# Ideal Cardiovascular Health Metrics in Couples: A Community-Based Study

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***Background***—Determination of the correlation of ideal cardiovascular health variables among spousal or cohabitating partners may guide the development of couple-based interventions to reduce cardiovascular disease risk.

***Method and Results***—We used data from the HeartSCORE (Heart Strategies Concentrating on Risk Evaluation) study. Ideal cardiovascular health, defined by the American Heart Association, comprises nonsmoking, body mass index <25 kg/m$^2$, physical activity at goal, diet consistent with guidelines, untreated total cholesterol <200 mg/dL, untreated blood pressure <120/80 mm Hg, and untreated fasting glucose <100 mg/dL. McNemar test and logistic regression were used to assess concordance patterns in these variables among partners (ie, concordance in achieving ideal factor status, concordance in not achieving ideal factor status, or discordance—only one partner achieving ideal factor status). Overall, there was a low prevalence of ideal cardiovascular health among the 231 couples studied (median age 61 years, 78% white). The highest concordances in achieving ideal factor status were for nonsmoking (26.1%), ideal fruit and vegetable consumption (23.9%), and ideal fasting blood glucose (35.6%). The strongest odds of intracouple concordance were for smoking (odds ratio, 3.6; 95% confidence interval, 1.9–6.5), fruit and vegetable consumption (odds ratio, 4.8; 95% confidence interval, 2.5–9.3) and blood pressure (odds ratio, 3.0; 95% confidence interval, 1.2–7.9). A participant had 3-fold higher odds of attaining ≥3 ideal cardiovascular health variables if he or she had a partner who attained ≥3 components (odds ratio 3.0; 95% confidence interval, 1.6–5.6).

***Conclusions***—Intracouple concordance of ideal cardiovascular health variables supports the development and testing of couple-based interventions to promote cardiovascular health. Fruit and vegetable consumption and smoking may be particularly good intervention targets. **(*J Am Heart Assoc*. 2018;7:e008768. DOI: 10.1161/JAHA.118.008768.)**

**Key Words:** couples • epidemiology • ideal cardiovascular health • primary prevention • risk factor

Cardiovascular disease (CVD) remains the leading cause of morbidity and mortality in the United States.[1,2] Epidemiologic studies have demonstrated that CVD risk factors (eg, smoking, high blood pressure, high blood glucose levels, increased body mass index [BMI]) are highly prevalent in the United States.[1,2] To reduce CVD morbidity and mortality, the American Heart Association (AHA) defined 7 components of ideal cardiovascular health (CVH). These include not smoking, BMI <25 kg/m$^2$, physical activity at goal, diet consistent with guidelines, untreated total cholesterol <200 mg/dL, untreated blood pressure <120/80 mm Hg, and untreated fasting glucose <100 mg/dL.[3] Better understanding of the determinants of these ideal CVH metrics can inform new approaches to CVD prevention.

Studies of spousal/cohabitating couples can provide insight into environmental determinants of ideal CVH because couples are expected to share environmental exposure.[4] For instance, factors such as smoking and blood pressure have been reported to have strong spousal correlation,[4–6] that may be explained by factors that are shared between couples such as salt intake and habit formation. Although several studies have investigated spousal concordance in CVD risk factors and health behavior–related factors,[4–6] data on the AHA's ideal CVH as a construct among spousal/cohabitating couples are limited.

We previously reported the low prevalence of ideal CVH in a community-based cohort study in Pittsburgh.[7,8] In the present study, we used the same cohort to investigate the

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## Clinical Perspective

### What Is New?

- We found significant intracouple concordance in ideal cardiovascular health variables, in particular for fruit and vegetable consumption, smoking, and blood pressure.

### What Are the Clinical Implications?

- The study supports development and testing of couple-based cardiovascular risk factor interventions to promote cardiovascular health.

correlation of the ideal CVH among heterosexual spousal/cohabitating partners to help identify the components of ideal CVH that may be responsive to couple-based interventions.

## Methods

The data, analytic methods, and study materials will be made available to other researchers, upon request, for purposes of reproducing the results or replicating the findings.

## Study Design

HeartSCORE (Heart Strategies Concentrating on Risk Evaluation) is an ongoing community-based, prospective cohort study of racial disparities in CVD based in western Pennsylvania and composed of black and white participants. The methods of HeartSCORE have been described previously.[7,8] Eligibility criteria included age 45 to 75 years at study entry, residence in the greater Pittsburgh metropolitan area, ability to undergo baseline and annual follow-up visits, and absence of known comorbidities expected to limit life expectancy to <5 years. The present analyses of baseline visit data were confined to the 231 heterosexual spousal/cohabitating couples (462 participants) who were enrolled in the study. The couples were initially identified by matching the residential address of the participants, and then by asking those participants if they were spousal or cohabitating partners with the individuals matching their address. The Institutional Review Board at the University of Pittsburgh approved the study. All subjects provided written informed consent.

## Data Collection

Demographic and medical histories were collected at the baseline visit (2001–2004). Race was self-reported. Participants completed detailed demographic and lifestyle questionnaires including information on marital/cohabitating status, education, income, smoking, physical activity, and dietary habits. Highest education level was categorized as less than high school diploma, high school diploma or some college less than bachelor's degree, and bachelor's degree or higher. Annual income was collected in categories <$10 000, $20 000 to 40 000, $40 000 to 80 000, and >$80 000. Physical measurements included measurement of vital signs and body fat distribution.

## Measurement of CVH Variables

The 7 components of ideal CVH evaluated are smoking status, blood pressure, BMI, total cholesterol, fasting blood glucose, physical activity, and diet. Participants underwent a standard exam using a manual sphygmomanometer and an appropriately sized cuff to measure blood pressure twice after 5 minutes of rest in a seated position. The average of the 2 readings was used. Total cholesterol was measured in fasting venous blood drawn using standard laboratory techniques at the University of Pittsburgh Medical Center clinical laboratory.

Physical activity was evaluated using the Lipid Research Clinic Questionnaire,[9] which includes questions about type and frequency of physical activity at work and during leisure time and permits classification of individuals as very active, moderately active, and inactive. The AHA uses exercise time in minutes per week for classifying physical activity into ideal (≥150 min/wk moderate activity or ≥75 min/wk vigorous activity), intermediate (1–149 min/wk moderate activity or 1–74 min/wk vigorous activity), or poor (no vigorous or moderate activity). Although the questionnaire could not be used to derive the amount of exercise in minutes per week, it provided approximations of ideal, intermediate, and poor physical activity.[9]

The PrimeScreen questionnaire[10] was used to evaluate average daily consumption of fruits and vegetables. This self-administered questionnaire evaluates diet quality using average frequency of consumption of specific foods and food groups during the previous year. A cutoff value of 3 servings per day of fruits and vegetables on the PrimeScreen questionnaire has been shown to correlate closely with 5 servings per day when derived from more extensive food frequency questionnaires.[10] Accordingly, we used the PrimeScreen questionnaire to classify individuals as having an ideal (≥3 servings/day) or intermediate-poor (<3 servings/day) consumption of fruits and vegetables. The AHA also recommended quantification of consumption of fish, fiber-rich whole grains, sodium, and sugar-sweetened beverages, but these data could not be derived from the PrimeScreen questionnaire.

## Ideal Cardiovascular Health

In accordance with AHA definitions, ideal CVH was defined as the simultaneous presence of 4 ideal health behaviors (never smoker, body mass index <25 kg/m$^2$, physical activity at goal level, diet consistent with current recommendations) and 3 ideal health factors (untreated total cholesterol <200 mg/dL, untreated blood pressure <120/80 mm Hg, and untreated fasting glucose <100 mg/dL) in the absence of diabetes mellitus or clinical CVD.[11]

## Statistical Analyses

Baseline characteristics of participants are presented by sex. Continuous variables are presented as means and standard deviations and were compared using paired t tests (because the male/female units are by nature "paired" data rather than independent samples). Categorical variables are presented as frequencies and percentages, and compared using the McNemar test, which takes into account "paired" data. To assess the degree of concordance in ideal CVH variables among couples, we cross-tabulated the number (and percentage) of concordant and discordant couples in 4 categories (ie, man/woman both ideal, man/woman both not ideal, man ideal and woman not ideal, man not ideal and woman ideal) for each ideal CVH variable. The strength of concordance was assessed using the phi coefficient (analogous to correlation coefficient for 2 binary variables) and odds ratios (ORs). ORs (95% confidence intervals [CIs]) were calculated using logistic regression; the OR indicates the probability that one partner meets the goal for an ideal CVH metric given that the other partner meets the goal for that CVH metric, or vice versa. We further assessed the presence of directionality in discordance among couples (ie, whether men or women are more likely to achieve "ideal" status for a given variable) using the McNemar test; a significant result for this indicates that the discordance has a strong directionality (ie, men or women are more likely to be "ideal" than the other sex within couples). We assessed for the presence of effect modification by race on the concordance rate of ideal CVH variables among partners, by fitting a statistical interaction term between race and the corresponding variable. Multivariable logistic regression was used to compute the OR of meeting 3+ or 4+ ideal CVH variables by 1 member of a couple if his or her partner also meets that number of ideal CVH variables. Adjustments were made for sociodemographic variables that may potentially confound the intra-couple correlation, namely, age (continuous), race (white versus black), and education status and income (categories are shown above). All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC). $P$ value <0.05 was considered statistically significant.

# Results

## Study Participants

Analyses were confined to 231 heterosexual spousal/cohabitating couples (462 participants) who were enrolled in the study at baseline. Table 1 presents baseline characteristics by sex. The mean (standard deviation) age of the participants at study entry was 61 (±7) years, with males 2 years older than females on average. Seventy-eight percent were white, with equal representation among men and women. A majority of individuals (52%) had at least a bachelor's degree, and nearly all the participants (97%) had at least a high school diploma. More than half reported an annual income of ≥$40 000, and 1 in 5 reported an annual income ≥$80 000. Income levels and physical activity were significantly higher among men. Women had significantly lower BMI and fasting blood glucose levels, as well as higher high-density lipoprotein cholesterol levels.

## Distribution of Ideal CVH Variables

The Figure shows the proportion of couples who are concordant for each ideal CVH variable (grouped as either both ideal, both nonideal, or discordant for the respective variable). The majority of the couples were concordant with respect to individual ideal CVH variables, with total concordance (ie, both partners having ideal or nonideal status) rates ranging from 53% (for fasting blood glucose) to 92% (for physical activity). Proportions of the couples by further categories of concordance (ie, both couples ideal versus both couples nonideal) or discordance (ie, male partner ideal and female partner nonideal versus female partner ideal and male partner nonideal) are presented in Table 2. Factors for which both partners had the highest concordance in achieving ideal status were nonsmoking (26.1%), ideal fruit and vegetable consumption (23.9%), and ideal fasting blood glucose (35.6%).

## Univariate and Multivariate Analyses

The strongest odds of intracouple concordance were for smoking (OR, 3.6; 95% CI, 1.9–6.5), fruit and vegetable consumption (OR, 4.8, 2.5–9.3) and blood pressure (OR, 3.0; CI, 1.2–7.9) (Table 2). The phi coefficient showed a similar pattern of between-couple correlation for the various factors. The $P$ value for the McNemar test was significant for smoking, BMI, blood pressure, fasting blood glucose, and fruit and vegetable consumption, indicating that, for discordant couples, women were significantly more likely to meet ideal CVH metrics than were men for these variables (Table 2). We did not find evidence of statistically significant interaction between race and concordance rates among couples for any of the ideal CVH variables ($P$>0.05 for all).

None of the couples had both partners who met ≥5 components of the ideal CVD health metrics. Only 9 (3.9%) couples had both members meeting ≥4 components of the ideal CVD health metrics, while 35 (15.2%) had both meeting ≥3 components (Tables 3 and 4). An individual had 3-fold higher odds of attaining ≥3 ideal CVD health factors if he or

**Table 1.** Baseline Characteristics* of Participants (HeartSCORE Study Couples), Overall and by Sex

| | Overall | Male | Female | *P* Value |
|---|---|---|---|---|
| Number of participants | 462 | 231 | 231 | |
| Age, y | 61±7 | 62±7 | 60±7 | 0.001 |
| Race | | | | <0.001 |
| White | 359 (78%) | 179 (78%) | 180 (78%) | |
| Black | 103 (22%) | 52 (23%) | 51 (22%) | |
| Education | | | | 0.012 |
| Less than high school diploma | 12 (3%) | 9 (4%) | 3 (1%) | |
| High school diploma or some college | 210 (46%) | 83 (40%) | 127 (55%) | |
| Bachelor's degree or more | 239 (52%) | 139 (60%) | 100 (44%) | |
| Annual income | | | | <0.001 |
| <\$10 000 | 18 (4%) | 3 (1%) | 15 (7%) | |
| \$10 000 to <\$20 000 | 28 (6%) | 4 (2%) | 24 (10%) | |
| \$20 000 to <\$40 000 | 101 (22%) | 56 (24%) | 45 (20%) | |
| \$40 000 to <\$80 000 | 131 (28%) | 70 (30%) | 61 (26%) | |
| \$80 000+ | 131 (28%) | 74 (32%) | 57 (25%) | |
| Not stated | 53 (12%) | 24 (10%) | 29 (13%) | |
| Current smoker | 33 (7%) | 20 (9%) | 13 (6%) | <0.001 |
| Triglycerides, mg/dL | 129±77 | 132±80 | 126±74 | 0.410 |
| Waist-hip ratio | 0.90±0.09 | 0.95±0.06 | 0.84±0.08 | <0.001 |
| BMI, kg/m$^2$ | 29±5 | 30±5 | 28±6 | <0.001 |
| SBP, mm Hg | 136±17 | 137±16 | 134±19 | 0.105 |
| DBP, mm Hg | 79±10 | 81±10 | 78±10 | 0.006 |
| Diabetes mellitus | 35 (8%) | 23 (10%) | 12 (5%) | <0.001 |
| Fasting blood glucose, mg/dL | 97±19 | 101±21 | 93±16 | <0.001 |
| Total cholesterol, mg/dL | 203±40 | 195±38 | 212±42 | <0.001 |
| HDL cholesterol, mg/dL | 53±16 | 46±13 | 59±17 | <0.001 |
| LDL cholesterol, mg/dL | 142±34 | 138±32 | 146±35 | 0.021 |
| Average servings per day (vegetable) | 1.7±1.0 | 1.6±0.9 | 1.8±1.1 | 0.015 |
| Average servings per day (fruit) | 1.2±0.8 | 1.1±0.8 | 1.2±0.8 | 0.156 |
| Physical activity | | | | <0.001 |
| Inactive | 306 (66%) | 141 (61%) | 165 (71%) | |
| Moderately active | 36 (8%) | 16 (7%) | 20 (9%) | |
| Very active | 115 (25%) | 72 (31%) | 43 (19%) | |

BMI indicates body mass index; DBP, diastolic blood pressure; HDL, high-density lipoprotein; HeartSCORE, Heart Strategies Concentrating on Risk Evaluation; LDL, low-density lipoprotein; SBP, systolic blood pressure.
*Continuous variables reported as median (range); tested using the paired t test. Categorical variables reported as n (%); tested using the McNemar test.

she had a partner who attained ≥3 components (OR, 3.0; 95% CI, 1.6–5.6). This association was minimally attenuated with adjustment for age, race, education, and income (OR, 2.64; 95% CI, 1.39–5.02). The corresponding OR for meeting ≥4 ideal health factors was 5.1 (95% CI, 1.9–13.7). The association persisted with adjustment for race, education, and income (OR, 5.21; 95% CI, 1.80–15.1) (Table 5).

## Discussion

The 2010 AHA Impact Goal for the current decade (2010–2020) focuses on a construct of ideal CVH that is directed at primordial prevention of CVD.[3] Consistent with other studies in the United States,[12–15] we have previously demonstrated the low prevalence of ideal CVH in a community-based cohort

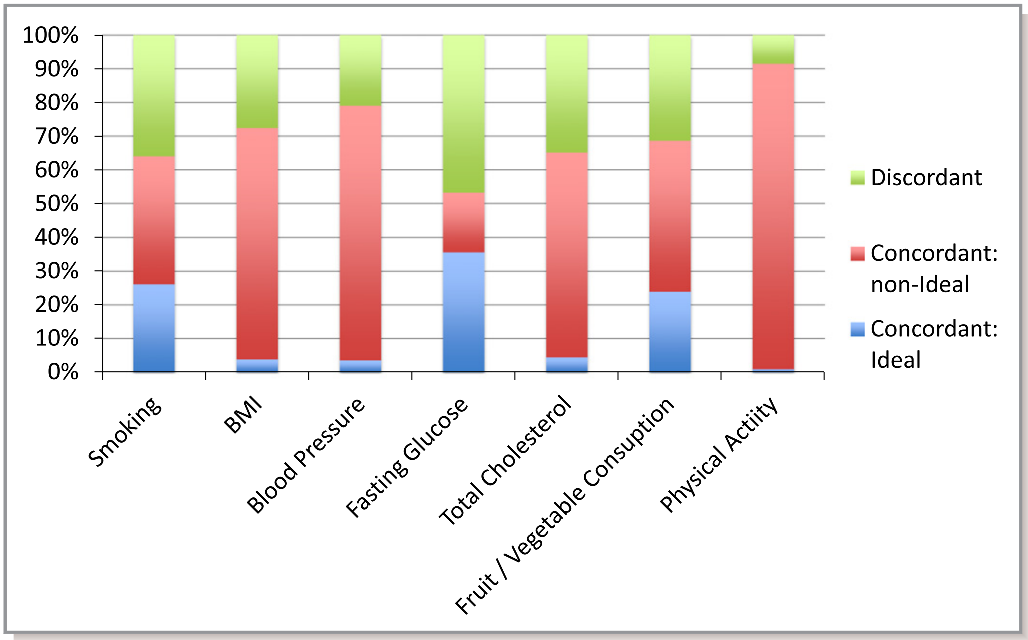


**Figure.** Percentage of male/female concordance (ie, either both partners ideal or both nonideal) or discordance by components of the ideal cardiovascular health metrics.

in western Pennsylvania.[8] To help further understand the determinants of ideal CVH, we investigated how the AHA's ideal CVH variables correlate among partners in heterosexual couples in the same cohort. We found a high concordance of ideal CV metrics among couples that was largely driven by "negative" concordance (ie, both partners not achieving target for a given ideal CVH variable). Factors that were most likely to be concordant among couples were nonsmoking, ideal fruit and vegetable consumption, and ideal blood pressure (OR >3 for all comparisons). Similarly, there were strong odds of an individual attaining ≥3 or ≥4 ideal CVH factors if he or she had a partner who attained ≥3 or ≥4 components, respectively. These associations persisted after adjusting for race, income, and education.

Our findings are consistent with a recent study by O'Flynn et al[16] performed with 181 couples from a single primary care center in Ireland that showed a significant within-couple concordance in ideal CVH variables. Our and O'Flynn's findings are particularly important because ideal CVH metrics have been shown to predict future risk of CVD events. They also serve as targets for interventions that are known to improve clinical outcome.[11,17] Our data suggest that interventions using a couples-based approach targeting smoking and healthy diet, which we found to have strong statistically significant odds of concordance, may be effective methods for reducing CVD risk. For instance, smoking cessation counseling may be more effective when provided to smoking partners as a couple rather than individually, as prior studies of dyadic efficacy have suggested.[18]

Although there are limited data on the associations of ideal CVH metrics as a construct between spousal/cohabitating partners, numerous prior studies have shown within-couple

**Table 2.** Correlation Patterns in Ideal Cardiovascular Health Metrics

| | Man/Woman Both Ideal | Man/Woman Both Not Ideal | Man Ideal/ Woman Not Ideal | Man Not Ideal/ Woman Ideal | Phi Coefficient | Odds Ratio (95% CI) | McNemar *P* Value |
|---|---|---|---|---|---|---|---|
| Smoking | 53 (26.1%) | 77 (37.9%) | 23 (11.3%) | 50 (24.6%) | 0.29 | 3.6 (1.9, 6.5) | 0.002 |
| BMI | 8 (3.8%) | 144 (68.6%) | 9 (4.3%) | 49 (23.3%) | 0.13 | 2.6 (1.0, 7.1) | <0.001 |
| Blood pressure | 8 (3.5%) | 173 (75.6%) | 13 (5.7%) | 35 (15.3%) | 0.16 | 3.0 (1.2, 7.9) | 0.002 |
| Fasting glucose | 79 (35.6%) | 39 (17.6%) | 26 (11.7%) | 78 (35.1%) | 0.09 | 1.5 (0.8, 2.7) | <0.001 |
| Total cholesterol | 10 (4.4%) | 139 (60.7%) | 47 (20.5%) | 33 (14.4%) | −0.02 | 0.9 (0.4, 2.0) | 0.12 |
| Fruit/vegetable consumption | 45 (23.9%) | 84 (44.7%) | 20 (10.6%) | 39 (20.7%) | 0.36 | 4.8 (2.5, 9.3) | 0.01 |
| Physical activity | 2 (0.9%) | 203 (90.6%) | 13 (5.8%) | 6 (2.7%) | 0.14 | 5.2 (1.0, 28.4) | 0.11 |

BMI indicates body mass index; CI, confidence interval.

**Table 3.** Proportion of Participants Meeting 3+ Components of Ideal Cardiovascular Health Metrics, by Sex

| | | Male | |
|---|---|---|---|
| | | No | Yes |
| Female | No | 114 (49.4%) | 22 (9.5%) |
| | Yes | 60 (25.9%) | 35 (15.2%) |

Missing: 10. McNemar *P* value: <0.001.

correlation for several cardiovascular risk factors, including hypertension, smoking, diabetes mellitus, and obesity.[4,5,19] Shared environment and behavioral influence are believed to play a role in these observed between-couple correlations.[5,19,20] Studies have shown the influence of partners on a couple's health behavior, such as exercise and smoking.[20–22] Furthermore, several studies have demonstrated that rates of incident clinical CVD outcome and mortality are lower among married couples than single individuals,[23,24] highlighting the importance of partners to improve health outcomes. The findings in our study of strong between-couple association in terms of nonsmoking, healthy diet, and ideal blood pressure indicate how behavioral (eg, smoking and dietary habit) and environmental (eg, presence of healthy food market and parks in the neighborhood) factors may influence cardiovascular risk. Connolly et al[25] previously demonstrated that a family-based preventive cardiology program intervention was successful in promoting healthy diet and physical activity and in achieving target BMI, blood pressure, and cholesterol levels.

The strengths and limitations of the present study merit consideration. We were able to explore the association of ideal CVH metrics as a construct among couples in the United States. The findings are relevant in helping identify approaches to primordial preventative interventions that can help achieve the AHA's Impact Goal for 2010–2020. Second, the study is community based, comprising both white and black participants, increasing its generalizability to other populations. Of note, the representation of white participants is higher in the couple subset (78%) compared with the main cohort (56%), which is due to higher prevalence of single living

**Table 4.** Proportion of Participants Meeting 4+ Components of Ideal Cardiovascular Health Metrics, by Sex

| | | Male | |
|---|---|---|---|
| | | No | Yes |
| Female | No | 178 (77.1%) | 9 (3.9%) |
| | Yes | 35 (15.2%) | 9 (3.9%) |

Missing: 10. McNemar *P* value: <0.001.

**Table 5.** Odds Ratios of a Participant Achieving 3+ or 4+ Components of Ideal Cardiovascular Health if His or Her Partner Does

| | Unadjusted | | | Adjusted* | | |
|---|---|---|---|---|---|---|
| | OR | 95% CI | *P* Value | OR | 95% CI | *P* Value |
| 3+ AHA Ideal Health Metrics | 3.02 | 1.63, 5.61 | 0.0005 | 2.63 | 1.38, 5.01 | 0.003 |
| 4+ AHA Ideal Health Metrics | 5.09 | 1.89, 13.7 | 0.001 | 5.68 | 1.90, 16.9 | 0.002 |

AHA indicates American Heart Association; CI, confidence interval; OR, odds ratio.
*Adjusted for age, race, income, and education.

status among blacks compared with whites in the study cohort. Nonetheless, we did not find evidence of significant confounding or effect modification by race in the association between couple status and concordance in ideal CVH variables. Third, composed of 231 couples (462 participants), the study had sufficient power to explore the prevalence and correlations of ideal CVH metrics among couples.

Regarding limitations, the present analysis is based on single/baseline measurements of CVH metrics and does not report on cardiovascular outcomes. Future studies looking at repeat measurements and trends as well as cardiovascular events can yield further insight into the role of a couple-based approach to primary prevention. Second, the use of the PrimeScreen and the Lipid Research Clinic questionnaires may have led to some misclassification, as these questionnaires were not designed to evaluate the total amount of nutrients and physical activity, respectively. However, any such misclassification is not likely to be differential and should not affect how these factors are correlated within couples, regardless of the absolute prevalence. Furthermore, the use of fruit and vegetable consumption as a proxy of a heart-healthy diet is supported by several epidemiologic studies that indicates that higher consumption of fruits and vegetables correlates with improved CVH.[26] Third, although we made attempts to control for potential confounders, including age, race, education, and income, residual confounding may still be present, limiting causal inference about within-couple concordance in ideal CVH metrics. In addition, we did not have information on the duration of partnership for the couples, which would be important in understanding the influence of partners on CVH.

In conclusion, our data support the development and testing of couple-based interventions that promote ideal CVH. Fruit and vegetable consumption and smoking may be particularly good targets for such interventions.

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## Disclosures

None.

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