ORIGINAL CONTRIBUTION

# Prevalence of a Healthy Lifestyle Among Individuals With Cardiovascular Disease in High-, Middle- and Low-Income Countries

## The Prospective Urban Rural Epidemiology (PURE) Study

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**Importance** Little is known about adoption of healthy lifestyle behaviors among individuals with a coronary heart disease (CHD) or stroke event in communities across a range of countries worldwide.

**Objective** To examine the prevalence of avoidance or cessation of smoking, eating a healthy diet, and undertaking regular physical activities by individuals with a CHD or stroke event.

**Design, Setting, and Participants** Prospective Urban Rural Epidemiology (PURE) was a large, prospective cohort study that used an epidemiological survey of 153 996 adults, aged 35 to 70 years, from 628 urban and rural communities in 3 high-income countries (HIC), 7 upper-middle-income countries (UMIC), 3 lower-middle-income countries (LMIC), and 4 low-income countries (LIC), who were enrolled between January 2003 and December 2009.

**Main Outcome Measures** Smoking status (current, former, never), level of exercise (low, <600 metabolic equivalent task [MET]-min/wk; moderate, 600-3000 MET-min/wk; high, >3000 MET-min/wk), and diet (classified by the Food Frequency Questionnaire and defined using the Alternative Healthy Eating Index).

**Results** Among 7519 individuals with self-reported CHD (past event: median, 5.0 [interquartile range {IQR}, 2.0-10.0] years ago) or stroke (past event: median, 4.0 [IQR, 2.0-8.0] years ago), 18.5% (95% CI, 17.6%-19.4%) continued to smoke; only 35.1% (95% CI, 29.6%-41.0%) undertook high levels of work- or leisure-related physical activity, and 39.0% (95% CI, 30.0%-48.7%) had healthy diets; 14.3% (95% CI, 11.7%-17.3%) did not undertake any of the 3 healthy lifestyle behaviors and 4.3% (95% CI, 3.1%-5.8%) had all 3. Overall, 52.5% (95% CI, 50.7%-54.3%) quit smoking (by income country classification: 74.9% [95% CI, 71.1%-78.6%] in HIC; 56.5% [95% CI, 53.4%-58.6%] in UMIC; 42.6% [95% CI, 39.6%-45.6%] in LMIC; and 38.1% [95% CI, 33.1%-43.2%] in LIC). Levels of physical activity increased with increasing country income but this trend was not statistically significant. The lowest prevalence of eating healthy diets was in LIC (25.8%; 95% CI, 13.0%-44.8%) compared with LMIC (43.2%; 95% CI, 30.0%-57.4%), UMIC (45.1%, 95% CI, 30.9%-60.1%), and HIC (43.4%, 95% CI, 21.0%-68.7%).

**Conclusion and Relevance** Among a sample of patients with a CHD or stroke event from countries with varying income levels, the prevalence of healthy lifestyle behaviors was low, with even lower levels in poorer countries.

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OBSERVATIONAL DATA INDICATE that following an acute coronary syndrome, those who adhere to a healthier lifestyle have a lower risk of recurrent events.[1-3] Smoking cessation is associated with a lower risk of death and myocardial infarction, high-quality diets[1,4] and regular exercise are associated with lower risk of death or recurrent cardiovascular disease events after a myocardial infarction.[1-3] Thus, avoidance of smoking or its cessation, improving diet quality, and increasing physical activity level are recommended for secondary prevention of cardiovascular disease.

**Author Video Interview available at www.jama.com.**

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Previous studies examining the lifestyle practices of individuals after vascular events have included individuals within 2 years after the event; these studies reported that only small proportions of individuals followed recommended lifestyle practices.[3-6] The proportion of the estimated 100 million individuals worldwide who have vascular disease[5] in the community, especially from lower-income countries, living in rural areas, and who adopt healthy lifestyle behaviors is not known. In this study, we examined the prevalence of the 3 healthy lifestyle behaviors at enrollment (avoidance or cessation of smoking, eating a healthy diet, and undertaking regular physical activities) in participants who report having had a coronary heart disease (CHD) or stroke event in the Prospective Urban Rural Epidemiology (PURE) study, a large prospective cohort of individuals enrolled from urban and rural communities in high-, middle-, and low-income countries.[7,8]

## METHODS

The methods and population characteristics of the PURE study have been described previously.[7,8] Briefly, 153 996 adults (151 966 aged 35-70 years, 1444 aged <35 years, and 586 aged >70 years) were recruited from 628 (348 urban and 280 rural) communities in 17 low-, middle-, and high-income countries of the world,[9,10] representing various levels of development and encompassing a large sociocultural diversity. Common and standardized approaches were used for the enumeration of households, identification of individuals, recruitment procedures, and data collection.

The method of approaching households differed between countries, but was designed to avoid biases based on levels of risk factors or prevalence of any disease. Households were eligible if at least 1 member of the household was between the ages of 35 and 70 years and the household members intended to continue living at their current address for another 4 years. All eligible individuals who provided written informed consent were enrolled.

### Training, Standardization, and Data Collection

To ensure standardization and high data quality, we used a comprehensive operations manual, reinforced by periodic training workshops, training DVDs, and regular communications. All data were entered into a customized database programmed with range and consistency checks and transmitted electronically to the project office at the Population Health Research Institute (Hamilton, Ontario, Canada) where further quality-control measures were implemented. Data collection occurred at 4 levels: national, community, household, and individual using standardized and common questionnaires.[9,10] We collected information about smoking, physical activity level, diet, and other risk factors using questionnaires from the INTERHEART[1] and INTERSTROKE[2] studies as well as other studies.[11-17]

### Definitions of Tobacco Smoking

Current smokers were individuals who smoked at least 1 tobacco product daily[18] in the previous 12 months, including those who had quit within the past year. Former smokers had quit more than 1 year earlier, either before or after the clinical event. Never smokers had never used tobacco products regularly. Ever smokers included current and former smokers. Smoking cessation rates were the proportion of ever smokers who had stopped smoking. Former smokers who had quit during the same year that their CHD or stroke events had occurred were deemed to have quit after the event.

### Physical Activity

Information on physical activity at work, at home, and during recreational or sport and leisure-time activities was obtained using the International Physical Activity Questionnaire or regional questionnaires with comparable variables.[11] Questions were asked about the specific activities during the previous week that the individual performed for at least 10 minutes, the total duration per day, the number of days, and whether the activity was heavy, moderate, or low.

For each individual, the recorded activities were converted to metabolic equivalent task (MET)-minutes per week.[11] Individuals participating in activities of less than 600 MET-min/wk were classified as low, 600 to 3000 MET-min/wk as moderate, and greater than 3000 MET-min/wk as having performed a high level of physical activity.

### Diet

Existing validated or newly developed and validated Food Frequency Questionnaires were used.[12-17] To enable comparability of all data and calculation of nutrients, a master international nutrient database was created, primarily based on the US Department of Agriculture's food composition database and modified appropriately with reference to local food composition tables and supplemented with the nutrient database that contained recipes of locally eaten mixed dishes. Food patterns were generated using data from the Food Frequency Questionnaires and following established methods.[12-17]

The overall diet quality in this study has been defined based on an adaptation of the Alternative Healthy Eating Index (AHEI), which was highly predictive of cardiovascular disease risk, as described by McCullough et al[19] and McCullough and Willett.[20] We measured 6 of the 9 food items included in the AHEI. Of these, 5 variables were identical (vegetables, fruits, nuts and soy protein, whole grain cereal fiber, ratio of white to red meat, ratio of polyunsaturated to saturated fatty acid) and 1 item was comparable (deep fried foods in place of *trans*fats).[21] We did not include alcohol and multivitamin intake in our scoring system. In 5 Muslim countries (Bangladesh, Iran, Pakistan, Malaysia, and United Arab Emirates), the frequency of alcohol intake was not included in the Food Frequency Questionnaires.

Alcohol was not included in the analysis to allow inclusion of all indi-

viduals in the study. Intake of multivitamins was very low among low-income and middle-income countries and was not included in the scoring system; recent randomized studies have not indicated any protective effect of multivitamins on cardiovascular disease. Our method of scoring food quality and cutoffs for scoring in the modified AHEI has been described previously.[21] Overall scores ranged from 6.2 to 70.0, with higher scores indicating higher quality. The population was stratified into 3 groups as eating unhealthy, less healthy, and healthy diet, with cutoff points of 30.9 and 37.8.

### Definition of Cardiovascular Disease

A history of cardiovascular disease and other diseases was obtained from each participant using standardized questionnaires. Coronary heart disease was based on self-reporting of angina, myocardial infarction, coronary artery bypass graft surgery, or percutaneous coronary angioplasty (each category was not separately identified). Stroke and diabetes were based on self-report. Hypertension was identified by self-report or a blood pressure level greater than 140/90 mm Hg at enrollment. We verified self-reporting of these conditions with medical or hospital records in a sample of 455 reported events during follow-up. The confirmation rates were 89% when adjudicated centrally.

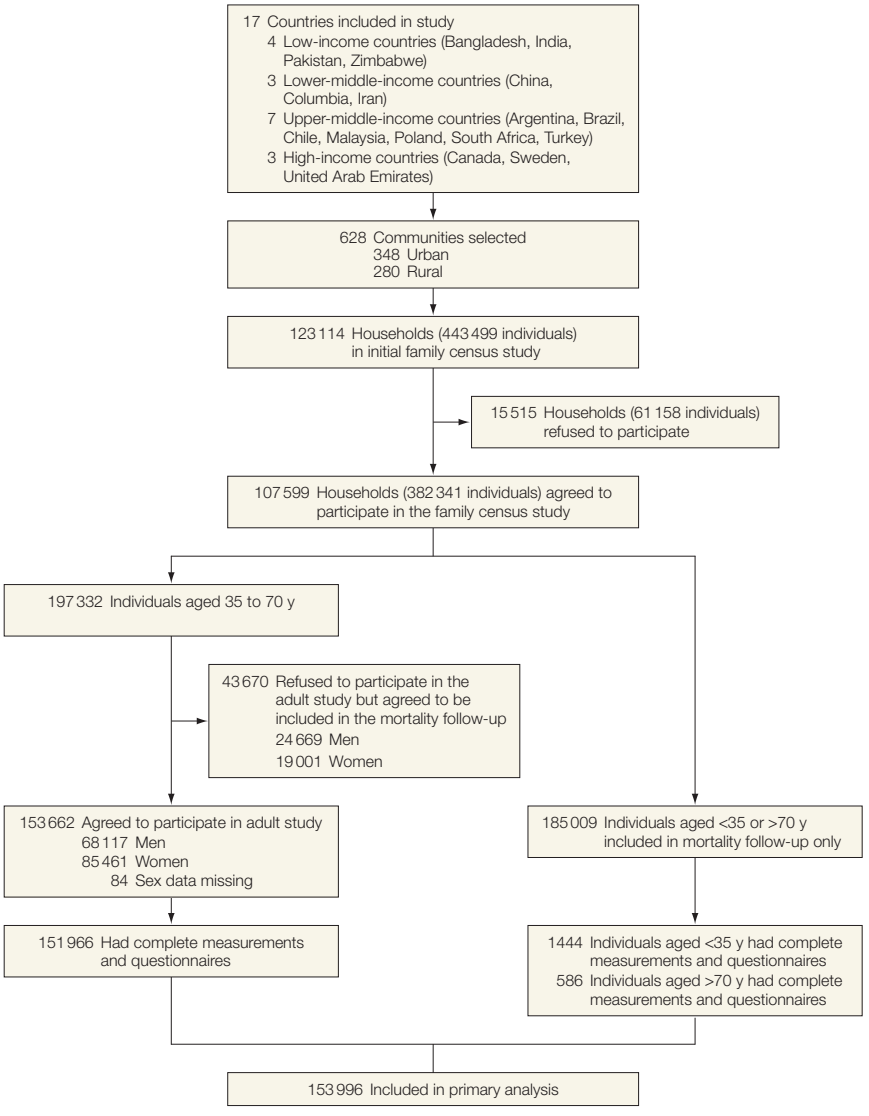
### Statistical Analysis

The prevalence of healthy lifestyle behaviors in the participants and their demographics were summarized using numbers with percentages as well as means and standard deviations or medians and interquartile ranges (IQRs) as appropriate. Means and proportions were adjusted for age, sex, and economic status of the country as appropriate. For this purpose, the generalized, linear mixed-effect model was used to take into account the effect of clustering, with appropriate link function and random effect, in which logit link function was used for binary outcomes and normal link function for continuous outcomes. The GLIMMIX procedure in SAS software version 9.2 (SAS Institute Inc) was used to obtain adjusted rates for all lifestyle behaviors for different strata including community as a random effect in the model with additional adjustments. Proportions and means were compared using $\chi^2$ and $t$ tests, respectively, using 2-sided testing. A $P$ value of less than .05 was considered significant.

## RESULTS

Participant enrollment in the study is depicted in FIGURE 1. Of the 153 996 enrolled participants, 16 073 were from 3 high-income countries, 43 518 from 7 upper-middle-income countries, 59 742 from 3 lower-middle-income countries, and 34 663 from 4 low-income countries; 7519 (4.9%) had a CHD or stroke event (5650 [3.7%] had a CHD event and 2292 [1.5%] had a stroke event; some participants had both events). The median interval from event to study enrollment was 5.0 years (IQR, 2.0-10.0 years) for CHD and 4.0 years (IQR, 2.0-8.0 years) for stroke. The baseline characteristics of the participants included in the study appear in TABLE 1. Full details of the overall study population and those with CHD and stroke have been reported previously.[8]

**Figure 1.** Participant Enrollment



### Smoking

Overall, 61.1% (95% CI, 60.0%-62.2%) were never smokers, 20.4% (95% CI, 19.5%-21.3%) were former smokers, and 18.5% (95% CI, 17.6%-19.4%) were current smokers. There were differences by country income status, country or region, and by education level (eTable at http://www.jama.com).

Among the participants who had ever smoked, 52.5% (95% CI, 50.7%-54.3%) had stopped smoking; the prevalence of smoking cessation was highest in the high-income countries (74.9%; 95% CI, 71.1%-78.6%) and lowest in the low-income countries (38.1%; 95% CI, 33.1%-43.2%), with graded decreases by decreasing country income status (56.5% [95% CI, 53.4%-58.6%] in upper-middle-income countries and 42.6% [95% CI, 39.6%-45.6%] in lower-middle-income countries) ($P<.001$ for trend). The highest prevalences of smoking cessation were found in countries in North America and Europe (70.5%; 95% CI, 67.2%-73.8%) and South America (67.2%; 95% CI, 63.4%-70.9%). The lowest rate (14.4%; 95% CI, 8.1%-20.7%) was in Africa. Proportionally, more men stopped smoking (53.0%; 95% CI, 50.9%-55.1%) than women (50.9%; 95% CI, 47.2%-54.6%) ($P=.004$) and more urban (57.3%; 95% CI, 55.1%-59.6%) than rural (44.4%; 95% CI, 41.5%-47.4%) ($P=.004$) residents (eTable). When examined by education and country economic status, individuals from high-income countries with the highest level of education showed the highest rate of smoking cessation (80.8%; 95% CI, 72.5%-87.1%) compared with those less educated ($P=.004$ for trend). These patterns of increasing rates of smoking cessation by education level were also observed in the upper-middle-income countries, lower-middle-income countries, and low-income countries (TABLE 2).

Information on the date of quitting smoking was available from 1296 of the 1526 participants. Of these, 510 (39.4%) stopped smoking after the CHD or stroke event. There was a graded increase in quitting rates after an event, by decreasing country income status, after adjusting for age and sex (29.2% [95% CI, 23.4%-35.9%] in high-income countries; 34.1% [95% CI, 28.8%-39.9%] in upper-middle-income countries; 46.7% [95% CI, 40.6%-53.0%] in lower-middle-income countries, and 68.2% [95% CI, 58.3%-76.6%] in low-income countries) ($P<.001$ for all trend comparisons).

**Table 1.** Baseline Characteristics of Participants With a Coronary Heart Disease (CHD) or Stroke Event

| | No. (%) of Participants With an Event[a] | | |
|---|---|---|---|
| | CHD or Stroke (n = 7519) | CHD (n = 5650) | Stroke (n = 2292) |
| Age, y | | | |
| Mean (SD) | 57.2 (9.0) | 57.4 (8.8) | 56.8 (9.4) |
| Median (IQR) | 58.0 (51.0-64.0) | 59.0 (52.0-64.0) | 58.0 (51.0-64.0) |
| Sex | | | |
| Female | 4017 (53.4) | 3036 (53.7) | 1218 (53.1) |
| Male | 3502 (46.6) | 2614 (46.3) | 1074 (46.9) |
| Country economic status | | | |
| High | 841 (11.2) | 669 (11.8) | 213 (9.3) |
| Upper-middle | 1967 (26.2) | 1396 (24.7) | 691 (30.1) |
| Lower-middle | 3669 (48.8) | 2857 (50.6) | 1042 (45.5) |
| Low | 1042 (13.9) | 728 (12.9) | 346 (15.1) |
| Region or country | | | |
| South Asia | 970 (12.9) | 683 (12.1) | 316 (13.8) |
| China | 3070 (40.8) | 2407 (42.6) | 872 (38.0) |
| Malaysia | 440 (5.9) | 289 (5.1) | 193 (8.4) |
| Africa | 283 (3.8) | 207 (3.7) | 91 (4.0) |
| North America/Europe | 1216 (16.2) | 951 (16.8) | 323 (14.1) |
| Middle East | 392 (5.2) | 332 (5.9) | 69 (3.0) |
| South America | 1148 (15.3) | 781 (13.8) | 428 (18.7) |
| Type of community | | | |
| Urban | 4555 (60.6) | 3447 (61.0) | 1367 (59.6) |
| Rural | 2964 (39.4) | 2203 (39.0) | 925 (40.4) |
| Education[b] | | | |
| None, primary school, or unknown | 3640 (48.4) | 2661 (47.2) | 1185 (51.8) |
| Secondary or high school | 2479 (33.0) | 1889 (33.5) | 731 (31.9) |
| Trade, college, or university | 1382 (18.5) | 1087 (19.3) | 372 (16.3) |
| Smoking status[b] | | | |
| Never | 4571 (61.1) | 3479 (61.9) | 1359 (59.6) |
| Former | 1526 (20.4) | 1158 (20.6) | 447 (19.6) |
| Current | 1382 (18.5) | 982 (17.5) | 475 (20.8) |
| Diabetes | 1754 (23.3) | 1367 (61.9) | 549 (24.0) |
| Hypertension | 5653 (75.2) | 4275 (75.7) | 1749 (76.3) |
| Body mass index[b,c] | | | |
| <25 | 2717 (38.1) | 2018 (37.3) | 851 (39.9) |
| 25-30 | 2771 (38.8) | 2110 (39.0) | 817 (38.3) |
| >30 | 1650 (23.1) | 1384 (23.7) | 464 (21.8) |
| Time since diagnosis, median (IQR), y | 5.0 (2.0-10.0) | 5.0 (2.0-10.0) | 4.0 (2.0-8.0) |

Abbreviation: IQR, interquartile range.
[a] Unless otherwise indicated.
[b] The percentages for this category do not add up to 100% due to missing data or incomplete measurements.
[c] Calculated as weight in kilograms divided by height in meters squared.

### Physical Activity Profiles

A little more than one-third (35.1%; 95% CI, 29.6%-41.0%) of individuals undertook high levels of work- or leisure-related physical activities. Although there were differences in the prevalence of high level of physical activity by country income status, these did not reach statistical significance. The prevalence was 25.5% (95% CI, 16.7%-36.6%) in low-income countries, 41.5% (95% CI, 33.1%-50.4%) in lower-middle-income

**Table 2.** Prevalence of Smoking Cessation, Healthy Eating, and High Level of Physical Activity

| | Prevalence (95% CI)[a] | | | | | *P* Values for Trend |
|---|---|---|---|---|---|---|
| | Overall | High-Income Countries | Upper-Middle-Income Countries | Lower-Middle-Income Countries | Low-Income Countries | |
| Smoking cessation by education level | | | | | | |
| None or primary school | 48.2 (41.5-55.0) | 63.6 (49.7-75.5) | 47.1 (35.8-58.7) | 46.8 (36.6-57.2) | 26.7 (19.9-34.7) | .02 |
| High or secondary school | 54.2 (47.1-61.1) | 69.5 (58.6-78.7) | 55.8 (42.7-68.1) | 51.6 (40.8-62.3) | 36.4 (26.3-47.8) | .02 |
| Trade school, college, or university | 57.7 (50.1-64.9) | 80.8 (72.5-87.1) | 56.5 (41.7-70.3) | 47.5 (35.9-59.4) | 47.7 (30.6-65.4) | .001 |
| All | 53.4 (50.1-64.9) | 70.8 (55.8-82.4) | 54.6 (44.9-63.9) | 47.6 (38.5-56.8) | 39.3 (27.3-52.7) | .001 |
| Healthy eating by education level | | | | | | |
| None or primary school | 32.2 (24.1-41.5) | 31.1 (11.6-60.7) | 38.1 (24.8-53.5) | 37.0 (28.8-46.0) | 19.4 (5.9-47.9) | .61 |
| High or secondary school | 39.0 (29.9-49.0) | 41.3 (17.6-69.8) | 45.5 (30.2-61.8) | 44.3 (35.3-53.7) | 26.5 (8.6-58.1) | .51 |
| Trade school, college, or university | 46.2 (36.2-56.5) | 56.6 (28.7-80.9) | 52.4 (35.4-68.8) | 48.2 (38.4-58.1) | 31.8 (10.3-65.4) | .07 |
| All | 39.0 (30.0-48.7) | 43.4 (21.0-68.7) | 45.1 (30.9-60.1) | 43.2 (30.0-57.4) | 25.8 (13.0-44.8) | .25 |
| High level of physical activity by education level | | | | | | |
| None or primary school | 34.8 (29.2-40.8) | 36.0 (19.6-56.9) | 29.9 (20.5-41.3) | 39.5 (32.2-47.3) | 29.5 (21.8-38.6) | .64 |
| High or secondary school | 36.1 (30.2-42.3) | 42.2 (24.6-62.0) | 28.1 (18.6-40.0) | 43.7 (35.9-51.8) | 27.1 (19.6-36.1) | .007 |
| Trade school, college, or university | 34.4 (28.5-40.8) | 43.6 (26.1-62.9) | 22.3 (13.9-33.8) | 43.2 (34.9-51.9) | 20.8 (13.1-31.4) | .001 |
| All | 35.1 (29.6-41.0) | 45.2 (29.8-61.5) | 29.9 (22.2-38.9) | 41.5 (33.1-50.4) | 25.5 (16.7-36.8) | .11 |

[a] Adjusted for age, sex, and education as appropriate based on mixed model.

countries, 29.9% (95% CI, 22.2%-38.9%) in upper-middle-income countries, and 45.2% (95% CI, 29.8%-61.5%) in high-income countries ($P=.11$ for trend). There were also differences in prevalence of physical activity by education level. However, these patterns varied by country income level, and the differences generally were not statistically significant (Table 2).

### Dietary Patterns

Using the modified AHEI score, 39.0% (95% CI, 30.0%-48.7%) of individuals with a history of CHD or stroke event consumed a healthy diet. Low-income countries had the lowest prevalence who had healthy diets (25.8%; 95% CI, 13.0%-44.8%) compared with the prevalences in high-income countries (43.4%; 95% CI, 21.0%-68.7%), upper-middle-income countries (45.1; 95% CI, 30.9%-60.1%), and lower-middle-income countries (43.2%; 95% CI, 30.0%-57.4%) (Table 2). Increasing levels of education were associated with graded increases in having healthy diets in high-income countries (56.6% [95% CI, 28.7%-80.9%] among the highest educated and 31.1% [95% CI, 11.6%-60.7%] among the lowest educated; $P<.001$ for trend). Similar trends were seen for upper-middle-income, lower-middle-income, and low-income countries (Table 2).

### Combination of Healthy Lifestyle Behaviors

Overall, 14.3% (95% CI, 11.7%-17.3%) of individuals did not have any of the 3 healthy lifestyle behaviors; 42.7% (95% CI, 39.3%-46.1%) had only 1 healthy behavior, 30.6% (95% CI, 27.4%-34.0%) had 2, and only 4.3% (95% CI, 3.1%-5.8%) had all 3 healthy lifestyle behaviors. Individuals in upper-middle-income and low-income countries had higher prevalences of not having any healthy lifestyle behaviors and lower prevalences of having all 3 healthy lifestyle behaviors (FIGURE 2A). Participants were more likely to have 2 or more healthy lifestyle behaviors if they were from high-income countries (odds ratio [OR], 2.61; 95% CI, 2.11-3.22), upper-middle-income countries (OR, 1.42; 95% CI, 1.18-1.70), and lower-middle-income countries (OR, 2.70; 95% CI, 2.33-3.13) vs those from low-income countries. These patterns are also reflected by lifestyle behaviors in the individual countries or regions (Figure 2B). Urban residents were more likely to have 2 or more healthy lifestyle behaviors than those living in rural areas (OR, 1.22 [95% CI, 1.11-1.34]; $P<.001$).

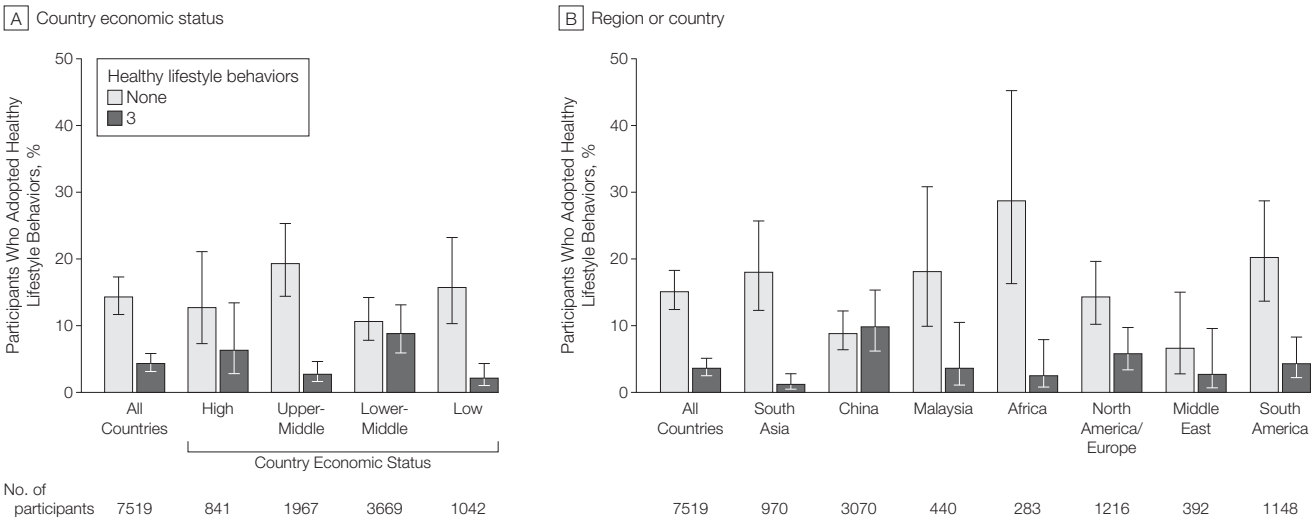
Overall, more men did not follow any healthy lifestyle behaviors (26.4%; 95% CI, 22.1%-31.1%) than women (7.2%; 95% CI, 5.7%-9.0% ($P<.001$; FIGURE 3). Conversely, more women had 3 healthy lifestyle behaviors (7.4%; 95% CI, 5.4%-10.0%) than men (2.4%; 95% CI, 1.7%-3.4%) ($P<.001$); the OR was 1.66 (95% CI, 1.51-1.82) for women having 2 or more healthy lifestyle behaviors compared with men ($P<.001$). These sex differences were consistent by country income status and by country or region.

## DISCUSSION

This study shows that a large gap exists globally between actual and ideal participation in the 3 key lifestyle behaviors of avoidance (or quitting) of smoking, undertaking regular physical activity, and eating a healthy diet after a CHD or stroke event. Nearly one-fifth of individuals continued to smoke, only about one-third undertook high levels of physical activity, and only two-fifths were eating a healthy diet.

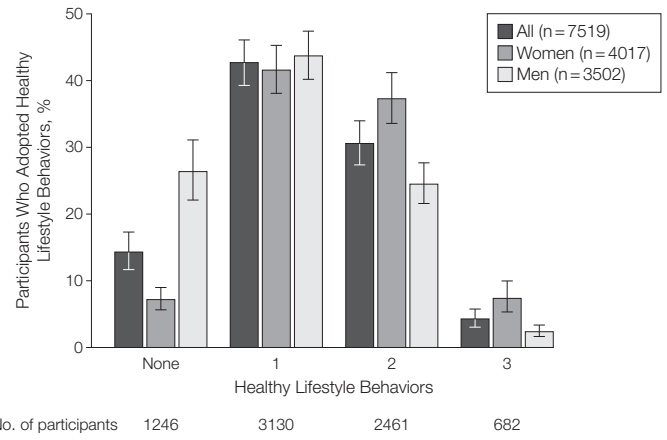
Substantial proportions of individuals did not have any of these 3 healthy lifestyle behaviors and less than 1 in 20

**Figure 2.** Prevalence of Adoption of Combination of Healthy Lifestyle Behaviors by Country, Economic Status, and Region for Patients With a Coronary Heart Disease or Stroke Event




Adjusted for age, sex, and country income status as appropriate based on mixed model.

**Figure 3.** Prevalence of Adoption of Combination of Healthy Lifestyle Behaviors by Sex for Patients With a Coronary Heart Disease or Stroke Event




Adjusted for age, sex, and country income status as appropriate based on mixed model.

had all 3. More women than men had 2 or 3 healthy lifestyle behaviors. Our study also shows important country and sex differences. There were higher rates of smoking cessation in high-income countries than in upper-middle-income, lower-middle-income, and low-income countries. Lower prevalence of healthy diets was observed in more individuals from high-income and low-income countries than in upper-middle-income and lower-middle-income countries.

Overall, individuals from upper-middle-income and low-income countries had a lower prevalence of 3 of the healthy lifestyle behaviors than those from high-income and lower-middle-income countries. Higher levels of education tended to be associated with higher prevalence of healthy lifestyle behaviors in high-income and lower-middle-income countries, but not in upper-middle-income and low-income countries, in which regular physical activity was undertaken less frequently among the more educated.

These variations in lifestyle prevalence can provide insights into opportunities to enhance cardiovascular disease prevention through adopting healthy lifestyle behaviors. For example, high-income countries, and to some extent upper-middle-income and lower-middle-income countries, had higher rates of smoking cessation than low-income countries, especially among the most educated. High-income countries had more comprehensive approaches to tobacco control (eg, education on tobacco, smoking cessation programs, and active taxation and legislative measures), which likely account for the higher cessation rates. The lower rates of smoking in women, most pronounced in the lower-middle-income and low-income countries, are likely due to cultural factors and social stigma associated with women smoking in these societies. However, some reports suggest that as incomes in these countries increase, smoking among women could also increase.[18,22]

In addition, even though only about one-third of those who quit smoking did so after a CHD or stroke event, we observed contrasting patterns in smoking cessation by country income status, with lower-income countries showing a greater prevalence of smoking

cessation after their events. Whether this was a result of the cardiovascular disease event or due to secular trends in smoking cessation in these countries is not clear. Smoking cessation efforts, which can have an effect in reducing recurrent cardiovascular disease, should specifically be targeted at those with known cardiovascular disease, especially among men, and in poorer countries. This should also be complemented with continued efforts to prevent individuals (especially women, children, and young adults) from smoking. Specific efforts to promote smoking cessation are required in Africa given the high rates of smoking and low prevalence of smoking cessation.

Individuals from high-income countries had the highest prevalence of high levels of physical activity, followed by lower-middle-income, upper-middle-income, and low-income countries, in that order, although these differences were not statistically significant. A greater proportion of individuals from high-income countries had high levels of physical activity as recreational or leisure activity, whereas in the lower-income countries, these levels of activity were predominantly related to work. This suggests that the population's economic need to work in poorer countries (as opposed to participating in recreational activities in richer countries) may be an important consideration.

In our study, a healthy diet was followed by less than half of individuals in all the countries studied, except low-income countries in which only one-quarter had healthy diets. The observation that despite higher incomes, individuals from high-income countries did not have a higher prevalence of high-quality diets suggests that different factors may be operating in countries at different economic levels that influence the adoption of healthy diets. In wealthier countries, red meats and fried foods are more commonly consumed, whereas in the poorer countries, healthy foods such as fruits and vegetables may not be affordable. The challenges inherent in getting populations to improve the quality of their diets are many and include cultural influences, tastes, traditional cooking methods, and availability and affordability of healthy foods (such as fruits and vegetables). Consequently, dietary recommendations from the Western or richer countries may not be acceptable or may be unaffordable in other regions of the world. This should lead to the development of locally sensitive (to culture, affordability, availability, and taste) guidelines for healthy diets.

Lifestyle modifications to reduce the risk of recurrent cardiovascular disease events are as essential as using proven secondary prevention medications such as β-blockers, angiotensin-converting enzyme inhibitors, statins, and antiplatelet agents.[8] Current approaches to modifying lifestyle behaviors, based on individual counseling, are expensive and only modestly effective. In high-income countries, rehabilitation programs, mostly lasting for a few months, are offered to only a small proportion of individuals with recent vascular events who are referred to these programs to initiate healthy lifestyle practices.[23] Moreover, such programs are not available in most low- and middle-income countries. Mendis et al[24] reported that much higher proportions of the 10 000 patients from 10 middle-income and low-income countries were aware of the cardiovascular benefits of healthy lifestyle behaviors than the much lower proportions of those who actually were undertaking these healthy lifestyle activities. This suggests the existence of a large gap between patient knowledge of healthy lifestyle behaviors and their adoption that needs bridging.

### Strengths and Limitations

Our study has several strengths. It is the only study we are aware of that has collected information on lifestyle behaviors using standardized measures from a large number of urban and rural communities in high-income, middle-income, and low-income countries. The identification of communities, participants, and the diagnoses of cardiovascular disease using uniform approaches avoided the potential selection biases related to collection of data only for patients attending clinics or hospitals. One limitation is that in individuals in whom the cardiovascular disease events occurred more than 5 years previously, obtaining the information on current lifestyle is only a snapshot of the activities that the individuals had carried out recently. We were not able to determine whether the adoption of healthy diets and physical activity occurred before or after the cardiovascular disease events. Nevertheless, this study shows the large gaps between actual and ideal prevalence of healthy lifestyle behaviors among those with previous CHD or stroke from high-, middle-, and low-income countries and in rural and urban areas.

## CONCLUSIONS

Our data indicate that the prevalence of following the 3 important healthy lifestyle behaviors was low in individuals after their CHD or stroke event. These patterns were observed worldwide but more so in poorer countries. This requires development of simple, effective, and low-cost strategies for secondary prevention that is applicable worldwide.

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