Original Contribution

Cardiovascular Disease Risk Factor Knowledge in Young Adults and 10-year Change in Risk Factors

The Coronary Artery Risk Development in Young Adults (CARDIA) Study

Elizabeth B. Lynch1, Kiang Liu1, Catarina I. Kiefe2, and Philip Greenland1

1 Department of Preventive Medicine, Feinberg School of Medicine, Northwestern University, Chicago, IL.
2 Division of Preventive Medicine, University of Alabama, Birmingham, AL.

Received for publication September 15, 2005; accepted for publication May 3, 2006.

This study's objective was assessment of cardiovascular disease (CVD) risk factor knowledge in young adults, its association with 10-year changes in risk factor levels, and variables related to risk factor knowledge. A total of 4,193 healthy persons (55% female, 48% Black; mean age \(\bar{x} = 30\) years) from four urban US communities were queried about risk factor knowledge in 1990–1991 and were reexamined in 2000–2001. Of six risk factors considered (hypertension, hyperlipidemia, smoking, overweight, sedentary lifestyle, and unhealthy diet), participants mentioned a mean of two; more than 65% were not aware of any risk factors, and less than 35% recognized being overweight as a risk factor. After adjustment, variables associated with mentioning more than two CVD risk factors versus one or fewer were Black race (OR = 0.52, 95% confidence interval (CI): 0.44, 0.61), having a high school education or less (OR = 0.88, 95% CI: 0.80, 0.95), having one or two (vs. zero) risk factors (OR = 1.27, 95% CI: 1.05, 1.53), and having three or more (vs. zero) risk factors (OR = 1.79, 95% CI: 1.35, 2.38). More knowledge was marginally associated with less increase in body mass index 10 years later \((p = 0.06)\) but was unrelated to other risk factor changes. Knowledge of CVD risk factors was very low in these young adults but increased with the presence of risk factors. Knowledge alone did not predict 10-year changes in risk factors.

cardiovascular diseases; health knowledge, attitudes, practice; risk factors

Abbreviations: CARDIA, Coronary Artery Risk Development in Young Adults; CI, confidence interval; CVD, cardiovascular disease; NHANES, National Health and Nutrition Examination Survey; OR, odds ratio.

It has been well-established that the presence of cardiovascular disease (CVD) risk factors in young adulthood is associated with increased mortality risk (1–4). In the past 40 years, the prevalences of hypertension, hypercholesterolemia, and cigarette smoking have decreased in the US population as a whole. Recently, however, the prevalence of several CVD risk factors has increased among subsets of young adults. From 1988–1991 to 1999–2000, the prevalence of hypertension in the National Health and Nutrition Examination Survey (NHANES) increased from 5.1 percent to 7.2 percent among adults aged 18–39 years (5), and total cholesterol levels increased 0.09 mmol/liter in men aged 29–34 years (6). From 1990 to 2000, smoking prevalence increased slightly among adults aged 18–24 years (from 24.5 percent to 26.8 percent) (7). Finally, the prevalence of obesity among adults aged 20–39 years increased significantly from NHANES 1988–1991 to NHANES 1999–2000 in both men (from 14.9 percent to 23.7 percent) and women (from 20.6 percent to 28.4 percent) (8).

Risk of CVD can be decreased by adherence to dietary and lifestyle recommendations, which results in lower risk factor levels (9). Thus, young adults must change their...
behavior in order to reverse the trend of increasing risk factor levels. Health behavior models propose that knowledge of the negative health consequences of a behavior is a necessary condition for behavior change, because without knowledge there is no motivation to change (10–23). Because other factors may prevent translation of knowledge into motivation and action, risk factor knowledge is not sufficient to promote behavior change (24–28). If knowledge of risk is necessary for motivation and action, greater risk factor knowledge should be associated with healthier risk factor development over time.

We examined the level and determinants of knowledge of CVD risk factors and the relation between knowledge and 10-year changes in CVD risk burden in a large population sample of young adult Whites and Blacks with a wide range of educational backgrounds. To date, only one observational study has examined the relation between individual knowledge and CVD risk factor development (29), and those investigators found no relation. However, that study was limited in two ways: 1) the follow-up period was only 12 weeks long and 2) the sample consisted of mostly White, relatively high socioeconomic status young adults. Thus, the results of the current study have potential public health importance. If lack of knowledge is related to long-term development of CVD risk factors, increasing knowledge may help decrease the pace of risk factor development.

MATERIALS AND METHODS

Study population

The Coronary Artery Risk Development in Young Adults (CARDIA) Study is a multicenter, longitudinal study of the evolution of CVD risk factors in Black and White adults aged 18–30 years. CARDIA participants were recruited in 1985–1986 from four US cities: Birmingham, Alabama; Chicago, Illinois; Minneapolis, Minnesota; and Oakland, California (30). The CARDIA sample of 5,115 participants at baseline was designed to include approximately equal numbers of participants by race (Black/White), sex, age (18–24 years/25–30 years), and education (high school or less/more than high school). In the current study, we used data from two follow-up examinations: the year 5 examination (1990–1991), the year the participants’ knowledge of CVD risk factors was assessed, and the year 15 examination (2000–2001), for calculation of 10-year changes in risk factors.

Exclusions

Of the 4,352 participants seen at the year 5 examination, those with missing data on the knowledge question, systolic blood pressure, total cholesterol, body mass index, smoking, or education (n = 159) were excluded from the cross-sectional analysis; this resulted in a sample size of 4,193. Of those 4,193 persons, 3,351 participants were also examined at year 15. After exclusions for missing data at year 15 (n = 80), the longitudinal sample consisted of 3,271 participants.

Knowledge assessment

At the year 5 examination (1990–1991), participants were asked, “What do you think are the most important causes of heart attack and stroke?” The interviewer was instructed to probe for up to five responses by saying, “Can you think of anything else?” The interviewer marked the category corresponding to the participant’s response from a list of possible responses, including: eating too much/too many calories/general dietary response, smoking, overweight, cholesterol in the blood, cholesterol in the diet, lack of exercise, stress, heredity, high blood pressure, eating too much meat, eating too much fat, eating too much sugar, not eating enough vegetables/fiber, being too thin, exercising too much, lack of knowledge of the causes of CVD, and not seeing a doctor. If the participant mentioned a cause that was not included on the list, this was coded as “other”; those responses were not analyzed in the current study. Risk factor knowledge scores were calculated for each participant based on the number of established modifiable CVD risk factors and lifestyle factors mentioned. Participants received one point for mentioning each of the following five established CVD risk factors: high blood pressure, blood cholesterol, smoking, overweight, and lack of exercise; and one point for mentioning at least one of the following specific dietary causes: eating too much fat/cholesterol, salt, or meat and not eating enough vegetables/fiber (31). Because participants could provide up to five responses, knowledge scores ranged from 0 to 5.

Risk factor measurements

Participants were asked to fast for 12 hours prior to each examination and to avoid smoking or physical activity for at least 2 hours prior to the examination. Lipid levels were measured by the CARDIA central laboratory according to CARDIA procedures (30). Cigarette smoking status, age, race, education, diabetes history, and medication use were based upon participant self-report. Blood pressure was measured three times using a random-zero device, and the average of the last two measurements was used. Height and weight were measured while participants stood wearing light clothing and no shoes. Body mass index was calculated as the ratio of weight (kg) to standing height (m) squared (kg/m²). Physical activity at years 5 and 15 was included as a behavioral risk factor. Physical activity was assessed using the CARDIA physical activity history questionnaire and was coded as “exercise units” (32).

Participants were assigned a risk score, ranging from 0 to 5, reflecting their CVD risk factor burden at year 5. Participants were assigned one point for each of the following risk factors: diabetes, body mass index ≥25 (33), current cigarette smoking, systolic blood pressure ≥120 mm/Hg or diastolic blood pressure ≥80 mm/Hg or use of antihypertensive medication, and serum cholesterol level ≥200 mg/dl or use of cholesterol-lowering medication. Because the participants were young adults, they were considered to have a given risk factor if the status of that factor was nonoptimal.

Ten-year change in CVD risk factor status was defined as the difference between year 5 and year 15 levels of the
following risk factors: body mass index, low density lipoprotein cholesterol, high density lipoprotein cholesterol, total cholesterol, systolic blood pressure, diastolic blood pressure, cigarette smoking, and physical activity. For cholesterol, blood pressure, and body mass index, change was calculated by subtracting the year 5 level from the year 15 level. Prevalences of smoking cessation were calculated among persons who were current smokers at year 5. A participant was defined as quitting smoking if he/she was a current smoker at the year 5 examination and a former smoker at the year 15 examination.

Statistical analysis

We present year 5 risk factor levels across sex/race groups, stratified by education (≤12 years vs. >12 years). T tests and chi-squared analyses were used to measure differences in race, stratified by sex and education.

We calculated the proportion of each sex/race/education group mentioning each recorded cause. Chi-squared tests were used to measure racial differences in the likelihood of mentioning each cause, stratified by sex and education. The following causes were mentioned by less than 5 percent of participants and were not analyzed further: being too thin, exercising too much, lack of knowledge of the causes of CVD, and not seeing a doctor. We also calculated the percentage of persons in each sex/education/race group mentioning each number of CVD risk factors, in order to collapse the knowledge score variable into levels with roughly equal numbers of participants. In addition, we calculated the mean knowledge scores for the sex/race/education subgroups.

We assessed cross-sectional relations between demographic and physiologic variables and risk factor knowledge. To assess the predictors of knowledge scores, participants were divided into three approximately equal-sized groups: The lowest knowledge group had a knowledge score of 0 or 1, the medium knowledge group had a knowledge score of 2, and the highest knowledge group had a knowledge score of 3 or higher. We used polychotomous logistic regression to determine predictors of being in the medium and highest knowledge groups relative to the lowest knowledge group, which served as the reference group. The model included demographic variables and participant risk scores. Participants with medium risk (one or two risk factors) and high risk (three or more risk factors) were compared with participants with low risk (zero risk factors), who served as the reference group.

We also used logistic regression models to test the relation between having a risk factor and mentioning that risk factor. Separate logistic regression models were used to test the relation between elevated total cholesterol level and mentioning cholesterol as a risk factor, body mass index ≥25 and mentioning overweight, current cigarette smoking and mentioning smoking, elevated blood pressure and mentioning high blood pressure, and low physical activity and mentioning lack of exercise. For this analysis, participants in the lowest quartile of the physical activity score were coded as having low physical activity. Covariates in these models included sex, race, education (coded as ≤12 years vs. >12 years), age, and risk factors (coded as dummy variables). Risk factors included nonoptimal cholesterol level, nonoptimal blood pressure level, being overweight, current cigarette smoking, and low physical activity.

Longitudinal relations between risk factor knowledge and risk factor changes were assessed in two ways, corresponding to two different measures of knowledge. First, general linear regression was used to test for a trend in which greater levels of overall CVD risk factor knowledge were associated with risk factor changes between years 5 and 15. For this analysis, the knowledge score (the number of CVD risk factors mentioned by the participant) was the independent variable and the dependent variable was the difference in risk factor levels between years 5 and 15. Covariates included in these analyses were age at the year 15 examination, race, sex, education at the year 15 examination, and year 5 level of the dependent-variable risk factor. Separate analyses were performed for each risk factor. The second set of analyses used a measure of specific knowledge, which was a dichotomous variable representing whether the person mentioned the specific CVD risk factor related to the dependent variable (whether mention of smoking as a CVD risk factor was related to quitting smoking, whether mention of overweight as a CVD risk factor was related to change in body mass index, etc.). Multivariate regression analyses, adjusting for education, sex, race, and baseline (year 5) level of the dependent variable, were used to examine the relation between specific knowledge and changes in risk factors.

RESULTS

In 1990–1991 (year 5), across sex and education level, Blacks were younger than Whites and were more likely to have nonoptimal blood pressure levels. Among women at both education levels, the prevalence of overweight was higher among Blacks than among Whites, and levels of physical activity were lower. Among less educated men, Whites had a higher prevalence of nonoptimal total cholesterol levels than Blacks. Among men in the high education group, Blacks had a higher prevalence of overweight and smoking than Whites (table 1).

Table 2 shows the proportion of participants mentioning each cause, by sex, race, and years of education. Across education levels, Whites mentioned all causes more frequently than Blacks, except for high blood pressure and specific dietary causes (especially eating too much salt). Mean knowledge scores were low overall. Mean knowledge scores among Black men were 1.72 and 1.83 for those with ≤12 years of education and >12 years of education, respectively. For Black women, the corresponding means were 1.61 and 1.79; for White men, they were 1.87 and 2.03; and for White women, they were 2.07 and 2.09.

After multivariable adjustment, Black participants were somewhat less likely than White participants to have medium and high knowledge scores (table 3). Participants with 12 or fewer years of education were less likely to be in the highest knowledge group, compared with those with more than 12 years of education. Number of risk factors showed a dose-response relation to knowledge. Participants with one or two risk factors were more likely than those with no risk...
factors to be in the high knowledge group. Participants with three or more risk factors were more likely than those with no risk factors to be in both the medium and highest knowledge groups.

In general, persons with a particular risk factor were more likely to mention that risk factor. Current smokers were more likely than nonsmokers to mention smoking as a risk factor (odds ratio (OR) \(= 2.1\), 95 percent confidence interval (CI): 1.83, 2.44), overweight persons were more likely than the nonoverweight to mention overweight (OR \(= 1.6\), 95 percent CI: 1.4, 1.9), persons with elevated cholesterol levels were more likely than those with normal cholesterol to mention blood cholesterol (OR \(= 1.2\), 95 percent CI: 1.0, 1.5), and persons with elevated blood pressure were more likely than those with normal blood pressure to mention high blood pressure (OR \(= 1.2\), 95 percent CI: 0.98, 1.41). The pattern whereby higher risk was associated with greater knowledge was reversed in the case of exercise—persons with low physical activity (in the first quartile across participants) were less likely than those with higher physical activity scores to mention lack of exercise (OR \(= 0.85\), 95 percent CI: 0.73, 0.99).

Table 4 shows the results of general linear regression analyses assessing the average change in risk factor levels from year 5 to year 15 associated with different levels of overall CVD risk factor knowledge. A marginally significant trend \((p = 0.06)\) suggested that persons with greater knowledge of CVD risk factors showed less increase in body mass index over time than persons without such knowledge. Except for low density lipoprotein and high density lipoprotein cholesterol levels and physical activity, the lowest knowledge group showed the most deleterious risk factor changes. However, only changes in body mass index were associated with year 5 CVD risk factor knowledge level.

In separate analyses, we failed to find a significant association between mentioning a particular risk factor and changes in that particular risk factor. For all factors but total and low density lipoprotein cholesterol and diastolic blood pressure, persons who mentioned a risk factor showed 10-year changes that were slightly but nonsignificantly more favorable than those who did not mention the risk factor. Persons who mentioned blood cholesterol showed slightly greater 10-year increases in both total and low density lipoprotein cholesterol than those who did not mention blood cholesterol \((p = 0.17\) and \(p = 0.20\), respectively).

**DISCUSSION**

This study was, to our knowledge, the first to evaluate the relation between knowledge of CVD risk factors and CVD risk factor development in a biracial cohort of young adults.
with varying levels of education. The findings indicated that knowledge of established modifiable CVD risk factors was very low. On average, participants mentioned approximately two of six risk factors, regardless of race, sex, or level of education. Smoking, hypertension, overweight, and lack of exercise were each recognized as a risk factor by only 20–60 percent of these young adults, and hyperlipidemia was recognized by fewer than 17 percent. Interestingly, persons who had a risk factor were more likely to mention that risk factor than were those who did not have the risk factor. After adjustment for initial risk factor levels, knowledge of risk factors had no relation to 10-year changes in risk factor levels. The one exception was a marginally significant trend ($p = 0.06$) in which higher knowledge was associated with less body mass index increase over time.

Black participants were less likely than White participants to have high levels of CVD risk factor knowledge, independent of education level. This racial difference is consistent with previous studies (34–38). Also consistent with previous studies is the current finding that more educated participants have higher risk factor knowledge than less educated participants (39–43). While race and education were significant predictors of knowledge in our study, they are of minor consequence given that the levels of knowledge across all groups were similarly low. Our study replicated prior work showing that lower education and Black race are associated with a higher CVD risk burden (44–47). However, we found no evidence that CVD risk factor knowledge mediates the relation between race and education and CVD risk burden.

A number of cross-sectional studies have found that higher CVD risk factor levels are associated with greater knowledge of CVD risk factors (29, 48–50). This cross-sectional association suggests that an important source of

### TABLE 2. Percentages of participants reporting potential causes of cardiovascular disease and associated risk factor knowledge scores, by sex, education, and race group, Coronary Artery Risk Development in Young Adults (CARDIA) Study, 1990–1991

<table>
<thead>
<tr>
<th>Cause named</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤12 years of education &gt;12 years of education</td>
<td>≤12 years of education &gt;12 years of education</td>
</tr>
<tr>
<td></td>
<td>Blacks  Whites  Blacks  Whites  Blacks  Whites  Blacks  Whites  Blacks  Whites</td>
<td></td>
</tr>
<tr>
<td>Stress</td>
<td>53.6 43.5* 57.1 54.3 44.0 53.0* 50.2 58.5**</td>
<td>23.0 28.7 24.6 28.6 25.1 24.6 24 27.3</td>
</tr>
<tr>
<td>Heredity</td>
<td>7.1 24.1*** 15.8 43.8*** 5.1 17.7*** 16.7 41.1****</td>
<td>22.3 35.0** 29.0 29.3 19.7 19.8 23.3 26.1</td>
</tr>
<tr>
<td>Eating too much, bad diet</td>
<td>38.2 50.1** 51.1 57.4* 35.0 48.7** 45.0 55.1****</td>
<td>7.1 3.4 4.7 4.4 8.0 2.6** 5.2 2.6*</td>
</tr>
<tr>
<td>Cholesterol in blood</td>
<td>11.6 15.6 12.0 16.4* 14.4 15.1 10.7 15.1*</td>
<td>16.7 41.1****</td>
</tr>
<tr>
<td>High blood pressure</td>
<td>25.9 19.0* 25.9 22.3 29.0 20.3* 26.1 16.6***</td>
<td>2.1 1.3 2.0 2.1 1.0 1.3 2.8 1.8</td>
</tr>
<tr>
<td>Smoking</td>
<td>43.4 59.5*** 39.4 49.3*** 45.0 57.3** 44.6 54.5**</td>
<td>31.1 30.4 29.5 31.3 32.6 26.7 24 27.3</td>
</tr>
<tr>
<td>Being overweight</td>
<td>22.3 35.0** 29.0 29.3 19.7 19.8 23.3 26.1</td>
<td></td>
</tr>
<tr>
<td>Lack of exercise</td>
<td>26.8 47.7*** 42.8 60.1*** 31.4 47.8*** 47.2 61.5***</td>
<td>31.1 30.4 29.5 31.3 32.6 26.7 24 27.3</td>
</tr>
<tr>
<td>At least one specific dietary cause</td>
<td>31.1 30.4 29.5 31.3 32.6 26.7 24 27.3</td>
<td></td>
</tr>
<tr>
<td>Eating too much fat/cholesterol</td>
<td>23.0 28.7 24.6 28.6 25.1 24.6 24 27.3</td>
<td></td>
</tr>
<tr>
<td>Eating too much meat</td>
<td>4.6 4.2 2.8 2.5 3.9 1.7 3.3 2.9</td>
<td></td>
</tr>
<tr>
<td>Eating too much salt</td>
<td>7.1 3.4 4.7 4.4 8.0 2.6** 5.2 2.6*</td>
<td></td>
</tr>
<tr>
<td>Not eating enough vegetables/fiber</td>
<td>2.1 1.3 2.0 2.1 1.0 1.3 2.8 1.8</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>33.6 28.7 31.6 26.5* 44.8 34.5* 35.4 29.4*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Knowledge score†</th>
<th>0 1 2 3 4 5 6 7 8 9 10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>0</td>
<td>15 37.2 32.5 32.5 16.4 2.7 0.7</td>
</tr>
<tr>
<td>1</td>
<td>9.3 21.1 35.4 22.8 10.1 1.3 1.3</td>
</tr>
<tr>
<td>2</td>
<td>12 7.1 30.7 35.7 24.0 6.9 1.2</td>
</tr>
<tr>
<td>3</td>
<td>7.1 2.8 23.0 4.4 18.4 6.6 0.7</td>
</tr>
<tr>
<td>4</td>
<td>2.7 0.7 32.2 5.7 17.8 6.6 0.7</td>
</tr>
<tr>
<td>5</td>
<td>0.7 0.7 35.4 7.1 35.7 6.6 0.7</td>
</tr>
</tbody>
</table>

* $p < 0.05$; **$p < 0.01$; ***$p < 0.001$ (two-sided $p$ value for the difference between racial groups within each sex/education group).
† Calculated for each participant based on the number of established modifiable cardiovascular disease risk factors and lifestyle factors mentioned. Participants received one point for mentioning each of the five established risk factors (high blood pressure, blood cholesterol, smoking, overweight, and lack of exercise) and one point for mentioning at least one dietary cause (eating too much fat/cholesterol, salt, or meat and not eating enough vegetables/fiber). Because participants could provide up to five responses, scores ranged from 0 to 5.

Am J Epidemiol 2006;164:1171–1179
risk factor knowledge is having a high level of a risk factor, perhaps because people are informed about the risk by their physicians. However, in our cohort, after adjustment for baseline risk factor levels, persons who had some knowledge of CVD risk factors showed the same pattern of risk factor development as those who were less knowledgeable.

There are a number of possible reasons why we may have failed to find a relation between CVD risk factor knowledge and changes in risk factor levels. The measure of knowledge used in our study may have been insufficient to capture the type of knowledge likely to influence CVD risk factor levels (51). The open-ended format used to assess knowledge in the current study is a more sensitive measure than the forced-choice methods (e.g., “Does high blood pressure lead to CVD?” [yes/no]) frequently used to assess knowledge (36–38). With the forced-choice method, a person with no knowledge still has a 50 percent chance of getting the correct answer. A benefit of open-ended measures of knowledge over forced-choice methods is that they capture knowledge that is salient and therefore more likely to influence behavior. However, there are other dimensions of knowledge not captured by our measure that are likely to be important to health behaviors. For example, our measure was not sufficient to capture information on the depth of risk factor knowledge. Information embedded within a coherent cognitive framework may be easier to use and therefore may have a greater influence on behavior (52, 53).

A related dimension of knowledge that is likely to be important to CVD risk factor development is the structure of knowledge—that is, how people understand the relations between different CVD risk factors (54). An individual may have knowledge of some CVD risk factors but may believe that other factors are more important to his or her own health. For example, stress was the most frequently mentioned cause of CVD across groups. A number of other studies have also found stress to be one of the most commonly cited

### TABLE 3. Odds ratios* for predictors of level of cardiovascular disease knowledge, Coronary Artery Risk Development in Young Adults (CARDIA) Study, 1995–1996

<table>
<thead>
<tr>
<th>Level of knowledge (no. of risk factors named)</th>
<th>OR†</th>
<th>95% CI</th>
<th>OR†</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium (2) vs. lowest (0 or 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demographic factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (per year)</td>
<td>1.00</td>
<td>0.98, 1.02</td>
<td>1.00</td>
<td>0.97, 1.02</td>
</tr>
<tr>
<td>Male sex</td>
<td>0.96</td>
<td>0.83, 1.11</td>
<td>0.93</td>
<td>0.80, 1.08</td>
</tr>
<tr>
<td>Black race</td>
<td>0.69</td>
<td>0.59, 0.80</td>
<td>0.52</td>
<td>0.44, 0.61</td>
</tr>
<tr>
<td>≤12 years of education</td>
<td>0.93</td>
<td>0.86, 1.01</td>
<td>0.88</td>
<td>0.80, 0.95</td>
</tr>
<tr>
<td>Cardiovascular disease risk status‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low (0 risk factors)</td>
<td>1.00§</td>
<td></td>
<td>1.00§</td>
<td></td>
</tr>
<tr>
<td>Medium (1 or 2 risk factors)</td>
<td>1.09</td>
<td>0.91, 1.30</td>
<td>1.27</td>
<td>1.05, 1.53</td>
</tr>
<tr>
<td>High (≥3 risk factors)</td>
<td>1.33</td>
<td>1.01, 1.74</td>
<td>1.79</td>
<td>1.35, 2.38</td>
</tr>
</tbody>
</table>

* Single multivariable polytomous logistic regression model.
† OR, odds ratio; CI, confidence interval.
‡ The risk factors specified were body mass index (weight (kg)/height (m)²) ≥25, self-reported diabetes, current cigarette smoking, systolic blood pressure ≥120 mmHg or diastolic blood pressure ≥80 mmHg or use of antihypertensive medication, and total cholesterol level ≥200 mg/dl or use of cholesterol-lowering medication.
§ Reference category.

### TABLE 4. Mean values for 10-year changes in cardiovascular disease risk factors according to level of risk factor knowledge,* Coronary Artery Risk Development in Young Adults (CARDIA) Study, 1990–2001

<table>
<thead>
<tr>
<th>10-year change in risk factor level or in no. of risk factors (year 15 – year 5)</th>
<th>Level of knowledge (no. of risk factors named)</th>
<th>( p ) for trend†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lowest (0 or 1)</td>
<td>Medium (2)</td>
</tr>
<tr>
<td>Total cholesterol (mg/dl)</td>
<td>6.94</td>
<td>6.26</td>
</tr>
<tr>
<td>Low density lipoprotein cholesterol (mg/dl)</td>
<td>4.58</td>
<td>5.35</td>
</tr>
<tr>
<td>High density lipoprotein cholesterol (mg/dl)</td>
<td>–2.71</td>
<td>–2.95</td>
</tr>
<tr>
<td>Body mass index† (kg/m²)</td>
<td>2.8</td>
<td>2.7</td>
</tr>
<tr>
<td>Quitting smoking (%)§</td>
<td>22</td>
<td>26</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>6.0</td>
<td>5.35</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>5.6</td>
<td>5.2</td>
</tr>
<tr>
<td>Activity level (exercise units)§</td>
<td>–26.9</td>
<td>–35.3</td>
</tr>
<tr>
<td>Total no. of risk factors</td>
<td>0.43</td>
<td>0.40</td>
</tr>
</tbody>
</table>

* \( p \) values were derived from a separate multivariable regression model for each row, including continuous (0–5) knowledge score and adjusting for sex, race, education, age, and year 5 risk factor level.
† Adjusted mean values were derived from separate linear regression models using the three-level knowledge score.
§ Weight (kg)/height (m)².
§ Logistic regression model including year 5 smokers only.
¶ Coded using the CARDIA physical activity questionnaire (32).
causes of CVD (34, 39, 48, 49, 55), and literature in medical anthropology suggests that patients explain illness using psychosocial rather than biomedical causes (56, 57). Lay belief in a “stress model” of CVD may dampen the impact of public health efforts to change health behavior. If an individual believes that stress is the main cause of ill health, he or she may discount the importance of behavioral changes (e.g., diet and exercise) that may be more directly actionable or effective in reducing the risk of CVD and other diseases. CVD risk factor knowledge exists within a system of beliefs, not in isolation (51).

Future research is necessary to determine whether different dimensions of knowledge are differentially related to health behaviors. Measures of knowledge vary widely across studies examining the relation between knowledge and lifestyle change. First, a broad range of assessment methods are used across studies (e.g. open-ended questions vs. yes/no questions vs. true/false questions). Second, different investigators have different criteria for what constitutes “knowledge” (e.g., “eating fat” vs. consuming the types of fat that are bad/good). It is likely that mixed results in the literature are due to this lack of systematicity in knowledge measures across studies.

Limitations

One limitation of the current study is that knowledge was only assessed at baseline (the year 5 examination); therefore, we were not able to measure the association between change in knowledge and change in risk factors. Another potential limitation is that baseline risk factors were measured only once and therefore were subject to measurement error; bias may have been present in our models measuring the relation between knowledge and change in risk factor levels, because we adjusted for baseline risk factor levels. However, none of the findings changed in models in which results were not adjusted for baseline risk factor levels, so we conclude that our findings are not due to spurious correlations between baseline risk factor levels and changes in risk factors.

Conclusion

In sum, the findings of this study suggest that knowledge of CVD risk factors is extremely low among young adults. Further, in this group of young adults, this knowledge does not appear to influence changes in risk factor levels. An important question is whether the current findings would generalize to persons with higher levels of CVD risk factor knowledge. That is, perhaps there is a threshold level of CVD knowledge which must be attained in order for knowledge to influence behavior and risk factor levels. On the other hand, it may be social norms and/or environmental changes created by policy decisions, rather than the beliefs of individuals, that have more influence on the behavior and risk factor levels of populations. Supporters of this theory might quote Geoffrey Rose: “It makes little sense to expect individuals to behave differently from their peers; it is more appropriate to seek a general change in behavioral norms and in the circumstances which facilitate their adoption” (58, p. 102).

ACKNOWLEDGMENTS

This work was supported by the following grants and contracts from the National Heart, Lung, and Blood Institute: T32 HL069771, N01-HC-48047, N01-HC-48048, N01-HC-48049, N01-HC-48050, and N01-HC-95095.

The authors thank Dr. Jeremiah Stamler for extensive comments on a previous draft of this paper. Conflict of interest: none declared.

REFERENCES

7. Tobacco Information and Prevention Source (TIPS), National Center for Chronic Disease Prevention and Health Promotion. Percentage of adults who were current, former, or never smokers, overall and by sex, Hispanic origin, age, and education. National Health Interview Surveys, selected years—United States, 1965–2000. Atlanta, GA: National Center for Chronic Disease Prevention and Health Promotion, 2005. (http://www.cdc.gov/tobacco/research_data/adults_prev/adstat1.htm).

Am J Epidemiol 2006;164:1171–1179
51. Whitehead D, Russell G. How effective are health education programmes—resistance, reactance, rationality and risk?