

Cardiovascular Health Metrics of 87,160 Couples: Analysis of a Nationwide Epidemiological Database

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Aim: Clinical evidence on cardiovascular health metrics of couples, as defined by the American Heart Association (AHA), remains to be scarce. This study aims to explore the correlation of the AHA-defined cardiovascular health metrics within couples using a nationwide epidemiological database.

Methods: We examined the modified cardiovascular health metrics among 87,160 heterosexual couples using the health claims database from the Japan Medical Data Center. The ideal cardiovascular health metrics is comprised of (1) nonsmoking, (2) body mass index <25 kg/m², (3) physical activity at goal, (4) untreated blood pressure <120/80 mm Hg, (5) untreated fasting glucose <100 mg/dL, and (6) untreated total cholesterol <200 mg/dL.

Results: A correlation was noted on the ideal modified cardiovascular health metrics between couples. The prevalence of meeting ≥ 5 ideal components in the female partners increased from 32 % in the male partners meeting 0–1 ideal component to 56 % in those meeting 6 ideal components. The same trend has been observed in all generations (20–39 years, 40–49 years, 50–59 years, ≥ 60 years). The association between couples is found to be better in terms of smoking status, blood pressure, and fasting glucose level.

Conclusion: There was an intracouple correlation of the ideal modified cardiovascular health metrics, suggesting the importance of couple-based intervention to improve cardiovascular health status.

Key words: Couples, Cardiovascular health metrics, Preventive cardiology, Epidemiology

Introduction

Preventing the development of cardiovascular disease through the management of risk factors and lifestyle is always essential. To promote primary prevention, the American Heart Association (AHA) has defined cardiovascular health (CVH) based on seven

risk factors and behaviors including smoking status, body mass index, physical activity, dietary habits, blood pressure, fasting glucose level, and total cholesterol level^{1,2}. A number of clinical evidence have supported the validity of these CVH metrics. Yang *et al.*³ have reported that higher values of CVH metrics were associated with a lower all-cause and cardiovascular

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disease mortality. Therefore, measuring CVH metrics is a simple way to assess the risk of cardiovascular disease in each individual, which leads to establishing an effective prevention of subsequent cardiovascular disease. From this point of view, it is important to understand the determinants of CVH metrics.

Couples have common environmental and lifestyle habits, which can affect their individual health status. Therefore, if there is a significant intra-couple concordance in CVH metrics, it supports the concept of couple-based interventions for primary and secondary prevention of cardiovascular disease. However, clinical data on the correlation of the CVH metrics among couples remain to be limited^{4, 5}. In this study, we sought to examine the relationship of CVH metrics in 87,160 couples using the nationwide epidemiological database.

Methods

Study Design and Data Source

This study is a retrospective observational cross-sectional analysis using the health claims database of the Japan Medical Data Center (JMDC; Tokyo, Japan), Tokyo, between January 2005 and December 2016⁶⁻⁹. The JMDC contracts with more than 60 insurers, and this includes data for health insurance claims on insured individuals, with more than 5 million individuals registered in it. Most insured individuals in the JMDC database are identified to be employees of relatively large Japanese companies¹⁰. The JMDC database is comprised of 1,529,893 individuals. Among these individuals, we extracted 253,001 couples based on the family identification number. We excluded 228 couples whose husband and/or wife were under the age of 20 at the first health check-up, 129,985 couples that did not have enough data to calculate CVH metrics, and 35,628 couples whose intervals of the first health checkups between husband and wife were longer than 1 year. In total, we examined 87,160 couples in this study.

Ethics

We conducted this study in accordance with the ethical guidelines set by our institution (approval by the Institutional Review Board of the University of Tokyo: 2018-10862) as well as with the principles of the Declaration of Helsinki. The requirement for informed consent was waived, as all data in the JMDC database were de-identified.

Definition

We modified the AHA definitions of ideal, intermediate, and poor CVH to fit our database. **Table 1**

presents these modified and original AHA definitions, which were used in this study. In the JMDC database, all CVH metrics data were found to be available, except for the diet metrics. The health check-up data used to assess CVH metrics were uniform and readily available as performing a regular health check-up is mandatory for most Japanese employees using a prescribed format and protocol.

Ideal metrics were set as follows: ideal body weight was defined as BMI <25 kg/m², ideal smoking was defined as not smoking (never smoked or prior smoker), and current smoker was defined as smoking ≥ 100 cigarettes or smoking duration ≥ 6 months. Physical activity was measured using a standardized questionnaire. Ideal physical activity was defined as 30 minutes exercise ≥ twice a week or ≥ 1 hour walk per day. Ideal blood pressure has been defined as untreated blood pressure of <120/80 mmHg. Ideal fasting plasma glucose was defined as untreated values of <100 mg/dL. Total cholesterol level was calculated using the low-density lipoprotein, high-density lipoprotein, and triglyceride measurements. We defined the ideal total cholesterol as untreated values of <200 mg/dL. We calculated CVH metrics of each individual based on the data of their first health check-up.

Statistical Procedures

Categorical and continuous data of the baseline characteristics are presented as percentages (%) and means ± standard deviation. The chi-square test was used to compare the categorical variables between men and women. Meanwhile, the unpaired *t*-test was used in comparing continuous variables between men and women. To evaluate the degree of concordance in ideal CVH variables between couples, we analyzed the percentage of concordant and discordant couples in four categories including man/woman both ideal, man/woman both not ideal, man ideal and woman not ideal, and man not ideal and woman ideal for each variable. We assessed the intra-couple association for each variable using the phi coefficient. We analyzed the difference in the percentage of ideal index between woman and man using ideal metrics of disagreement among couples. We calculated the odds ratios (ORs) using the logistic regression analysis. We then performed subgroup analysis in each generation (men aged 20–39 years, 40–49 years, 50–59 years, and ≥ 60 years). A probability value <0.05 was considered statistically significant. We performed all statistical analyses using SPSS version 25 software (SPSS Inc., Chicago, IL, USA).

Table 1. Definitions of ideal, intermediate, and poor cardiovascular health metrics

Cardiovascular health metrics	Definition of the AHA	Definition in our study
Smoking status		
Ideal	Never or quit > 12 months ago	Never or Prior smoking
Intermediate	Former or quit ≤ 12 months	Not available
Poor	Current smoking	Current smoking
Body mass index		
Ideal	< 25 kg/m ²	< 25 kg/m ²
Intermediate	25 – 29.9 kg/m ²	25 – 29.9 kg/m ²
Poor	≥ 30.0 kg/m ²	≥ 30.0 kg/m ²
Physical activity		
Ideal	≥ 150 min/week moderate or ≥ 75 min/week vigorous or ≥ 150 min/week moderate + vigorous	30 minutes exercise equal or more than twice a week or Equal or more than one hour walk per day
Intermediate	1 – 149 min/week moderate or 1 – 74 min/week vigorous or 1 – 149 min/week moderate + vigorous	Not available
Poor	None	None
Healthy diet score		
Ideal	4 - 5 components	Not available
Intermediate	2 - 3 components	Not available
Poor	0 - 1 components	Not available
Blood pressure		
Ideal	SBP < 120 and DBP < 80 mmHg	SBP < 120 and DBP < 80 mmHg
Intermediate	SBP 120 – 139 or DBP 80 – 89mmHg or treated to goal	SBP 120 – 139 or DBP 80 – 89mmHg or treated to goal
Poor	SBP ≥ 140 or DBP ≥ 90mmHg	SBP ≥ 140 or DBP ≥ 90mmHg
Fasting plasma glucose		
Ideal	< 100 mg/dL	< 100 mg/dL
Intermediate	100 – 125 mg/dL or treated to goal	100 – 125 mg/dL or treated to goal
Poor	≥ 126 mg/dL	≥ 126 mg/dL
Total cholesterol		
Ideal	< 200 mg/dL	< 200 mg/dL
Intermediate	200 – 239 mg/dL or treated to goal	200 – 239 mg/dL or treated to goal
Poor	≥ 240 mg/dL	≥ 240 mg/dL

AHA, American Heart Association.

Results

Characteristics of Study Population

We analyzed 87,160 heterosexual couples in this study. The average age of participants was determined to be 51.5 ± 9.5 years in men and 49.5 ± 9.0 years in women. Distribution of the CVH metrics is shown in **Table 2**. Women have reported to show better CVH status than men in all components.

Number of Ideal Cardiovascular Health Metrics

Fig. 1 presents an intra-couple concordance in the number of ideal CVH metrics. The prevalence of meeting ≥ 5 ideal components of women increased from 32 % in spousal men meeting 0–1 ideal compo-

nent to 56 % in those meeting 6 ideal components. The proportion of persons meeting ≥ 5 ideal components is shown in **Table 3**. A man who meets ≥ 5 ideal components probably had a partner who meets ≥ 5 ideal components (odds ratio (OR) 1.6, 95 % CI 1.6–1.7, $p < 0.001$).

Subgroup Analysis

A similar trend of intra-couple concordance in the number of ideal CVH metrics is observed in all generations including men aged 20–39 years ($n = 7,471$) (**Fig. 2A**), 40–49 years ($n = 31,791$) (**Fig. 2B**), 50–59 years ($n = 26,426$) (**Fig. 2C**), and ≥ 60 years ($n = 21,472$) (**Fig. 2D**). A man who meets ≥ 5 ideal components probably had a partner who meets ≥ 5

Table 2. Distribution of the Cardiovascular Health Metrics

Cardiovascular health metrics	Total Sample (<i>N</i> =174,320)	Men (<i>n</i> =87,160)	Women (<i>n</i> =87,160)	<i>P</i> Value
Smoking status				<0.001
Ideal	143,032 (82)	61,003 (70)	82,029 (94)	
Intermediate	Not Available	Not Available	Not Available	
Poor	31,288 (18)	26,157 (30)	5,131 (6)	
Body mass index				<0.001
Ideal	137,745 (79)	63,004 (72)	74,741 (86)	
Intermediate	31,753 (18)	21,490 (25)	10,263 (12)	
Poor	4,822 (3)	2,666 (3)	2,156 (2)	
Physical activity				<0.001
Ideal	83,000 (48)	39,810 (46)	43,190 (50)	
Intermediate	Not Available	Not Available	Not Available	
Poor	91,320 (52)	47,350 (54)	43,970 (50)	
Healthy diet score				
Ideal	Not Available	Not Available	Not Available	
Intermediate	Not Available	Not Available	Not Available	
Poor	Not Available	Not Available	Not Available	
Blood pressure				<0.001
Ideal	83,263 (48)	31,560 (36)	51,703 (59)	
Intermediate	67,903 (39)	41,076 (47)	26,827 (31)	
Poor	23,154 (13)	14,524 (17)	8,630 (10)	
Fasting plasma glucose				<0.001
Ideal	130,064 (75)	57,245 (66)	72,819 (84)	
Intermediate	37,697 (22)	24,937 (29)	12,760 (15)	
Poor	6,559 (4)	4,978 (6)	1,581 (2)	
Total cholesterol				<0.001
Ideal	65,934 (38)	32,313 (37)	33,621 (39)	
Intermediate	77,323 (44)	40,494 (46)	36,829 (42)	
Poor	31,063 (18)	14,353 (16)	16,710 (19)	
Number of Ideal Cardiovascular Health Metrics				<0.001
0	1,261 (1)	1,163 (1)	98 (0)	
1	8,231 (5)	6,428 (7)	1,803 (2)	
2	23,182 (13)	16,468 (19)	6,714 (8)	
3	40,864 (23)	24,821 (28)	16,043 (18)	
4	50,205 (29)	23,137 (27)	27,068 (31)	
5	38,431 (22)	12,298 (14)	26,133 (30)	
6	12,146 (7)	2,845 (3)	9,301 (11)	

Data are expressed as number (percentage).

ideal components in men aged 20–39 years (OR 1.4, 95 % CI 1.3–1.6, $p < 0.001$), 40–49 years (OR 1.3, 95 % CI 1.3–1.4, $p < 0.001$), 50–59 years (OR 1.4, 95 % CI 1.3–1.5, $p < 0.001$), and ≥ 60 years (OR 1.3, 95 % CI 1.2–1.5, $p < 0.001$).

Association of each Cardiovascular Health Metrics Component Between Couples

Fig. 3 presents the association of each CVH metrics component between couples. The phi coefficient showed that intracouple association was better in terms of smoking status, blood pressure, and fasting glucose level. Women have met ideal metrics of disagreement between couples.

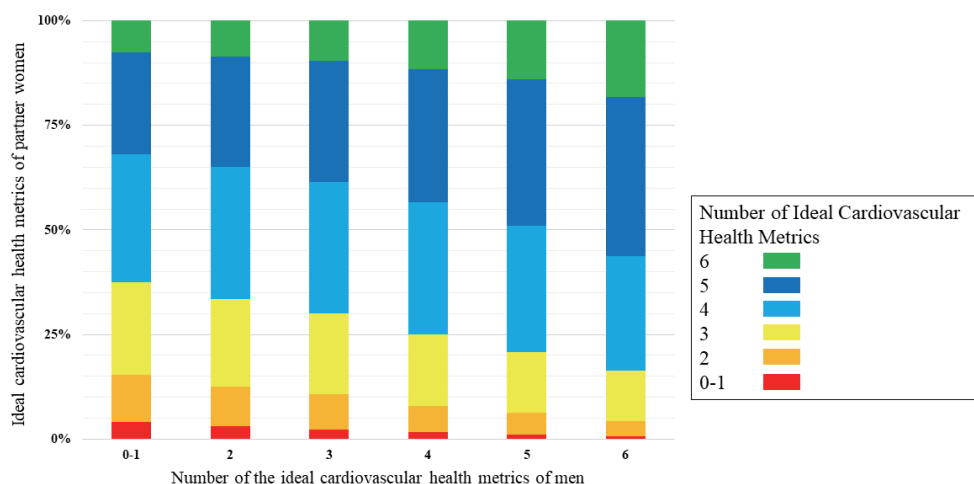


Fig. 1. Correlation of the ideal modified cardiovascular health metrics between couples

Fig. 1 shows an intra-couple concordance in the number of ideal cardiovascular health metrics between couples.

Table 3. Proportion of Subjects Meeting ≥ 5 Ideal Components

		Men	
		No	Yes
Women	No	44,204 (50.7%)	7,522 (8.6%)
	Yes	27,813 (31.9%)	7,621 (8.7%)

Discussion

There are three major findings in this study. First, there was an intra-couple association of the ideal modified CVH metrics. Second, the prevalence of meeting ≥ 5 ideal components of the woman partners increased from 32% in the man partners meeting 0–1 ideal component to 56% in those meeting 6 ideal components. Third, the phi coefficient indicated that the intracouple association was better in terms of smoking status, blood pressure, and fasting glucose level.

CVH metrics are seen to aid in the risk stratification of subsequent cardiovascular diseases. Previous studies have shown an association between CVH metrics and the risk of cardiovascular event^{3, 11, 12}. Folsom *et al.*¹¹ have examined the data from the Atherosclerosis Risk in Communities Study cohort and showed that persons with the highest values of CVH metrics experienced few cardiovascular events including stroke, heart failure, myocardial infarction, and fatal coronary disease. Further, Kim *et al.*¹³ recently reported that a higher ideal CVH metrics score was associated with a lower prevalence of calcification in the coronary artery, accompanied with slower progres-

sion of coronary artery calcification in apparently healthy adults, suggesting the importance of CVH metrics in preventive cardiology.

Previous studies examining couples (spousal and cohabitating) support our findings¹⁴⁻¹⁷. For instance, Knuiman *et al.*¹⁴ have identified statistically significant positive correlations in terms of blood pressure, body mass index, and cholesterol between couples. Di Castelnuovo *et al.*¹⁷ also studied the spousal concordance for major coronary risk factors and reported that the most strongly correlated intra-couple risk factors were smoking and body mass index. Statistically significant correlations were also found for diastolic blood pressure, triglycerides, and total and low-density lipoprotein cholesterol. After comparing with the previous reports, we reasoned that CVH metrics were concordant between couples.

Two studies focusing on intra-couple concordance of CVH metrics were reported previously^{4, 5}. First was the study of O' Flynn *et al.*⁴, who examined 181 couples in a single center in Ireland and presented an intra-couple concordance in ideal CVH metrics. Second was the study of Erqou *et al.*⁵, who studied 231 couples using a community-based cohort in western Pennsylvania and also reported the same findings.

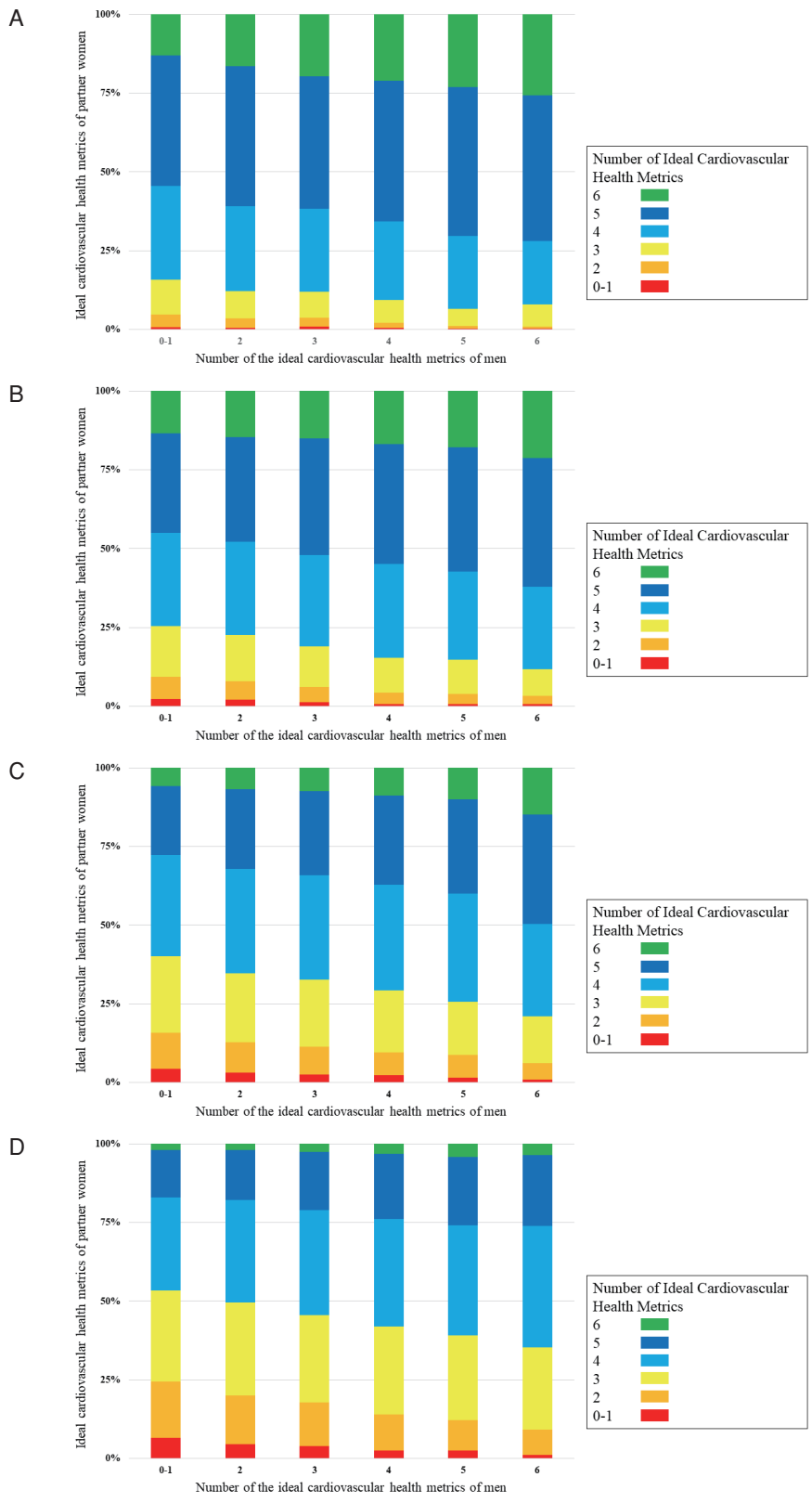
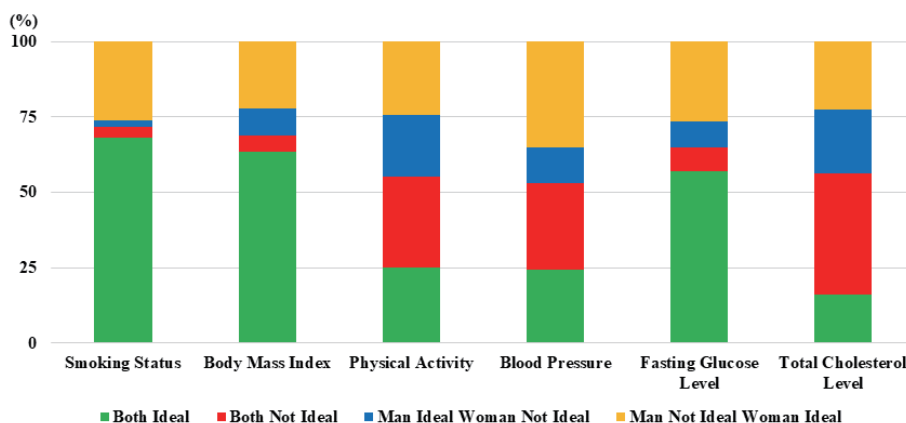


Fig. 2. Subgroup analysis on correlation of the ideal modified cardiovascular health metrics between couples
 Fig. 2 presents an intra-couple concordance in the number of ideal cardiovascular health metrics between couples among all generations including men aged 20–39 years (Fig. 2A), 40–49 years (Fig. 2B), 50–59 years (Fig. 2C), and ≥ 60 years (Fig. 2D).



Phi coefficient and difference in proportion of ideal index between woman and man						
Variables	Both Ideal	Both Not Ideal	Man Ideal Woman Not Ideal	Man Not Ideal Woman Ideal	Phi Coefficient	Difference in percentage of ideal index between woman and man
Smoking Status	59,201	3,329	1,802	22,828	0.190 (0.184-0.197)	24.1 (23.8-24.4)
Body Mass Index	55,262	4,677	7,742	19,479	0.091 (0.084-0.097)	13.4 (13.1-13.8)
Physical activity	21,941	26,101	17,869	21,249	0.102 (0.095-0.109)	3.9 (3.4-4.3)
Blood Pressure	21,146	25,043	10,414	30,557	0.118 (0.111-0.124)	23.1 (22.7-23.5)
Fasting Glucose Level	49,707	6,803	7,538	23,112	0.123 (0.116-0.129)	17.9 (17.5-18.2)
Total Cholesterol Level	13,937	35,163	18,376	19,684	0.072 (0.065-0.078)	1.5 (1.1-1.9)

Phi Coefficient was expressed as number (95% confidence interval). Difference in proportion of ideal index between woman and man was expressed as percentage (95% confidence interval).

Fig. 3. Intra-couple association of each cardiovascular health metrics component

Fig. 3 indicates the association between couples for each cardiovascular health metrics component.

The results of our study were found to be concordant with these studies, and intra-couple association of CVH metrics was confirmed in our study as well.

The strength of our study is its large sample size. As described above, two preceding studies are based on single center or local community data and, therefore, had small sample sizes. However, considering the variety and heterogeneity of lifestyles and behaviors, we believe that examining the intra-couple concordance of CVH metrics using a nationwide large-scale database is resourceful. In this study, we also conducted a subgroup analysis and found out that a correlation of CVH metrics between couples may exist irrespective of age. The effect of age on the association of CVH metrics between couples is seemingly not so large.

The association between couples is better in the component of smoking, blood pressure, and fasting glucose level. Regarding smoking habits, it should be noted that the disagreement ratio is at 29%. These couples should be aware of the risk of passive smoking. Given that blood pressure and fasting glucose level are strongly affected by dietary habits, it is also reasonable that there was a good association between couples for these components. Our findings confirm that couple-based lifestyle assessment and interven-

tional strategy have potentials for application in preventive cardiology. In addition, the number of ideal CVH metrics of men was lower than that of women. This may contribute to the gender difference in cardiovascular risks. Preventive interventions targeting couples may contribute to the reduction of the higher cardiovascular risk in men.

We acknowledge several limitations in this study. First, the data of the JMDC database were mainly obtained from an employed, working-age population. Therefore, “healthy worker” bias should be recognized. Second, as noted above, the JMDC database did not have any records of diet information. Diet is thought to be the most frequently shared between cohabitating couples, and maintaining optimal diet habit is important for preventing metabolic disorders and cardiovascular disease^{18, 19}. However, analysis of the effects of dietary habits was impossible due to the unavailability of data. Further research is required to assess the influence of dietary habits on CVH metrics scores. Third, we did not have the information on the duration of marriage and whether couples live together. These can affect intra-couple association of the CVH metrics. As described in the Methods section, we identified couples in the JMDC database using family identification number which was given to

all individuals enrolled in the JMDC database. Therefore, if husband and wife joined different health insurance, such couple was not identified as couples and not included in this study. Intra-couple association of the CVH metrics would change if we could include couples joining different health insurance. The number of couples in men aged 20–39 years is relatively small. It may reflect the current social situation in Japan, such as late marriage and rising unmarried rate among young people. Further data on younger age couples are needed.

Conclusion

Our analysis of a nationwide epidemiological data showed an association of CVH metrics between 87,160 heterosexual couples. The results of this study may support the concept of couple-based intervention for improving CVH status.

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Disclosures

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