ORIGINAL ARTICLE

Favorable self-rated health is associated with ideal cardiovascular health: a cohort study

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KEY WORDS

cardiovascular diseases, risk factors, self-rated health

ABSTRACT

INTRODUCTION Both self-rated health (SRH) and the cardiovascular health (CVH) metrics of the American Heart Association have been reported as predictors of cardiovascular events. However, a longitudinal study of the relationships between these metrics has not been conducted before.

OBJECTIVES We investigated the association between SRH and CVH metrics in a longitudinal study involving an Asian population.

PATIENTS AND METHODS Eligible participants were enrolled between 2009 and 2014. Multivariable logistic regression models were used to examine the association between SRH and overall ideal CVH metrics as well as each ideal CVH metric at baseline and during follow-up. Additionally, we classified participants into 3 groups according to the change in SRH after 3 years of follow-up and analyzed the changes in ideal CVH metrics in these groups.

RESULTS Our study group consisted of 15 608 participants. After a mean follow-up of 2.69 years, participants who classified their health as "Poor" or "Very Poor" had reduced odds ratios (ORs) for ideal CVH metrics, with ORs of 0.68 (95% CI, 0.54–0.85; $P = 0.001$) and 0.59 (95% CI, 0.37–0.96; $P = 0.03$) for "Poor" and "Very Poor" SRH, respectively. In contrast, the odds for increased ideal CVH metrics rose as SRH improved (OR, 1.20; 95% CI, 1.07–1.36; $P = 0.002$).

CONCLUSIONS Changes in SRH ratings might accurately reflect changes in CVH metrics. Our longitudinal study demonstrated that SRH was significantly associated with the number of ideal CVH metrics. Our findings provide epidemiological evidence for future public health strategies targeting cardiovascular disease.

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INTRODUCTION Approximately 17.9 million people died of cardiovascular disease (CVD) in 2015.[1] A statistical report from the American Heart Association (AHA) indicated that more than 40% of the adult population in the United States is expected to have CVD by 2030. Moreover, the annual total costs incurred by CVD are projected to approach US $1 trillion by 2030.[2] Therefore, much progress has recently been made in decreasing the costs of this disease. The AHA 2020 Impact Goals are to improve cardiovascular health (CVH) by 20% and to reduce total CVD and stroke deaths by 20%.[3]

To improve CVH, epidemiological evidence suggests that it is more important to emphasize health promotion than disease treatment. As a result, the concept of ideal CVH has been defined by researchers in populations that meet the criteria outlined by the AHA "Life's Simple 7."[3] These optimal metrics included 4 ideal health behaviors and 3 ideal health measures. Previous studies have revealed that ideal levels of the above metrics are related to a decreased incidence of stroke[4] and atrial fibrillation,[5] as well as preserved cardiac structure and function.[6] Moreover, participants with a greater number of ideal

WHAT'S NEW?

This is the first prospective study to investigate the association between self-rated health (SRH) and the cardiovascular health (CVH) metrics of the American Heart Association. It provides additional evidence of links between single-item scales that are useful in large surveys and objective health status. Favorable SRH was significantly associated with an increase in the number of ideal CVH metrics in this longitudinal study. Individuals with worse SRH should be educated about improving their CVH metrics, as a cost-effective public health strategy to improve CVH.

CVH metrics were reported to have less frailty,[7] lower mortality,[8] and lower risks of noncardiovascular health problems[9] such as diabetes,[10] venous thromboembolism,[11] dementia, and cognitive decline.[12]

In accordance with the integrative definition of health, more attention is being paid to incorporating patients' perspectives on their health and quality of life evaluation. As a result, the concept of self-rated health (SRH) has been proposed as an easy way to assess individual physical condition. As early as 1982, a large study demonstrated that SRH could be a mortality predictor among older adults.[13] Subsequently, other systematic reviews also proved that poor SRH was strongly connected with a higher mortality risk even after adjusting for comorbidities and functional and mental statuses, independent of country of origin.[14-16] The latest prospective cohort study also revealed that SRH was strongly connected with mortality.[17] In addition, a prospective cohort study conducted in the United Kingdom described SRH as a strong predictor of CVD.[18] In a population-based cohort study of Chinese adults, a significantly lower incidence of coronary artery disease was observed in the population with favorable SRH.[19] Therefore, a better understanding of the potential effect of SRH on CVH conditions is needed.

Both SRH and CVH metrics have been reported as predictors of cardiovascular events and prior research has highlighted the strong association between SRH and ideal CVH metrics.[20-24] However, no longitudinal study of the association between SRH and ideal CVH metrics has been conducted to date. Moreover, in the studies cited,[20-24] the participants were from Western regions, while data on Asian populations are scarce. Thus, our objective was to investigate the relationship between SRH and ideal CVH metrics in a longitudinal study. We hypothesized that participants with better SRH would have better CVH metrics, regardless of chronic disease status, sociodemographic characteristics, or other covariates.

PATIENTS AND METHODS

Study population and design The present study used data from the MJ Health Management Center, which is a self-paid service providing comprehensive health screening programs in Taiwan.[25] Branches of this center are distributed throughout the country. All the participants were somewhat healthy because they had volunteered to undergo a regular health check-up program for primary prevention. All the programs and data collection processes used standard protocols (conforming to ISO 9001). The participants who had undergone 2 health evaluations 2 to 4 years apart between July 2009 and August 2014 were eligible for inclusion in the present analysis. The mean (SD) period between the first and second health evaluation was 2.69 (0.79) years. Participants without data on SRH (n = 57 128) or data on CVH metrics (n = 654), as well as those with a history of CVD (n = 300) were excluded. After a mean follow-up period of 2.69 years, participants with missing SRH (n = 2011) or CVH metric data (n = 405) were also excluded. Ultimately, 15 608 eligible participants aged 21 to 80 years were included in this longitudinal analysis (FIGURE 1). The number of participants was 3311 (21.2%) in 2009, 3851 (24.7%) in 2010, 2909 (18.6%) in 2011, 2273 (14.6%) in 2012, 1969 (12.6%) in 2013, and 1295 (8.3%) in 2014. Informed consent, including consent for the use of anonymous personal data for research purposes, was obtained from each participant. The information was collected from participants through physical examinations, laboratory measurements, and standardized questionnaires. This study obtained ethical approval from the Institutional Review Board of Tri-Service General Hospital.

Self-rated health Self-rated health was assessed by the response to the following question, which all study participants were asked: "Do you think your health in general is excellent, good, fair, poor, or very poor? Please choose one option. Excellent is the highest level, and very poor is the lowest level." The responses to this question were found to relate to mortality[15] and inflammation.[26]

Cardiovascular health metrics Based on the AHA 2020 goals, the CVH metrics were classified into 7 health metrics: 4 health behavior indicators (smoking status, physical activity, healthy diet score, and body mass index [BMI]) and 3 measurement tests (blood pressure [BP], total cholesterol [TC], and fasting glucose [FG]).[3] Each CVH metric was categorized into 3 levels: ideal, intermediate, and poor. Smoking status was self-reported. The participants who had never smoked were assigned the ideal smoking status; those who had quit smoking were assigned the intermediate status; and current smokers were assigned the poor status. To evaluate physical activity during leisure time, the participants answered a questionnaire that assessed leisure time physical activity in minutes per week. We classified at least 210 minutes of physical activity per week as ideal, between 60 and 210 minutes per week as intermediate, and less than 60 minutes per week as poor. To determine the healthy diet score, the participants were asked to fill out a food-frequency questionnaire, reporting their daily consumption of vegetables, fresh fruit, fish, whole grains, sodium, and milk. The healthy diet

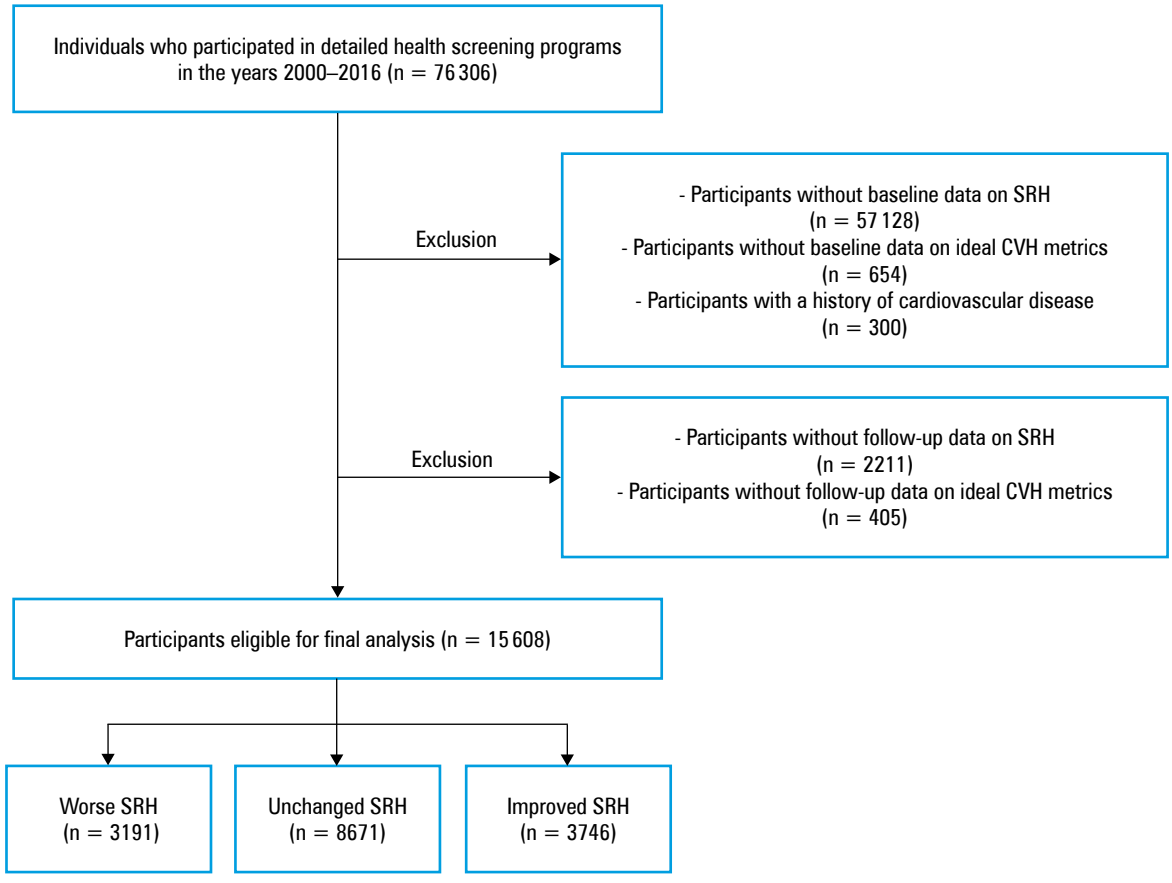

FIGURE 1 Flowchart for participant selection
Abbreviations: CVH, cardiovascular health; SRH, self-rated health

score was calculated following the AHA suggestions and was based on the dietary criteria that the participants reported. Ideal, intermediate, and poor healthy diet scores were defined as achieving 4 to 5 components, 2 to 3 components, and 0 to 1 component, respectively. Body mass index was estimated as weight (kg) divided by the square of height (m^2). Values under 25 kg/m^2 were defined as the ideal BMI level, values between 25 and 29.99 kg/m^2 as intermediate, and values of 30 kg/m^2 and above as poor. Blood pressure was measured using a digital sphygmomanometer after at least 10 minutes of rest in a sitting position. Ideal BP was categorized as a systolic blood pressure (SBP) of less than 120 mm Hg and a diastolic blood pressure (DBP) of less than 80 mm Hg. Intermediate BP was classified as an SBP between 120 and 139 mm Hg or a DBP between 80 and 89 mm Hg. Poor BP was classified as an SBP of 140 mm Hg or higher or a DBP of 90 mm Hg or higher. If SBP and DBP of a participant were in different categories, the BP level was assigned to the worse category. Blood samples for the measurement of FG and TC were collected from the participants after 8 hours of fasting. Total cholesterol was categorized as ideal, intermediate, and poor when the level was less than 200 mg/dl, between 200 and 239 mg/dl, and greater than or equal to 240 mg/dl, respectively. In addition, FG was categorized as ideal, intermediate, and poor when the level was less than 100 mg/dl, between 100 and 125 mg/dl, and greater than or equal to 126 mg/dl, respectively (Supplementary data, *Table S1*).

Related variables Data on education, income, marital status, and medical history were gathered using questionnaires. Education level was divided into 7 categories: illiterate, elementary school, middle school, high school, college, university degree, and postgraduate degree. Income was classified into 7 levels ranging from 0 to more than 2 million New Taiwan dollars (US $66 000) per year. Marital status was divided into 4 categories: single, married, divorced, and widowed. Medical history was assessed using the question, "Have you ever had the following diseases?" Hypertension, diabetes, thyroid disease, and gout were recorded as either absent or present in the history.

Statistical analysis Age, BMI, BP as well as serum TC and FG levels were regarded as continuous variables. They were compared by analysis of variance across the 5 SRH categories. Sex, education, income, marital status, medical history, and CVH metrics were defined as categorical variables and compared by χ^2 tests across the 5 SRH categories. The association between SRH and the sum of ideal CVH metrics (5–7 vs 0–4 [reference]) and each ideal CVH metric at baseline and follow-up were examined by multivariable logistic regression analysis. Additionally, the participants

were divided into 3 groups: those with worse SRH, those with unchanged SRH, and those with improved SRH during a mean of 2.69 years. The associations of these 3 SRH groups with changes in the ideal CVH metrics were also examined by multivariable logistic regression analysis. Changes in the ideal CVH metrics were defined as increased, unchanged, or decreased during the follow-up period. Three models were designed for covariate adjustment in the present study. First, we adjusted for age and sex (Model 1). Second, we adjusted for the covariates in Model 1 plus education, income, and marital status (Model 2). Finally, we adjusted for the covariates in Model 2 plus history of hypertension, diabetes, thyroid disease, and gout (Model 3). A *P* value of less than 0.05 was chosen for statistical significance. All statistical analyses were performed using SPSS (version 22.0, SPSS Inc, Chicago, Illinois, United States).

RESULTS The characteristics of the participants are summarized in TABLE 1. Our study group consisted of 15 608 individuals. A total of 50.5% of the participants were female, and the mean age was 36.8 years. The participants rated their health as "Fair" (49.7%), "Good" (30.1%), "Poor" (13.0%), "Excellent" (5.8%), or "Very Poor" (1.4%). The percentage of participants with an ideal level in 5 to 7 of the CVH metrics was lower among those with "Poor" and "Very Poor" SRH compared to "Excellent" SRH. Female gender, lower education level, lower income, and a marital status of divorced or widowed were found to be significantly associated with worse SRH. In addition, a history of diabetes, hypertension, thyroid disease, or gout was more common among the participants with "Very Poor" and "Poor" SRH.

The results of the multivariable logistic regression analysis of the relationship between SRH and the ideal CVH metrics at baseline are presented in TABLE 2. The participants with "Poor" and "Very Poor" SRH were less likely to have ideal CVH metrics. What is more, this association did not change after adjusting for further covariates. In Model 3, the participants who classified their health as "Poor" or "Very Poor" were less likely to have ideal CVH metrics; the odds ratio (OR) for "Poor" SRH was 0.57 (95% CI, 0.45–0.71; $P < 0.001$), and the OR for "Very Poor" SRH was 0.63 (95% CI, 0.40–1.00; $P = 0.048$). Furthermore, the ORs for ideal CVH metrics were lower for those who reported "Very Poor" SRH, except for BP, FG, TC, and healthy diet. The results of the same survey performed after a mean follow-up of 2.69 years are shown in TABLE 3. A similar association between baseline SRH and follow-up ideal CVH metrics was observed. The participants who classified their health as "Poor" or "Very Poor" had lower ORs for ideal CVH metrics: the ORs were 0.68 (95% CI, 0.54–0.85; $P = 0.001$) for "Poor" SRH and 0.59 (95% CI, 0.37–0.96; $P = 0.03$) for "Very Poor" SRH. Likewise, the participants with "Poor" or "Very Poor" SRH were more likely to have worse CVH metrics, except for FG, smoking, and healthy diet. To investigate the effect of changes in SRH on CVH metrics, a mean of 2.69 years of longitudinal follow-up research was performed (FIGURE 2). In contrast to worse SRH, the odds for a greater number of ideal CVH metrics increased with improved SRH. The ORs were 1.26 (95% CI, 1.13–1.41; $P < 0.001$) for Model 1, 1.21 (95% CI, 1.07–1.36; $P = 0.002$) for Model 2, and 1.20 (95% CI, 1.07–1.36; $P = 0.002$) for Model 3.

DISCUSSION To our best knowledge, our analysis is the first to investigate the association between SRH and CVH metrics in a cohort study. The results demonstrated that there was a decrease in the number of ideal CVH metrics among individuals with a deterioration in SRH, even when potential covariates were taken into consideration. In addition, after a mean follow-up of 2.69 years, improvement in CVH profiles was observed along with improvement in SRH.

Our main results are consistent with those of previous cross-sectional studies focused on the relationship between SRH and CVH metrics.[21-24] Nevertheless, not all metrics of CVH were found to be significantly associated with better SRH, and the findings in those previous studies are inconsistent. A cross-sectional analysis conducted in Finland revealed an association between SRH and ideal CVH metrics only among women of working age. Additionally, an excellent or good SRH rating was related to a healthy diet, physical activity, BMI, and nonsmoking status, whereas BP and glycated hemoglobin levels were not associated with SRH.[21] A study by Manczuk et al[22] found that participants with a SRH score greater than 7 had a higher OR for ideal CVH metrics, except for smoking, healthy diet, and controlled cholesterol. However, their use of an SRH rating scale of 1 to 10 and a cutoff score of 7 to dichotomize "good / very good" and "very poor / poor / neutral" on the common 5-point scale might be uncorroborated.[27] Another cross-sectional analysis, this one from South Florida, reported that participants with favorable SRH had a higher OR for intermediate and ideal CVH metrics, excluding smoking.[23] Nevertheless, this study combined fair and poor SRH into one group because the sample size with poor SRH was small. In our large study sample, less ideal CVH metrics were observed in the "Poor" and "Very Poor" SRH groups, except for BP, FG, TC, and healthy diet.

Furthermore, in contrast to our analysis, none of the above studies used a longitudinal approach. A longitudinal design strengthens the support for the association between long-term changes in SRH and CVH. In addition, over a mean follow-up of 2.69 years, a greater number of ideal CVH metrics was observed in the participants with improved SRH than in those with worsening SRH in the fully adjusted models. In other words, a change in SRH might affect the CVH metrics. As a result, SRH could be a surrogate for risk of poor CVH, and if so, we should focus on helping this population improve its CVH metrics.

TABLE 1 Characteristics of the study population according to the categories of self-rated health

Variable		Self-rated health						*P* value
		Total (n = 15 608)	Excellent (n = 911)	Good (n = 4702)	Fair (n = 7757)	Poor (n = 2024)	Very Poor (n = 214)	
Age, y		36.82 (10.06)	39.17 (11.51)	37.61 (10.62)	36.52 (9.71)	35.08 (8.88)	36.81 (10.32)	<0.001
BMI, kg/m^2		23.13 (3.8)	22.93 (3.08)	22.93 (3.44)	23.12 (3.81)	23.67 (4.57)	24 (5.29)	<0.001
Total cholesterol, mg/dl		192.31 (34.14)	194.30 (35.65)	192.19 (33.34)	192.31 (34.26)	191.33 (34.63)	195.64 (35.59)	0.14
Fasting glucose, mg/dl		98.98 (17.46)	98.48 (15.32)	98.21 (14.79)	99.07 (17.08)	99.99 (22.03)	105.09 (34.9)	<0.001
SBP, mm Hg		116.3 (16.02)	116.46 (15.7)	116.12 (15.53)	116.52 (16.19)	115.64 (16.48)	118.23 (17.46)	0.09
DBP, mm Hg		71.51 (11.28)	71.21 (11.04)	71.36 (10.95)	71.64 (11.41)	71.40 (11.69)	72.50 (11.14)	0.41
Gender	Male	7732 (49.5)	511 (56.1)	2431 (51.7)	3831 (49.4)	855 (42.2)	104 (48.6)	<0.001
	Female	7876 (50.5)	400 (43.9)	2271 (48.3)	3926 (50.6)	1169 (57.8)	110 (51.4)	
Number of ideal CVH metrics	0–2	4128 (26.4)	238 (26.1)	1141 (24.3)	2102 (27.1)	579 (28.6)	68 (31.8)	0.002
	3–4	7792 (49.9)	441 (48.4)	2405 (51.1)	3850 (49.6)	991 (49)	105 (49.1)	
	5–7	3688 (23.6)	232 (25.5)	1156 (24.6)	1805 (23.3)	454 (22.4)	41 (19.2)	
Education	Illiterate	78 (0.5)	4 (0.4)	18 (0.4)	44 (0.6)	9 (0.4)	3 (1.4)	<0.001
	Elementary school	458 (2.9)	27 (3)	142 (3)	223 (2.9)	50 (2.5)	16 (7.5)	
	Junior high school	408 (2.6)	33 (3.6)	114 (2.4)	196 (2.5)	52 (2.6)	13 (6.1)	
	Senior high school	2264 (14.6)	151 (16.6)	622 (13.3)	1114 (14.4)	331 (16.4)	46 (21.5)	
	College	2658 (17.1)	164 (18.1)	772 (16.5)	1350 (17.5)	332 (16.5)	40 (18.7)	
	University degree	6586 (42.3)	353 (38.9)	1984 (42.3)	3289 (42.6)	882 (43.8)	78 (36.4)	
	Postgraduate degree	3101 (19.9)	175 (19.3)	1038 (22.1)	1511 (19.6)	359 (17.8)	18 (8.4)	
Income[a], TWD, thousand	0	412 (2.7)	22 (2.5)	113 (2.5)	202 (2.7)	60 (3)	15 (7.2)	<0.001
	1–400	1883 (12.3)	104 (11.7)	472 (10.3)	969 (12.8)	295 (14.9)	43 (20.6)	
	401–800	4630 (30.3)	258 (29.1)	1338 (29.1)	2345 (30.9)	622 (31.4)	67 (32.1)	
	801–1200	4020 (26.3)	206 (23.3)	1231 (26.8)	2047 (27)	495 (25)	41 (19.6)	
	1201–1600	1653 (10.8)	92 (10.4)	565 (12.3)	780 (10.3)	206 (10.4)	10 (4.8)	
	1601–2000	863 (5.7)	57 (6.4)	283 (6.2)	411 (5.4)	108 (5.5)	4 (1.9)	
	>2001	1069 (7)	102 (11.5)	377 (8.2)	474 (6.3)	101 (5.1)	15 (7.2)	
Marital status	Single	5654 (41.3)	309 (40)	1634 (40.1)	2780 (40.3)	854 (48.2)	77 (43.8)	<0.001
	Married	7429 (54.3)	418 (54.1)	2253 (55.3)	3829 (55.5)	847 (47.8)	82 (46.6)	
	Divorced	371 (2.7)	24 (3.1)	119 (2.9)	173 (2.5)	44 (2.5)	11 (6.3)	
	Widowed	232 (1.7)	21 (2.7)	68 (1.7)	111 (1.6)	26 (1.5)	6 (3.4)	
History of hypertension		685 (4.4)	27 (3)	158 (3.4)	342 (4.4)	138 (6.8)	20 (9.3)	<0.001
History of diabetes		209 (1.3)	7 (0.8)	39 (0.8)	94 (1.2)	56 (2.8)	13 (6.1)	<0.001
History of thyroid disease		394 (2.5)	20 (2.2)	95 (2)	198 (2.6)	71 (3.5)	10 (4.7)	0.002
History of gout		557 (3.6)	24 (2.6)	125 (2.7)	280 (3.6)	118 (5.8)	10 (4.7)	<0.001
Uric acid medication		146 (0.9)	3 (0.3)	30 (0.6)	67 (0.9)	37 (1.8)	9 (4.2)	0.1
Anti-ischemic medication		74 (0.5)	4 (0.4)	14 (0.3)	36 (0.5)	14 (0.7)	6 (2.8)	0.07
Antihypertensive medication		606 (3.9)	24 (2.6)	152 (3.2)	292 (3.8)	118 (5.8)	20 (9.3)	0.19
Antidiabetic medication		205 (1.3)	7 (0.8)	39 (0.8)	98 (1.3)	49 (2.4)	12 (5.6)	0.11
Thyroid medication		150 (1)	11 (1.2)	27 (0.6)	79 (1)	28 (1.4)	5 (2.3)	0.1
Cholesterol-lowering medication		151 (1)	9 (1)	37 (0.8)	68 (0.9)	35 (1.7)	2 (0.9)	0.1

Continuous variables are presented as mean (SD) and categorical variables as number (percentage).

SI conversion factors: to convert total cholesterol to mmol/l, multiply by 0.0259; glucose to mmol/l, by 0.0555.

a 1 TWD equals approximately 0.036 USD.

Abbreviations: BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure; TWD, Taiwan dollar; USD, United States dollar; others, see **FIGURE 1**

TABLE 2 Self-rated health in relation to ideal cardiovascular health metrics at initial assessment

Parameter	Self-rated health				
	Excellent (n = 911)	Good (n = 4702)	Fair (n = 7757)	Poor (n = 2024)	Very Poor (n = 214)
Number of ideal CVH metrics[a]					
Model 1[b]	1 (reference)	0.82 (0.67–1.00)[c]	0.68 (0.56–0.82)[c]	0.52 (0.42–0.65)[c]	0.52 (0.33–0.82)[c]
Model 2	1 (reference)	0.81 (0.66–0.99)[c]	0.69 (0.56–0.83)[c]	0.53 (0.43–0.66)[c]	0.58 (0.37–0.91)[c]
Model 3	1 (reference)	0.82 (0.67–1.01)	0.71 (0.58–0.86)[c]	0.57 (0.45–0.71)[c]	0.63 (0.40–1.00)[c]
Blood pressure					
Model 1	1 (reference)	0.86 (0.72–1.02)	0.72 (0.61–0.85)[c]	0.64 (0.53–0.77)[c]	0.70 (0.49–1.00)[c]
Model 2	1 (reference)	0.85 (0.72–1.01)	0.73 (0.61–0.86)[c]	0.65 (0.54–0.79)[c]	0.75 (0.52–1.07)
Model 3	1 (reference)	0.88 (0.74–1.05)	0.77 (0.66–0.92)[c]	0.75 (0.62–0.91)[c]	0.90 (0.62–1.31)
Total cholesterol					
Model 1	1 (reference)	1.06 (0.90–1.25)	0.95 (0.81–1.12)	0.95 (0.79–1.14)	0.83 (0.58–1.17)
Model 2	1 (reference)	1.06 (0.90–1.25)	0.96 (0.82–1.12)	0.95 (0.79–1.15)	0.85 (0.60–1.20)
Model 3	1 (reference)	1.05 (0.89–1.24)	0.95 (0.81–1.11)	0.93 (0.77–1.12)	0.80 (0.56–1.13)
Fasting glucose					
Model 1	1 (reference)	1.06 (0.89–1.27)	0.88 (0.74–1.04)	0.72 (0.59–0.87)[c]	0.84 (0.58–1.21)
Model 2	1 (reference)	1.06 (0.89–1.26)	0.88 (0.74–1.05)	0.72 (0.59–0.87)[c]	0.85 (0.59–1.23)
Model 3	1 (reference)	1.08 (0,90–1.29)	0.91 (0.77–1.08)	0.78 (0.64–0.95)[c]	0.98 (0.67–1.44)
BMI					
Model 1	1 (reference)	0.79 (0.65–0.96)[c]	0.60 (0.50–0.73)[c]	0.37 (0.30–0.46)[c]	0.43 (0.29–0.62)[c]
Model 2	1 (reference)	0.79 (0.65–0.96)[c]	0.61 (0.51–0.74)[c]	0.38 (0.31–0.47)[c]	0.46 (0.31–0.67)[c]
Model 3	1 (reference)	0.81 (0.67–0.99)[c]	0.65 (0.54–0.79)[c]	0.43 (0.35–0.53)[c]	0.52 (0.35–0.77)[c]
Smoking					
Model 1	1 (reference)	1.08 (0.89–1.31)	0.98 (0.81–1.18)	0.81 (0.65–1.00)[c]	0.51 (0.35–0.75)[c]
Model 2	1 (reference)	1.07 (0.88–1.30)	1.03 (0.85–1.24)	0.87 (0.70–1.08)	0.68 (0.45–1.00)[c]
Model 3	1 (reference)	1.06 (0.87–1.29)	1.01 (0.83–1.22)	0.83 (0.67–1.04)	0.64 (0.43–0.96)[c]
Physical activity					
Model 1	1 (reference)	0.63 (0.47–0.83)[c]	0.42 (0.32–0.55)[c]	0.35 (0.24–0.51)[c]	0.37 (0.16–0.88)[c]
Model 2	1 (reference)	0.62 (0.47–0.83)[c]	0.38 (0.29–0.51)[c]	0.31 (0.21–0.46)[c]	0.28 (0.12–0.68)[c]
Model 3	1 (reference)	0.62 (0.47–0.82)[c]	0.38 (0.29–0.51)[c]	0.30 (0.20–0.44)[c]	0.27 (0.11–0.64)[c]
Healthy diet					
Model 1	1 (reference)	0.77 (0.46–1.29)	0.57 (0.34–0.94)[c]	0.55 (0.29–1.04)	0.25 (0.03–1.86)
Model 2	1 (reference)	0.77 (0.46–1.28)	0.57 (0.34–0.94)[c]	0.55 (0.29–1.04)	0.24 (0.32–1.82)
Model 3	1 (reference)	0.77 (0.46–1.29)	0.57 (0.35–0.96)[c]	0.54 (0.28–1.03)	0.23 (0.03–1.76)

Data are presented as odds ratios (95% CIs).

a Number of ideal CVH metrics: 5–7 vs 0–4 (reference)

b Adjusted covariates: Model 1 = age and gender; Model 2 = Model 1 + education, income, and marital status; Model 3 = Model 2 + history of hypertension, diabetes, thyroid disease, or gout

c *P* value <0.05

Abbreviations: see **FIGURE 1**

Of note, our study highlighted the relationship between SRH and ideal CVH metrics in the Asian population. A cross-sectional study revealed that race and ethnicity may influence SRH, demonstrating that more Black and Latino participants than White respondents rated their health status as fair to poor, but the Asian population was not discussed.[28] Additionally, a study conducted at Pennsylvania State University found that Hispanic people were more likely to have poor to fair SRH than non-Hispanic individuals.[29] Furthermore, even in the non-Hispanic group, Black participants were more likely to assess their health as worse than White participants.[30] Another study that enrolled Asian immigrants of different ethnicities in the United States revealed significantly higher scores of SRH in the Asian Indian subgroup than in other Asian subgroups.[31] Therefore, ignoring racial and ethnic differences could mask health variations. For instance, the Multi-Ethnic Study of Atherosclerosis reported a significant association between higher SRH ratings and better CVH.[24] However, among Chinese-American individuals, who constituted

TABLE 3 Self-rated health in relation to ideal cardiovascular health metrics during follow-up

Parameter	Self-rated health				
	Excellent (n = 911)	Good (n = 4702)	Fair (n = 7757)	Poor (n = 2024)	Very Poor (n = 214)
Number of ideal CVH metrics[a]					
Model 1[b]	1 (reference)	0.84 (0.69–1.04)	0.75 (0.61–0.91)[c]	0.63 (0.50–0.79)[c]	0.51 (0.32–0.82)[c]
Model 2	1 (reference)	0.83 (0.68–1.03)	0.75 (0.61–0.92)[c]	0.64 (0.51–0.81)[c]	0.56 (0.35–0.90)[c]
Model 3	1 (reference)	0.84 (0.69–1.04)	0.77 (0.63–0.94)[c]	0.68 (0.54–0.85)[c]	0.59 (0.37–0.96)[c]
Blood pressure					
Model 1	1 (reference)	0.86 (0.72–1.02)	0.74 (0.63–0.88)[c]	0.64 (0.53–0.77)[c]	0.64 (0.45–0.92)[c]
Model 2	1 (reference)	0.86 (0.72–1.02)	0.75 (0.63–0.88)[c]	0.65 (0.53–0.78)[c]	0.68 (0.47–0.97)[c]
Model 3	1 (reference)	0.88 (0.74–1.05)	0.79 (0.67–0.94)[c]	0.74 (0.61–0.89)[c]	0.79 (0.55–1.15)
Total cholesterol					
Model 1	1 (reference)	1.11 (0.95–1.31)	1.02 (0.87–1.19)	0.95 (0.79–1.13)	0.75 (0.53–1.05)
Model 2	1 (reference)	1.12 (0.95–1.31)	1.02 (0.87–1.19)	0.94 (0.79–1.13)	0.74 (0.53–1.05)
Model 3	1 (reference)	1.11 (0.94–1.30)	1.00 (0.85–1.17)	0.90 (0.75–1.08)	0.69 (0.49–0.96)[c]
Fasting glucose					
Model 1	1 (reference)	0.95 (0.80–1.13)	0.83 (0.70–0.98)[c]	0.78 (0.64–0.94)[c]	0.81 (0.57–1.16)
Model 2	1 (reference)	0.95 (0.80–1.13)	0.83 (0.70–0.98)[c]	0.78 (0.64–0.94)[c]	0.83 (0.58–1.19)
Model 3	1 (reference)	0.97 (0.81–1.15)	0.86 (0.73–1.01)	0.85 (0.70–1.03)	0.94 (0.65–1.37)
BMI					
Model 1	1 (reference)	0.73 (0.60–0.88)[c]	0.58 (0.49–0.70)[c]	0.39 (0.32–0.48)[c]	0.38 (0.26–0.55)[c]
Model 2	1 (reference)	0.73 (0.60–0.88)[c]	0.60 (0.49–0.72)[c]	0.40 (0.32–0.49)[c]	0.41 (0.28–0.59)[c]
Model 3	1 (reference)	0.75 (0.62–0.90)[c]	0.63 (0.52–0.76)[c]	0.44 (0.36–0.55)[c]	0.46 (0.31–0.66)[c]
Smoking					
Model 1	1 (reference)	1.13 (0.93–1.37)	1.04 (0.86–1.25)	0.84 (0.68–1.04)	0.61 (0.41–0.91)[c]
Model 2	1 (reference)	1.12 (0.92–1.36)	1.09 (0.90–1.32)	0.91 (0.73–1.14)	0.83 (0.55–1.25)
Model 3	1 (reference)	1.11(0,91–1.35)	1.07 (0.89–1.30)	0.88 (0.70–1.09)	0.79 (0.53–1.03)
Physical activity					
Model 1	1 (reference)	0.75 (0.56–1.00)[c]	0.48 (0.36–0.64)[c]	0.43 (0.29–0.63)[c]	0.45 (0.19–1.06)
Model 2	1 (reference)	0.75 (0.56–1.00)[c]	0.46 (0.34–0.62)[c]	0.41 (0.28–0.60)[c]	0.40 (0.17–0.96)[c]
Model 3	1 (reference)	0.74 (0.55–0.99)[c]	0.45 (0.34–0.61)[c]	0.38 (0.26–0.57)[c]	0.37 (0.16–0.89)[c]
Healthy diet					
Model 1	1 (reference)	0.90 (0.56–1.45)	0.60 (0.37–0.97)[c]	0.84 (0.49–1.47)	0.88 (0.30–2.62)
Model 2	1 (reference)	0.90 (0.56–1.46)	0.62 (0.38–1.00)[c]	0.88 (0.50–1.52)	0.97 (0.33–2.89)
Model 3	1 (reference)	0.91 (0.56–1.47)	0.63 (0.39–1.01)	0.88 (0.50–1.53)	0.95 (0.32–2.83)

Data are presented as odds ratios (95% CIs).

a Number of ideal CVH metrics: 5–7 vs 0–4 (reference)

b Adjusted covariates: Model 1 = age and gender; Model 2 = Model 1 + education, income, and marital status; Model 3 = Model 2 + history of hypertension, diabetes, thyroid disease, or gout

c *P* value <0.05

Abbreviations: see **FIGURE 1**

11% of the study population, those with higher SRH levels were not significantly more likely to have higher ORs for better CVH than those with lower SRH levels in the unadjusted model. Therefore, our investigation provides further information on the relationship between SRH and CVH in the Asian population.

The ability of SRH to predict ideal CVH needs to be elucidated. Optimism might be the mechanism that links SRH and ideal CVH. Higher optimism, evaluated with the Life Orientation Test-Revised, was reported to be associated with favorable SRH.[32] The Multi-Ethnic Study of Atherosclerosis revealed that participants in the most optimistic group presented a higher OR for intermediate and ideal CVH than those in the lower quartile of optimism.[33] In addition, the underlying biological mechanisms could support our epidemiological findings. Self-rated health has been reported to be associated with the autonomic nervous system, evaluated as heart rate variability,[34] which is interconnected with CVH and metabolic disorders.[35,36] Another association could be attributed to inflammatory markers. A recent study

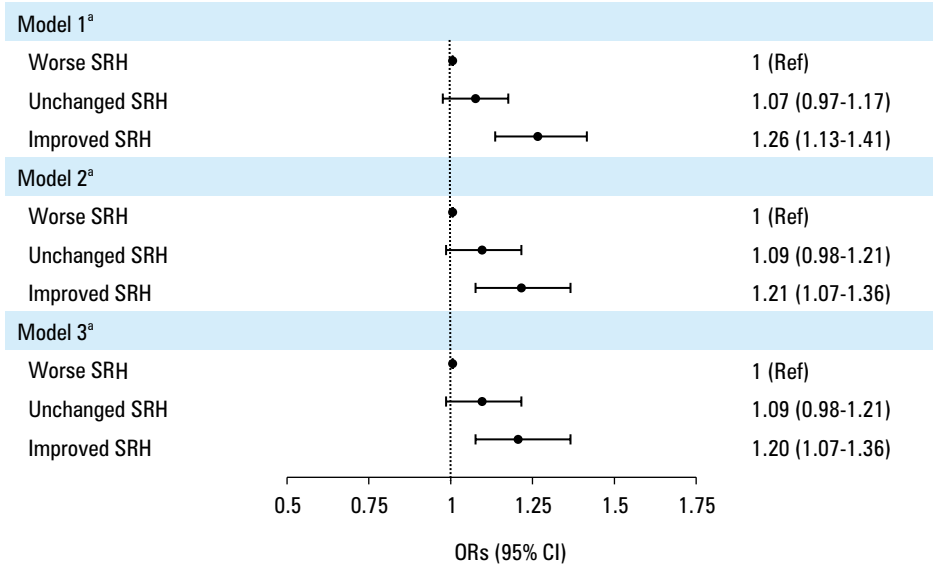

FIGURE 2 Odds ratios (ORs) and 95% CIs for increased (vs decreased or unchanged) number of ideal cardiovascular health metrics during follow-up

a Adjusted covariates: Model 1 = age and gender; Model 2 = Model 1 + education, income, and marital status; Model 3 = Model 2 + history of hypertension, diabetes, thyroid disease, or gout

Abbreviations: see **FIGURE 1**

indicated that less favorable SRH was correlated with higher levels of high-sensitivity C-reactive protein (hs-CRP) and leptin.[26,37] Likewise, serum hs-CRP and leptin levels were reported to be inversely associated with ideal CVH.[38,39] Thus, poor SRH might be due to higher concentrations of hs-CRP and leptin, which are also related to poor CVH.

Our longitudinal study showed a significant association between SRH and CVH metrics; however, several limitations have to be considered. Firstly, the participants in our study were not recruited by random selection, and only approximately 21.1% of them were eligible for final analysis, given that approximately 74.9% were not asked the question about self-rated health. However, we compared the baseline characteristics of the 15 608 eligible and 58 483 ineligible participants and found no significant difference between them in terms of age, sex, and BMI. Secondly, the use of self-reporting questionnaires in the study may have resulted in social desirability bias and recall bias, particularly in the responses related to diet, physical activity, and cigarette consumption. Thirdly, none of the participants in the study had a history of CVD. Therefore, our findings might reflect a contribution of SRH to early detection and primary prevention of CVD, but not to secondary CVD prevention.

This study highlights the fact that SRH shows an association with ideal CVH metrics. Most importantly, it supports the finding that improvement in SRH was significantly associated with an increase in the number of ideal CVH metrics via a longitudinal design. A change in SRH might be an accurate reflection of changes in the ideal CVH metrics.

SUPPLEMENTARY MATERIAL

Supplementary material is available at www.mp.pl/paim.

ARTICLE INFORMATION

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CONTRIBUTION STATEMENT T-HT, L-XY, W-LC, T-WK, and T-CP were responsible for the design of the study. T-HT, L-XY, H-FY, W-LC, and T-CP collected the data. T-HT, L-WW, Y-WC, H-FY, and T-CP analyzed the data. T-HT, L-XY, W-LC, L-WW, and T-CP prepared the manuscript. All authors read and approved the final version of the manuscript.

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