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Turning Back the Clock: Adopting a Healthy Lifestyle in Middle Age

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ABSTRACT

PURPOSE: To determine the frequency of adopting a healthy lifestyle (5 or more fruits and vegetables daily, regular exercise, BMI 18.5-29.9 kg/m^2, no current smoking) in a middle-aged cohort, and determine the subsequent rates of cardiovascular disease (CVD) and mortality among those who adopt a healthy lifestyle.

METHODS: We conducted a cohort study in a diverse sample of adults age 45-64 in the Atherosclerosis Risk in Communities survey. Outcomes are all-cause mortality and fatal or non-fatal cardiovascular disease.

RESULTS: Of 15,708 participants, 1344 (8.5%) had 4 healthy lifestyle habits at the first visit, and 970 (8.4%) of the remainder had newly adopted a healthy lifestyle 6 years later. Men, African Americans, individuals with lower socioeconomic status, or a history of hypertension or diabetes were less likely to newly adopt a healthy lifestyle (all $P < .05$). During the following 4 years, total mortality and cardiovascular disease events were lower for new adopters (2.5% vs 4.2%, χ^2 $P < .01$, and 11.7% vs 16.5%, χ^2 $P < .01$ respectively) compared to individuals who did not adopt a healthy lifestyle. After adjustment, new adopters had lower all-cause mortality (OR 0.60, 95% Confidence Interval [CI], 0.39-0.92) and fewer cardiovascular disease events (OR 0.65, 95% CI, 0.39-0.92) in the next 4 years.

CONCLUSIONS: People who newly adopt a healthy lifestyle in middle-age experience a prompt benefit of lower rates of cardiovascular disease and mortality. Strategies to encourage adopting healthy lifestyles should be implemented, especially among people with hypertension, diabetes, or low socioeconomic status.

KEYWORDS: Aging; Cardiovascular; Diet; Exercise; Healthy habits; Healthy lifestyle

Lifestyle choices are associated with subsequent cardiovascular disease and mortality from all causes. While research has supported healthy lifestyle habits individually,[1,2] fewer studies[3,4,5] have investigated the benefit of a more complete healthy lifestyle that combines a prudent diet, regular exercise, maintaining a healthy weight (body mass index [BMI] 18.5-30 kg/m^2), and not smoking. The Healthy Ageing: a Longitudinal study in Europe (HALE) investigation examined a combination of healthy habits in 1507 men and 832 women aged 70-90 years who were followed for 10-year mortality from coronary heart disease, cardiovascular diseases, cancer, and all causes.[4] In adjusted analyses, adhering to a Mediterranean diet, moderate alcohol use, physical activity, and nonsmoking were associated with a 65% lower risk of all-cause mortality and a similar reduction in cardiovascular disease. The Health Professionals Follow-Up Study[5] recently studied the impact of a healthy lifestyle (5 health factors) on subsequent coronary heart disease and documented a 62% reduction in coronary events among men who maintained the healthy lifestyle for 16 years. Similar results were obtained in an analysis of the Women's Health Study.[6] Whether the benefits observed in these studies are the result of life-long good health habits or can be achieved by people who adopt a combination of healthy lifestyle habits later in life needs to be confirmed.

Despite the well known benefits of having a lifestyle that includes exercise, eating a diet high in fruits and vegetables, maintaining a healthy weight, and not smoking, only a small proportion of adults follow this healthy lifestyle pattern.[3,5,7]

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Part of the rationale for failing to adopt beneficial behaviors may be the belief that adopting such behaviors later in life will not be very beneficial in the context of a several preceding years of less than ideal health behavior.[8,9] Another possibility is that public health information may not be reaching certain populations, such as people of lower socioeconomic status.[10,11] Further characterization of individuals who adopt a healthy lifestyle in middle-age, and determining the extent of the health benefit would be extremely helpful in formulating appropriate lifestyle advice for such individuals.

The purpose of this study was to determine the proportion of individuals who adopt a four-element healthy lifestyle in middle-age (more fruits/vegetables in the diet, regular exercise, weight control and not smoking), and examine the consequences of adopting the 4-element lifestyle on cardiovascular disease events and all-cause mortality.

CLINICAL SIGNIFICANCE

- Only 8.5% of middle-aged adults practice healthy lifestyles that include diets high in fruits and vegetables, regular exercise, maintaining a healthy weight (BMI 18.5-29.9 kg/m^2), and not smoking, and only 8.4% newly adopt such a lifestyle past age 45.
- Adopting a healthy lifestyle in middle age has substantial benefits: Mortality and cardiovascular disease risk was significantly reduced (40% and 35% respectively) after only 4 years compared to people with less healthy lifestyles.
- Men, African-Americans, and individuals with less than college education, lower income, or a history of hypertension or diabetes are less likely to adopt a healthy lifestyle past age 45, and are therefore at greater risk of mortality and cardiovascular disease.

METHODS

Study Population

The Atherosclerosis Risk in Communities Study (ARIC) is a prospective epidemiologic study of 15,792 men and women ages 45 to 64 years at enrollment in four communities across the United States that was designed to investigate the origin and progression of various atherosclerotic diseases.[12] The first set of interviews and examinations (Visit 1) in which baseline information was collected were conducted from years 1987 to 1989. The full interview and exam methodology can be found on the ARIC web site: http://www.cscc.unc.edu/aric/pubuse/. The public use data set also contains data from annual telephone interviews and three visits (Visits 2-4) which follow the cohort through the end of 1998. Follow up visits every 3 years include an interval medical history, weight, height, diet questionnaire, updated smoking history, and current participation in sports and leisure exercise. The Medical University of South Carolina IRB has approved this research.

Healthy Lifestyle Factors

An individual's participation in an overall healthy lifestyle was evaluated from information collected during Visits 1 and 3. A healthy lifestyle was characterized by having all 4 of the following lifestyle characteristics: eating at least 5 fruits and vegetables daily; exercising (at least walking) a minimum of 2.5 hours per week; BMI maintained between 18.5 and 30 kg/m^2; and not smoking. A more ideal lifestyle pattern (Optimal) was defined using the 4 lifestyle criteria above, with the exception of adding moderate alcohol consumption (1-14 drinks per week) and restricting the optimal BMI to 18.5-24.9 kg/m^2.

The ARIC dietary questionnaire consisted of items regarding the frequency of consumption of various foods over the previous year. From these questions we calculated the average daily consumption of fruits and vegetables (excluding starches such as potatoes and grains), using >5 daily as optimal. While a heart healthy diet is characterized by several diet habits including low fat intake,[13] fruit and vegetable intake has often been used as a reflection of a heart healthy "prudent" diet.[14-16] Previous AHA guidelines in force during the time of the ARIC study recommended a total of 5 fruits and vegetables a day as part of a healthy diet.[17] Further, higher intake of fruits and vegetables corresponds with lower fat and higher fiber intake, improved anti-oxidant status, and lower cardiovascular disease risk.[16,18,19]

For assessment of physical activity, the ARIC data set includes information about the top 4 sports and leisure-time activities in which an individual participates. For each activity the hours per week and the months per year are reported, and these values then were used to calculate the average number of hours per week spent on that activity over the course of the year. We summed the average hours per week for these 4 activities. To this sum we added the average number of minutes per week of walking or riding a bicycle to and from work or shopping. Individuals with a total of 150 minutes per week or more were classified as getting sufficient exercise. This standard is based on the longstanding recommendation of several groups including the President's Fitness Council.[20] The American College of Sports Medicine suggests all adults should engage in 30 minutes or more of moderately intense physical activity daily.[21]

Body mass index was available in the ARIC dataset and calculated from measurements taken during the ARIC exam. Individuals with a BMI 18.5-30 kg/m^2 were considered acceptable. While a BMI of 18.5-24.9 kg/m^2 is considered optimal, our intent was to determine the impact of modest lifestyle changes. Further, in their analysis of mortality data from the NHANES I, II, and III surveys, Flegal

and colleagues[22] found no excess mortality risk for overweight individuals (BMI 25-30 kg/m^2) as compared to normal weight individuals (BMI 18.5-24.9 kg/m^2) in middle-aged individuals.

Current smokers were identified by questionnaire during each visit.

Demographic Variables

These variables include age, race, gender, education, and family income, all from self-report at Visit 1. Participants were divided into 2 age groups: 45-54 and 55-64 years. Race was defined as African American and other than African-American according to the categorization used by the ARIC investigators. Education was categorized as less than high school, high school or trade school graduate, and at least some college education. Family income was divided at $35,000 per year.

History of Disease Variables

Cardiovascular disease and risk factor history was determined for both Visits 1 and 3, as indicated below.

Hypertension. Individuals were considered to have a history of hypertension if their measured blood pressure was >139 mm Hg (systolic) or >89 mm Hg (diastolic), they reported having been told by a doctor that they had hypertension, or they were taking hypertension medication. Blood pressure was determined in the sitting position after 5 minutes rest, and was taken 3 times over the next 10-15 minutes. The average of the second and third measures was used in the study.

Diabetes. A history of diabetes came from participant self-report, having a fasting plasma glucose >126 mg/dL, or if they reported taking medicine for diabetes.

Hypercholesterolemia. Individuals were considered to have a history of high cholesterol if they reported a history of high cholesterol, were taking medicine for high cholesterol, or if their measured total cholesterol exceeded 200 mg/dL or LDL cholesterol exceeded 160 mg/dL.

Cardiovascular Disease. A single variable in the ARIC dataset (PRVCHD05) identified individuals who, prior to Visit 1, had a history of myocardial infarction (MI), have had heart or arterial surgery (coronary bypass, balloon angioplasty, angioplasty of coronary artery), or were adjudicated to have an MI from the Visit 1 ECG data. A series of questions regarding a history of stroke, heart attack, or revascularization were used in annual telephone interviews and in face-to-face Visits 3 and 4 to determine the presence of subsequent cardiovascular disease events that occurred after Visit 1.

Outcome Determination

Variables in the ARIC dataset described a participant's status at the end of the year 1998. Patients known to have died, as determined from state death certificates, are identified in the ARIC dataset along with their primary underlying cause of death. We identified participants who developed fatal or non-fatal cardiovascular disease from those whose underlying cause of death was coded as cardiovascular disease, or who had an MI, a silent MI, diagnosed coronary heart disease, a coronary heart disease procedure, or a definite or probable stroke since Visit 1 (1987-1989). For the analysis of people who switched to a healthy lifestyle as of Visit 3, outcomes were determined based on cardiovascular disease events that occurred after Visit 3 (1994).

Statistical Analyses

The demographics of the ARIC population with regards to their adherence to a totally healthy lifestyle were examined using χ square statistics. We used a multiple logistic regression model incorporating the demographic and disease history variables to predict the relative likelihood of switching to an overall healthy lifestyle among individuals who did not practice all 4 healthy lifestyle factors at Visit 1. Using the same control variables, we also ran models to examine the effect on our chosen outcomes of newly adopting a healthy lifestyle between Visit 1 and Visit 3, using people with <3 habits as the reference group. Disease histories at the time of Visit 3 were used as control variables. The outcomes of interest were experiencing a cardiovascular disease event (fatal or non-fatal) or total mortality. An additional analysis was conducted to examine the same outcomes in people with <2 healthy habits at Visit 1, who adopted 3 habits or all 4 habits by Visit 3.

RESULTS

Initial lifestyle status could be determined for 15,708 individuals in the study, and 1344 (8.5%) engaged in all 4 healthy lifestyle factors during Visit 1 (Table 1). Participants aged 45-54 years, men, African-American, and individuals with histories of hypertension or diabetes were significantly less likely to be leading a healthy lifestyle during Visit 1. Individuals with less than college education or family annual incomes less than $35,000 (lower socioeconomic status) also were less likely to be leading a healthy lifestyle.

Among the individuals not practicing all 4 healthy lifestyle habits at Visit 1, 970 people (8.4%) newly adopted a lifestyle that included all four healthy lifestyle factors by 6 years later at Visit 3 (Table 2). In this group, 670 switched from practicing 3 healthy habits at Visit 1, 270 switched from 2 habits, 26 switched from 1 habit, and none switched from 0 habits. Four had an unknown number of healthy habits (but <4) at Visit 1. Among these switchers the most common change, by 78% of them, was the adoption of a healthy diet of at least 5 fruits and vegetables a day, up from an average of 3.8 servings per day. The second most common change, by 38% of these individuals, was an increase in their exercise to at least 2.5

Table 1 Lifestyle Status of the Atherosclerosis Risk in Communities Study (ARIC) Population at Visit 1

Demographics	All Participants, % (n = 15,708)	All 4 Healthy Lifestyle, % (n = 1344)	χ^2 P =
Age			
45-54	52.7	7.8	<.001
55-64	47.3	9.5	
Gender			
Male	44.8	7.8	.003
Female	55.2	9.2	
Race			
Other than African American	73.0	10.0	<.001
African American	27.0	4.7	
Education			
<High school	24.0	5.4	<.001
High school or trade school	40.7	7.9	
College	35.3	11.5	
Family Income			
≤$35,000/yr	57.8	7.2	<.001
>$35,000/yr	42.2	10.3	
Hypertension			
Yes	47.0	7.1	<.001
No	53.0	9.8	
Diabetes			
Yes	7.6	5.8	<.001
No	92.4	8.8	
High Cholesterol			
Yes	64.3	8.6	.596
No	35.7	8.4	
Coronary Heart Disease			
Yes	4.9	9.9	.162
No	95.1	8.5	

In the first column is the percent of all participants in the designated group at left; and in the next column is the percent of individuals in that particular category that had all 4 healthy lifestyle factors, out of the 14,367 participants who were less than healthy (<4 factors).

hours per week. Smoking cessation and weight loss were newly adopted by 12.3% and 4.6% of these individuals. The individuals who adopted the all-4 healthy lifestyle between Visits 1 and Visit 3 were more likely to be older, female, other than African-American, more educated, with greater family incomes, or have no history of hypertension or diabetes (Table 2). Having a history of high cholesterol or coronary heart disease was not significantly related to a change in healthy habits. In analyses examining the optimal lifestyle pattern that included moderate alcohol consumption and an ideal BMI of 18.5-24.9 kg/m^2, fewer than 300 individuals were identified that had newly adopted the optimal pattern. Further analyses of the mortality and cardiovascular disease outcomes of the optimal pattern that could not be completed were not carried out.

In the logistic regression model predicting which individuals would switch to an overall healthy lifestyle, individuals who are older, female, with a college education, with family annual incomes greater than $35,000, or with no history of hypertension are more likely to have switched than others (Table 3). Race or having a history of diabetes, elevated cholesterol, or coronary heart disease were not significantly related to switching to an overall healthy lifestyle.

Over a 4-year follow up period starting at Visit 3, individuals who switched to an all-4 healthy lifestyle were less likely to have experienced a subsequent cardiovascular disease event (11.7% vs 16.5%, χ^2 P <.001) or death (2.5% vs 4.2%, χ^2 P = .009) than those who persisted with 3 or fewer healthy factors. In logistic regression analyses adjusting for demographics, socioeconomic status, and disease history, individuals who switched to a healthy lifestyle experienced a 40% reduction in all-cause mortality risk (odds ratio [OR] 0.60, 95% confidence interval [CI], 0.39-0.92) and a 35% relative risk reduction of cardiovascular disease events (OR

Table 2 Characteristics of New Adopters of Healthy Habits

Demographics	Switched to All 4 Healthy Habits, % (n = 970)*	χ^2 P =
Visit 1 Age		
45-54	7.0	<.001
55-64	9.9	
Gender		
Male	7.4	.001
Female	9.1	
Race		
Other than African American	8.8	.003
African American	7.0	
Education		
<High school	5.1	<.001
High school or trade school	7.9	
College	10.7	
Family Income		
≤$35,000/yr	7.2	<.001
>$35,000/yr	9.7	
Hypertension†		
Yes	7.6	<.001
No	9.3	
Diabetes†		
Yes	6.5	.013
No	8.6	
High Cholesterol†		
Yes	8.6	.110
No	7.8	
Coronary Heart Disease†		
Yes	8.4	.991
No	8.4	

Demographics and disease history of the Atherosclerosis Risk in Communities Study (ARIC) population who initially had less than 4 Healthy Habits during Visit 1 and who adopted the remaining habits.

*Compared to 10,647 participants who remained less healthy (<4 healthy factors).

†History of the disease at Visit 3.

Table 3 Likelihood of Switching from a Less Healthy Lifestyle (≤3 Healthy Factors) at Visit 1 to a Healthy Lifestyle (All 4 Factors) at Visit 3

Demographics		OR	95% CI
Visit 1 Age (Reference 45-54)	55-64	1.68	1.46-1.92
Gender (Reference Female)	Male	0.72	0.63-0.83
Race (Reference Other than African American)	African American	1.01	0.84-1.21
Education (reference college)	<High school	0.46	0.36-0.57
	High school or trade school	0.71	0.61-0.83
Family Income (reference >$35,000/yr)	≤$35,000/yr	0.81	0.69-0.95
Hypertension*	Yes	0.83	0.72-0.96
Diabetes*	Yes	0.83	0.65-1.05
High Cholesterol*	Yes	1.10	0.95-1.27
Coronary Heart Disease*	Yes	1.11	0.94-1.32

CI = confidence interval; OR = odds ratio.
*History of the disease at Visit 3.

0.65, 95% CI, 0.52-0.81) over the next 4 years compared to people who did not practice all 4 healthy habits (Table 4).

People who had <2 healthy habits at Visit 1 and who had adopted 1 more healthy habit (not all 4) did not experience a reduction in cardiovascular disease (CVD) (OR 0.88, 95% CI, 0.75-1.02) but did experience a reduction in total mortality (OR 0.75, 95% CI, 0.58-0.97). Individuals adopting all 4 healthy habits experienced reductions in both ($P < .01$).

DISCUSSION

In this study, we found that a midlife switch to a healthy lifestyle that includes a diet of at least 5 daily fruits and vegetables, exercise, maintaining a healthy weight, and not smoking results in a substantial reduction in mortality and cardiovascular disease over the subsequent 4 years. This benefit was independent of age, race, gender, socioeconomic status, a history of hypertension, hypercholesterolemia, diabetes, or previous cardiovascular disease. The study adds 3 new features to the current literature: first, that the benefit of switching to a healthy lifestyle past age 45 was evident in short-term follow up of 4 years; second, that the beneficial impact of the changes occurred despite the relatively modest changes in health habits; and third, the healthy lifestyle was beneficial when compared to all persons with ≤3 healthy habits, not just in comparison to people with none or 1 habit. People adopting only 3 healthy habits experienced lower mortality but not fewer CVD events over the same period.

The study's findings are consistent with recent research conducted in the Health Professionals Follow-up Study[5] and the Women's Health Study[6] that analyzed the impact of following 5 healthy lifestyle factors over a period of time. The current study included the same lifestyle factors except one, moderate alcohol consumption. We did not include alcohol consumption in our analyses because we focused on adopting new healthy behaviors, and newly adding this behavior has not been recommended.[23-25]

The study has some limitations that should be reviewed. As in other epidemiologic studies, misclassification is a concern. In the ARIC study, a food frequency questionnaire was used that specifically asked about average intake of fruits and vegetables, and also asked about weekly intake, to capture foods that are eaten regularly but less frequently. Still, seasonal variation and availability of fruits and vegetables could affect the data obtained in this way. In addition, an optimally healthy diet has other characteristics, including adequate fiber intake, low fat intake, and optimizing sodium, magnesium and several other nutrients (AHA 2006 guidelines), but these factors were not assessed in the current investigation. Further, food or exercise habits could have changed between the visits and the outcome assessment. However, our own data and several studies have demonstrated that middle-aged people are likely to have a fairly stable nutrient intake over many years.[26,27] To take this issue into account, we updated our classification using Visit 3 diet data to assess the outcomes of new adopters from that visit forward. Also, individuals may have exaggerated their exercise frequency or their intake of fruits and vegetables, which would tend to reduce the differences between groups. Thus, our estimates of reduced cardiovascular disease and mortality may be conservative. We could not investigate results in Hispanics or other races due to the categorization limited to black/non-black in the ARIC study database.

This study has important implications for public health. Despite prominent public health messages,[28] the average intake of fruits and vegetables by people in the current study was 3.8 servings a day, and the proportion of people exer-

Table 4 Switchers to Healthy Lifestyle and Persistently Healthy Compared to Persistently Unhealthy Individuals

	Cardiovascular Disease Event, OR (95% CI)	Death, OR (95% CI)
Switched from Unhealthy to Healthy Lifestyle	0.65* (0.52-0.81)	0.60* (0.39-0.92)
Persistently Unhealthy (<4 Healthy Factors at Both Visits)	1.00 (reference)	1.00 (reference)

CI = confidence interval; OR = odds ratio.
Relative likelihood of experiencing a cardiovascular disease event (fatal or non-fatal) or death during the 4-year follow up period.
*Controlled for age group, gender, race, education, family income, and histories of hypertension, diabetes, elevated cholesterol, and previous coronary heart disease.

cising 150 minutes a week was only about half. Almost 30% of the participants in the study are obese or current smokers. While one can envision a more optimal lifestyle, our intent was to evaluate the impact of modest lifestyle changes that would be attainable in middle age. The finding that less than 10% of individuals newly adopted even these modest healthy lifestyle changes demonstrates that the American public has a lot of potential for improvement.

Of concern is the fact that new adoption of a healthy lifestyle was not evenly distributed in the population. People with hypertension, diabetes, men, blacks, and people with lower socioeconomic status adopted the healthy lifestyle pattern less often. One implication is that access to care may be a contributing factor. Another possible conclusion is that efforts to educate individuals with hypertension and diabetes regarding healthy lifestyle are falling short, or that public health messages are not reaching some segments of the population.

The potential public health benefit from adopting a healthier lifestyle in middle age is substantial. The current study demonstrated that adopting 4 modest healthy habits considerably lowers the risk of cardiovascular disease and mortality in relatively short-term 4-year follow up period. The findings emphasize that making the necessary changes to adhere to a healthy lifestyle is extremely worthwhile, and that middle-age is not too late to act.

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