 2020 [cited 2021 March 11]. Available from: <https://data.worldbank.org/indicator/SP.POP.TOTL?>
14. Kim HC, Cho SMJ, Lee H, et al. Korea hypertension fact sheet 2020: analysis of nationwide population-based data. *Clin Hypertens* 2021;27:8.
[PUBMED](#) | [CROSSREF](#)
15. Fuchs FD, Whelton PK. High blood pressure and cardiovascular disease. *Hypertension* 2020;75:285-92.
[PUBMED](#) | [CROSSREF](#)
16. Ueshima H, Sekikawa A, Miura K, et al. Cardiovascular disease and risk factors in Asia: a selected review. *Circulation* 2008;118:2702-9.
[PUBMED](#) | [CROSSREF](#)
17. Soenarta AA, Buranakitjaroen P, Chia YC, et al. An overview of hypertension and cardiac involvement in Asia: focus on heart failure. *J Clin Hypertens (Greenwich)* 2020;22:423-30.
[PUBMED](#) | [CROSSREF](#)
18. Oh HJ, Lee S, Lee EK, et al. Association of blood pressure components with mortality and cardiovascular events in prehypertensive individuals: a nationwide population-based cohort study. *Ann Med* 2018;50:443-52.
[PUBMED](#) | [CROSSREF](#)
19. Lida M, Ueda K, Okayama A, et al. Impact of elevated blood pressure on mortality from all causes, cardiovascular diseases, heart disease and stroke among Japanese: 14 year follow-up of randomly selected population from Japanese -- Nippon data 80. *J Hum Hypertens* 2003;17:851-7.
[PUBMED](#) | [CROSSREF](#)
20. Jung HH. Association of optimal blood pressure with critical cardiorenal events and mortality in high-risk and low-risk patients treated with antihypertension medications. *JAMA Netw Open* 2019;2:e199307.
[PUBMED](#) | [CROSSREF](#)
21. Lee CJ, Ryu J, Kim HC, et al. Clinical benefit of treatment of stage-1, low-risk hypertension. *Hypertension* 2018;72:1285-93.
[PUBMED](#) | [CROSSREF](#)
22. Ikeda A, Iso H, Yamagishi K, Inoue M, Tsugane S. Blood pressure and the risk of stroke, cardiovascular disease, and all-cause mortality among Japanese: the JPHC study. *Am J Hypertens* 2009;22:273-80.
[PUBMED](#) | [CROSSREF](#)
23. Kim MK, Ko SH, Kim BY, et al. 2019 Clinical practice guidelines for type 2 diabetes mellitus in Korea. *Diabetes Metab J* 2019;43:398-406.
[PUBMED](#) | [CROSSREF](#)
24. Araki E, Goto A, Kondo T, et al. Japanese clinical practice guideline for diabetes 2019. *J Diabetes Investig* 2020;11:1020-76.
[PUBMED](#) | [CROSSREF](#)
25. International Diabetes Federation. *IDF Diabetes Atlas*. 9th ed. Brussels: International Diabetes Federation; 2019.
26. De Rosa S, Arcidiacono B, Chiefari E, Brunetti A, Indolfi C, Foti DP. Type 2 diabetes mellitus and cardiovascular disease: genetic and epigenetic links. *Front Endocrinol (Lausanne)* 2018;9:2.
[PUBMED](#) | [CROSSREF](#)
27. Aambø A, Klemsdal TO. Cardiovascular disease and diabetes in patients with African or Asian background. *Tidsskr Nor Laegeforen* 2017;137.
[PUBMED](#) | [CROSSREF](#)
28. Kim HK, Lee JB, Kim SH, et al. Association of prediabetes, defined by fasting glucose, HbA1c only, or combined criteria, with the risk of cardiovascular disease in Koreans. *J Diabetes* 2016;8:657-66.
[PUBMED](#) | [CROSSREF](#)

29. Bae JC, Cho NH, Suh S, et al. Cardiovascular disease incidence, mortality and case fatality related to diabetes and metabolic syndrome: a community-based prospective study (Ansung-Ansan cohort 2001–12). *J Diabetes* 2015;7:791-9.
[PUBMED](#) | [CROSSREF](#)
30. Hayama-Terada M, Muraki I, Imano H, et al. Diabetes trend and impact on risk of cardiovascular disease in middle-aged Japanese people - the CIRCS study. *Circ J* 2016;80:2343-8.
[PUBMED](#) | [CROSSREF](#)
31. Saito I, Kokubo Y, Yamagishi K, Iso H, Inoue M, Tsugane S. Diabetes and the risk of coronary heart disease in the general Japanese population: the Japan Public Health Center-based prospective (JPHC) study. *Atherosclerosis* 2011;216:187-91.
[PUBMED](#) | [CROSSREF](#)
32. Cui R, Iso H, Yamagishi K, et al. Diabetes mellitus and risk of stroke and its subtypes among Japanese: the Japan Public Health Center study. *Stroke* 2011;42:2611-4.
[PUBMED](#) | [CROSSREF](#)
33. Rhee EJ, Kim HC, Kim JH, et al. 2018 Guidelines for the management of dyslipidemia in Korea. *J Lipid Atheroscler* 2019;8:78-131.
[PUBMED](#) | [CROSSREF](#)
34. Kinoshita M, Yokote K, Arai H, et al. Japan Atherosclerosis Society (JAS) guidelines for prevention of atherosclerotic cardiovascular diseases 2017. *J Atheroscler Thromb* 2018;25:846-984.
[PUBMED](#) | [CROSSREF](#)
35. Kim HS, Kim JH, Yu SH, et al. Dyslipidemia fact sheets in Korea, 2018 [Internet]. Seoul: Korean Society of Lipid and Atherosclerosis; 2018 [cited 2021 March 28]. Available from: https://www.lipid.or.kr/bbs/index.html?code=fact_sheet&category=&gubun=&page=1&number=896&mode=view&keyfield=&key=.
36. Ministry of Health, Labour and Welfare (JP). National Health and Nutrition Survey in Japan [Internet]. Tokyo: Ministry of Health, Labour and Welfare; 2015 [cited 2021 March 11]. Available from: <http://www.mhlw.go.jp/toukei/itiran/gaiyo/k-eisei.html>.
37. Stein R, Ferrari F, Scolari F. Genetics, dyslipidemia, and cardiovascular disease: new insights. *Curr Cardiol Rep* 2019;21:68.
[PUBMED](#) | [CROSSREF](#)
38. Lee H, Park JB, Hwang IC, et al. Association of four lipid components with mortality, myocardial infarction, and stroke in statin-naïve young adults: a nationwide cohort study. *Eur J Prev Cardiol* 2020;27:870-81.
[PUBMED](#) | [CROSSREF](#)
39. Okamura T, Tanaka H, Miyamatsu N, et al. The relationship between serum total cholesterol and all-cause or cause-specific mortality in a 17.3-year study of a Japanese cohort. *Atherosclerosis* 2007;190:216-23.
[PUBMED](#) | [CROSSREF](#)
40. World Health Organization. *WHO global report on trends in prevalence of tobacco smoking 2000–2025*. 2nd ed. Geneva: World Health Organization; 2018.
41. Yusuf S, Hawken S, Ounpuu S, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet* 2004;364:937-52.
[PUBMED](#) | [CROSSREF](#)
42. Baba S, Iso H, Mannami T, et al. Cigarette smoking and risk of coronary heart disease incidence among middle-aged Japanese men and women: the JPHC study Cohort I. *Eur J Cardiovasc Prev Rehabil* 2006;13:207-13.
[PUBMED](#) | [CROSSREF](#)
43. Honjo K, Iso H, Tsugane S, et al. The effects of smoking and smoking cessation on mortality from cardiovascular disease among Japanese: pooled analysis of three large-scale cohort studies in Japan. *Tob Control* 2010;19:50-7.
[PUBMED](#) | [CROSSREF](#)
44. World Health Organization. Global recommendations on physical activity for health [Internet]. Geneva: World Health Organization; 2010 [cited 2021 March 11]. Available from: http://whqlibdoc.who.int/publications/2010/9789241599979_eng.pdf?ua=1.
45. An KY. Physical activity level in Korean adults: the Korea National Health and Nutrition Examination Survey 2017. *Epidemiol Health* 2019;41:e2019047.
[PUBMED](#) | [CROSSREF](#)
46. Chen T, Kishimoto H, Honda T, et al. Patterns and levels of sedentary behavior and physical activity in a general Japanese population: the Hisayama study. *J Epidemiol* 2018;28:260-5.
[PUBMED](#) | [CROSSREF](#)
47. Li J, Siegrist J. Physical activity and risk of cardiovascular disease--a meta-analysis of prospective cohort studies. *Int J Environ Res Public Health* 2012;9:391-407.
[PUBMED](#) | [CROSSREF](#)

48. Jeong SW, Kim SH, Kang SH, et al. Mortality reduction with physical activity in patients with and without cardiovascular disease. *Eur Heart J* 2019;40:3547-55.
[PUBMED](#) | [CROSSREF](#)
49. Kubota Y, Iso H, Yamagishi K, Sawada N, Tsugane SJPHC Study Group (Japan Public Health Center). Daily total physical activity and incident cardiovascular disease in Japanese men and women: Japan Public Health Center-based prospective study. *Circulation* 2017;135:1471-3.
[PUBMED](#) | [CROSSREF](#)
50. Noda H, Iso H, Toyoshima H, et al. Walking and sports participation and mortality from coronary heart disease and stroke. *J Am Coll Cardiol* 2005;46:1761-7.
[PUBMED](#) | [CROSSREF](#)
51. World Health Organization. Obesity and overweight [Internet]. Geneva: World Health Organization; 2020 [cited 2021 March 11]. Available from: <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>.
52. Seo MH, Lee WY, Kim SS, et al. 2018 Korean Society for the study of obesity guideline for the management of obesity in Korea. *J Obes Metab Syndr* 2019;28:40-5.
[PUBMED](#) | [CROSSREF](#)
53. Examination Committee of Criteria for 'Obesity Disease' in Japan/Japan Society for the Study of Obesity. New criteria for 'obesity disease' in Japan. *Circ J* 2002;66:987-92.
[CROSSREF](#)
54. Seo MH, Kim YH, Han K, et al. Prevalence of obesity and incidence of obesity-related comorbidities in Koreans based on National Health Insurance Service Health Checkup data 2006–2015. *J Obes Metab Syndr* 2018;27:46-52.
[PUBMED](#) | [CROSSREF](#)
55. Yoshiike N, Miyoshi M. Epidemiological aspects of overweight and obesity in Japan--international comparisons. *Nihon Rinsho* 2013;71:207-16.
[PUBMED](#)
56. Cercato C, Fonseca FA. Cardiovascular risk and obesity. *Diabetol Metab Syndr* 2019;11:74.
[PUBMED](#) | [CROSSREF](#)
57. Shin J, Ham D, Shin S, Choi SK, Paik HY, Joung H. Effects of lifestyle-related factors on ischemic heart disease according to body mass index and fasting blood glucose levels in Korean adults. *PLoS One* 2019;14:e0216534.
[PUBMED](#) | [CROSSREF](#)
58. Choi S, Kim K, Kim SM, et al. Association of obesity or weight change with coronary heart disease among young adults in South Korea. *JAMA Intern Med* 2018;178:1060-8.
[PUBMED](#) | [CROSSREF](#)
59. Li Y, Yatsuya H, Iso H, et al. Body mass index and risks of incident ischemic stroke subtypes: the Japan Public Health Center-based prospective (JPHC) study. *J Epidemiol* 2019;29:325-33.
[PUBMED](#) | [CROSSREF](#)
60. Zheng W, McLerran DF, Rolland B, et al. Association between body-mass index and risk of death in more than 1 million Asians. *N Engl J Med* 2011;364:719-29.
[PUBMED](#) | [CROSSREF](#)
61. Hozawa A, Okamura T, Oki I, et al. Relationship between BMI and all-cause mortality in Japan: NIPPON DATA80. *Obesity (Silver Spring)* 2008;16:1714-7.
[PUBMED](#) | [CROSSREF](#)
62. Saito I, Konishi M, Iso H, Inoue M, Tsugane S. Impact of weight change on specific-cause mortality among middle-aged Japanese individuals. *J Epidemiol Community Health* 2009;63:447-54.
[PUBMED](#) | [CROSSREF](#)
63. Anand SS, Hawkes C, de Souza RJ, et al. Food consumption and its impact on cardiovascular disease: importance of solutions focused on the globalized food system: a report from the workshop convened by the World Heart Federation. *J Am Coll Cardiol* 2015;66:1590-614.
[PUBMED](#) | [CROSSREF](#)
64. Koyama T, Yoshita K, Okuda N, et al. Overall nutrient and total fat intake among Japanese people: the INTERLIPID study Japan. *Asia Pac J Clin Nutr* 2017;26:837-48.
[PUBMED](#) | [CROSSREF](#)
65. Raatz SK, Silverstein JT, Jahns L, Picklo MJ Sr. Issues of fish consumption for cardiovascular disease risk reduction. *Nutrients* 2013;5:1081-97.
[PUBMED](#) | [CROSSREF](#)
66. Wang YJ, Yeh TL, Shih MC, Tu YK, Chien KL. Dietary sodium intake and risk of cardiovascular disease: a systematic review and dose-response meta-analysis. *Nutrients* 2020;12:12.
[PUBMED](#) | [CROSSREF](#)

67. Son J, Lee Y, Park K. Effects of processed red meat consumption on the risk of type 2 diabetes and cardiovascular diseases among Korean adults: the Korean Genome and Epidemiology Study. *Eur J Nutr* 2019;58:2477-84.
[PUBMED](#) | [CROSSREF](#)
68. Nagao M, Iso H, Yamagishi K, Date C, Tamakoshi A. Meat consumption in relation to mortality from cardiovascular disease among Japanese men and women. *Eur J Clin Nutr* 2012;66:687-93.
[PUBMED](#) | [CROSSREF](#)
69. Eshak ES, Iso H, Date C, et al. Rice intake is associated with reduced risk of mortality from cardiovascular disease in Japanese men but not women. *J Nutr* 2011;141:595-602.
[PUBMED](#) | [CROSSREF](#)
70. Eshak ES, Iso H, Yamagishi K, et al. Rice consumption is not associated with risk of cardiovascular disease morbidity or mortality in Japanese men and women: a large population-based, prospective cohort study. *Am J Clin Nutr* 2014;100:199-207.
[PUBMED](#) | [CROSSREF](#)
71. Park JE, Ryu Y, Cho SI. The effect of reference group classification and change in alcohol consumption on the association between alcohol consumption and cardiovascular disease. *Alcohol Clin Exp Res* 2017;41:379-87.
[PUBMED](#) | [CROSSREF](#)
72. Lin Y, Kikuchi S, Tamakoshi A, et al. Alcohol consumption and mortality among middle-aged and elderly Japanese men and women. *Ann Epidemiol* 2005;15:590-7.
[PUBMED](#) | [CROSSREF](#)
73. Iso H, Kobayashi M, Ishihara J, et al. Intake of fish and n3 fatty acids and risk of coronary heart disease among Japanese: the Japan Public Health Center-based (JPHC) study cohort I. *Circulation* 2006;113:195-202.
[PUBMED](#) | [CROSSREF](#)
74. Yamagishi K, Iso H, Date C, et al. Fish, omega-3 polyunsaturated fatty acids, and mortality from cardiovascular diseases in a nationwide community-based cohort of Japanese men and women the JACC (Japan Collaborative Cohort Study for Evaluation of Cancer Risk) study. *J Am Coll Cardiol* 2008;52:988-96.
[PUBMED](#) | [CROSSREF](#)
75. Park Y, Park S, Yi H, et al. Low level of n-3 polyunsaturated fatty acids in erythrocytes is a risk factor for both acute ischemic and hemorrhagic stroke in Koreans. *Nutr Res* 2009;29:825-30.
[PUBMED](#) | [CROSSREF](#)
76. Choi-Kwon S, Kim JS. Lifestyle factors and risk of stroke in Seoul, south Korea. *J Stroke Cerebrovasc Dis* 1998;7:414-20.
[PUBMED](#) | [CROSSREF](#)
77. Lim H, Choue R. Dietary pattern, nutritional density, and dietary quality were low in patients with cerebral infarction in Korea. *Nutr Res* 2011;31:601-7.
[PUBMED](#) | [CROSSREF](#)
78. Takachi R, Inoue M, Shimazu T, et al. Consumption of sodium and salted foods in relation to cancer and cardiovascular disease: the Japan Public Health Center-based prospective study. *Am J Clin Nutr* 2010;91:456-64.
[PUBMED](#) | [CROSSREF](#)
79. Nakamura Y, Ueshima H, Okamura T, et al. A Japanese diet and 19-year mortality: national integrated project for prospective observation of non-communicable diseases and its trends in the aged, 1980. *Br J Nutr* 2009;101:1696-705.
[PUBMED](#) | [CROSSREF](#)
80. Shima A, Miyamatsu N, Miura K, et al. Relationship of household salt intake level with long-term all-cause and cardiovascular disease mortality in Japan: NIPPON DATA80. *Hypertens Res* 2020;43:132-9.
[PUBMED](#) | [CROSSREF](#)
81. Umesawa M, Iso H, Date C, et al. Relations between dietary sodium and potassium intakes and mortality from cardiovascular disease: the Japan Collaborative Cohort Study for Evaluation of Cancer Risks. *Am J Clin Nutr* 2008;88:195-202.
[PUBMED](#) | [CROSSREF](#)
82. Ikehara S, Iso H, Date C, et al. Salt preference and mortality from stroke and coronary heart disease for Japanese men and women: the JACC study. *Prev Med* 2012;54:32-7.
[PUBMED](#) | [CROSSREF](#)
83. Kweon S, Kim Y, Jang MJ, et al. Data resource profile: the Korea National Health and Nutrition Examination Survey (KNHANES). *Int J Epidemiol* 2014;43:69-77.
[PUBMED](#) | [CROSSREF](#)
84. Ikeda N, Takimoto H, Imai S, Miyachi M, Nishi N. Data resource profile: the Japan National Health and Nutrition Survey (NHNS). *Int J Epidemiol* 2015;44:1842-9.
[PUBMED](#) | [CROSSREF](#)